SHIPBUILDING CYCLOPEDIA

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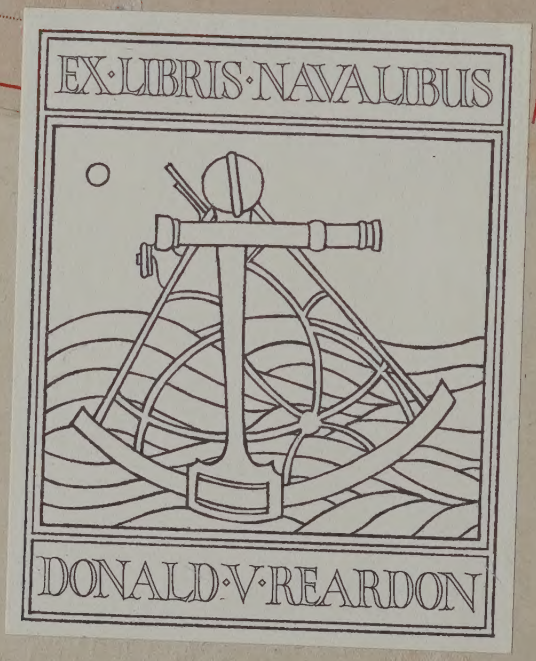

SHIPBUILDING CYCLOPEDIA

A REFERENCE BOOK

COVERING

DEFINITIONS OF SHIPBUILDING TERMS, BASIC DESIGN, HULL SPECIFICATIONS, PLANNING AND ESTIMATING, SHIP'S RIGGING AND CARGO HANDLING GEAR, TABLES OF DISPLACEMENT OF COMMODITIES, ARRANGEMENT AND WORKING DRAWINGS OF MODERN VESSELS

AND A

COMPOSITE CATALOG OF MARINE EQUIPMENT

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Foreword

As the title indicates, this volume is designed to present the basic reference requirements of the shipbuilding industry. It has been published because a comprehensive collection of design data, arrangement and working drawing and catalogs is not only difficult and exceedingly expensive to accumulate, but when obtained demands much time and attention if the data is to be systematically arranged and maintained in such a way that it can be referred to easily and quickly.

Much of the design data included in this treatise have never before been published in such a simple form—in a form that can be quickly and readily used in the practical designing of ships. As an illustration, the longitudinal coefficient, curve of sectional area, load waterline, stability and horsepower for a merchant vessel can now be readily approximated by reference to the charts covering these features. It is important to note in this connection that this method of design has been successfully used for the last ten years by the Bureau of Construction and Repair, Navy Department.

Another valuable and unique feature of the Cyclopedia is the fact that it includes the only published collection of arrangement and working drawings of American ships, fully dimensioned and accompanied by bills of material. These drawings are excellent types of the latest designs and many are susceptible of more or less standardization—a matter of vital importance to economical construction.

The Catalog Section also contains a large amount of valuable information regarding ship and shipyard equipment, every effort having been made to keep this section as definitely informative as possible.

The editors take this opportunity to express their most hearty appreciation for the advice and suggestions which have been made by Mr. S. B. Crosby, naval architect, Newburgh Shipyards; Mr. A. B. Raymond, naval architect, New York City; and Mr. E. L. Stewart, naval architect, San Francisco, Cal.

New York, April 6, 1920.

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Note.—Complete index is given with definitions, page 1 to 150.

A Dictionary of

Ship and Shipbuilding Terms

Aback. The condition of a sailing ship when the pressure of the wind on the sails has a tendency to drive it astern.

Abaft. Towards the stern; aft, relative to.

Abandon. To leave, to forsake. Usually descriptive of the act of leaving a ship when it is no longer safe or seaworthy.

Abeam. At right angles to the vessel's longitudinal axis and in her plane of flotation.

Aboard. On or in a ship.

About. A ship is said to come about when in beating to windward it changes its course allowing the wind to bear on the opposite side of the sails. To change from the starboard to the port tack or the reverse.

Aboveboard. Above deck as distinguished from in the hold or below decks.

Abreast. Over against; opposite. See also ABEAM.

Access Hole. A hole cut through a portion of a vessel's structure in order to permit ingress to or egress from a given space or compartment.

Accommodation Ladder. See LADDER, ACCOMMODATION.

Accountants. Those who keep records or accounts; bookkeepers.

Page 1107.

Accumulator, Hydraulic. A tank designed to store water under pressure.

Accumulator, Pneumatic. A tank designed to store air under pressure.

Acetylene. A gas produced by the action of water upon calcium chloride. This gas combined with oxygen burns with a very hot flame.

Acetylene Gas Compressor. See COMPRESSOR, ACETYLENE GAS.

Acid Open Hearth Steel. See STEEL AND IRON.

Acidity, Boiler. A term used when the feed water in a boiler is acid.

Admiralty Coefficient. See COEFFICIENT, ADMIRALTY.

Admiralty Metal. Described under Metals.

Admiralty Pump. See PUMP, ADMIRALTY.

Adrift. Afloat without effective means of propulsion or control.

Adze. A carpenter's tool having its blade set at right angles with a long curved handle and used for trimming ship timbers. The act of trimming the timbers with this tool is called "dubbing."

Aft. In the direction of or toward the stern.

After Collision Bulkhead. See BULKHEAD, AFTER PEAK.

After Deck. See DECK, AFTER.

After Peak. A compartment immediately forward of the stern post. Generally situated entirely below the load waterline.

After Peak Bulkhead. See BULKHEAD, AFTER PEAK.

After Perpendicular. A line perpendicular to the base line, intersecting the after edge of the stern post at the designed waterline.

American naval practice locates the after perpendicular at the point of intersection of the designer's waterline and the stern contour.

Aground. The situation of a ship in which its bottom touches or rests on the ground; stranded.

Ahead. Forward; in front of.

Air-break Switch. See SWITCH, AIR-BREAK.

Air Casing, Stack. A ring-shaped plate coaming surrounding the stack and fitted at the upper deck, just below the umbrella. Its purpose is to protect the deck structure from heat and to help ventilate the fire room

Air Compressor. An auxiliary designed to furnish air under pressure for pneumatic tools, cleaning purposes, etc.

A form of compressor in common use is the single stage type. This type has two cast iron cylinders, one steam, the other air, each double acting. The steam cylinder is located vertically over the air cylinder, both pistons being on the same rod. Thus, air is compressed and delivered on both the upward and downward stroke of the piston.

Pages 442, 443, 779, 783, 786, 787.

Air Courses. A wood ship term applied to air spaces running fore and aft in the sides or bottom of a vessel to provide for a circulation of air to prevent decay in the timbers.

Air Ejector. A steam ejector connected to the condenser dry suction for the purpose of discharging the air and vapor into the atmosphere. A condensate pump handles the condensed steam.

Pages 934, 1024, 1042.

Air Hammer. An air-driven tool arranged to deliver rapid longitudinal impulses against one end of a steel pin. It is contained in a cylindrical shaped casing about three inches in diameter and two feet long with a pistol grip at the opposite end from the pin. Various shaped tools can be fitted on the outer end of the pin to perform such operations as heading up rivets or calking and chipping.

Pages 780, 784, 788, 790.

Air Holding on Hammer. A tool to hold against the head of a rivet while it is being driven. Its head is fitted on a piston which is cushioned in a cylinder filled with compressed air.

Pages 781, 782, 784, 788.

Air Pipes. Pipes leading from tanks to the open air as vents or to provide a supply or escape of air when pumping out or filling the tanks.

Air Port. See PORT, AIR.

Air Propellers or Beeswing Fans. A fan usually consisting of from two to four blades operated by an electric motor, the blades being so shaped that the air leaves the fan at right angles to its plane of rotation.

Air Pump. See PUMP, AIR.

Air Pump, Dry Vacuum. See PUMP, AIR, DRY VACUUM.

Air Pump, Dual. See PUMP, AIR, DUAL.

Air Resistance. See RESISTANCE, AIR.

Air Tight Door. See DOOR, AIR TIGHT.

Air Trunk or Conduit. The passage forming the main air supply to a fan or exhaust from a fan.

Air Valve. See VALVE, AIR.

Air and Circulating Pump. See PUMP, AIR AND CIRCULATING.

Alarm Valve. See VALVE, ALARM.

A-lee. Away from the wind. A sailing ship which constantly requires the helm to be moved to the side of the vessel away from the direction from which the wind is coming in order to keep his course is said to carry a-lee helm.

Alkalinity, Boiler. A term used when the feed water in a boiler is alkaline and has the power of neutralizing acids.

All Hands. Every person on board a ship.

Alligator Shear. See SHEAR, ALLIGATOR.

Alloy Steels. See STEEL AND IRON.

Aloft. In the tops or upper rigging; on the yards; above the decks.

Alongside. Parallel and in close proximity to. Used frequently relative to a ship lying parallel and close to another ship or a pier.

Alow. Low in or on; below.

Alternating Current. An electric current in which the instantaneous values of current at any point in the circuit vary from zero to a positive maximum value, back to zero; then to a negative maximum value and back to zero. When plotted it consists of half waves of equal area in successive opposite direction from the zero line.

Aluminum Paint. See PAINT.

Amidships. In the vicinity of the middle portion of a vessel as distinguished from her ends. The term is used to convey the idea of general locality but not that of definite extent.

Ammeter. An instrument for measuring the electric current flowing in a circuit. The scale of the meter is calibrated to read in amperes.

Ammonia. A volatile alkali, a transparent, pungent gas that can be easily liquified by pressure. It is used extensively as a refrigerating medium for cold storage systems aboard ship.

Ammonia Joint. On account of the penetrating nature of ammonia, great care should be taken with the joints in a refrigerating system where that alkali is used. The joints should be made of wrought iron or steel, the connections should be soldered after they are screwed in place. Lead gaskets should be placed between flanges and lead or white metal packing used for the valve stems.

Ampere. The practical unit of electric current. It represents that value of current which will cause the electrolytic deposition of silver at the rate of 0.001118 gm. per second.

Analysis of Flue Gas. See BOILER, ANALYSIS OF FLUE GAS.

Anchor. A heavy iron or cast steel implement attached to a vessel by a rope or chain cable. When the anchor is thrown overboard it lays hold of the ground and holds the vessel in its place. The earlier anchors were made of wood, with one arm and later with two. Stones were attached to give weight to sink and to increase holding power.

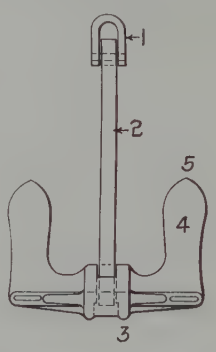
An iron anchor, having a wood stock, followed the wood anchor. This in turn was replaced by an all-metal anchor.

The *solid* or old-fashioned anchor consists of the shank, the ring (shackle or Jew's harp), the arms, and the stock.

The shank is the main body of the anchor, having the ring bolted to one end and the arms welded to the other, the crown being the heavy end of the shank from which the arms branch out. The stock is the beam attached to the shank opposite the arms.

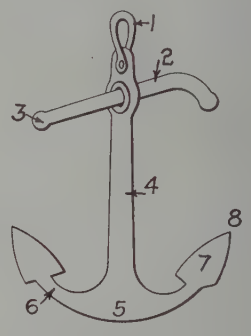
Various patent anchors exist, most of which are stockless and have their arms pivoted upon the shank and the palms in the plane of the arms.

Pages 868, 869, 871, 872, 873, 970.



Stockless Anchor

1 Anchor Shackle.
2 Shank of Anchor
3 Anchor Flukes.
4 Crown of Anchor.
5 Anchor Bills.



Common Anchor

1 Anchor Shackle.
2 Anchor Stock.
3 Nut of Anchor Stock.
4 Shank of Anchor.
5 Crown of Anchor.
6 Arms of Anchor.
7 Anchor Flukes.
8 Anchor Bills.

Anchors, Bowers. The principal anchors carried by a vessel. They are so named because they are carried on the bows. In earlier times they were of different weights, the larger being known as the *best* bower and the smaller as the *small* bower. These anchors are now usually the same size.

Anchors, Chains and Hawsers. For method of selection and tables, see under EQUIPMENT.

Pages 872, 874, 875, 880, 881, 882, 970.

Anchor Deck. See DECK, ANCHOR.

Anchor Handling Gear. The windlass and gear installed aboard ship, for letting go, taking in and handling the anchor.

Page 529.

Anchor, Kedge. A term applied to a light anchor used for warping or kedging.

Anchor Lights. See LIGHTS, ANCHOR.

Anchor, Mooring. A term applied to a second or extra anchor used for holding a ship at her mooring.

Anchor, Mushroom. An especial type of anchor having a bowl-shaped crown into the center of which the shank is welded. The upper end of the shank is fitted for the reception of shackle pin as in anchors of the ordinary type. The mushroom anchor has been much used on submarines. It has great holding power in soft bottoms.

Anchor, Sea. A device constructed of spars and canvas in the form of a parachute, to which is bent a hawser

or cable. It is put overboard in a heavy sea for the purpose of keeping a vessel head-on to the sea and to enable her to ride out a gale.

Also termed a driving anchor or drag.

Anchor, Stream. An anchor used for anchoring in a narrow roadway or channel to prevent the stern swinging with the tide. The weight of this anchor is equal to about one-fourth that of the bower anchor.

Anchorage. A suitable place for a ship to lie at anchor. Harbor dues for anchoring in a port.

Angle. An abbreviation for angle iron or angle bar.

Angle Bar. A rolled shape, generally of mild steel, having a cross section shaped like the legs of a right angle.

In ship work it is used for frames, bulkhead stiffeners, attachment of one plate or shape to another, etc.

The size is denoted by dimensions of cross section and weight per running foot.

Angle Bar Frame. See FRAME, ANGLE BAR.

Angle Bars, Frame. See FRAME ANGLE BARS.

Angle Clip. A term applied to a short piece of angle bar used for attachment.

Angle Iron. See ANGLE BAR.

Angle Valve. See VALVE, ANGLE.

Angle Furnace. See FURNACE, BAR.

Anglesmiths. Workmen who forge steel shapes such as angle or channel bar into the various parts of the ship's hull and fittings such as watertight staples and collars, door frames, etc.

Anneal. To soften metal by heating and slowly cooling. In annealing cast iron the carbon is burned out, near the surface, leaving the outer surface tough and strong while the interior is hard.

Annunciator. An electrical device for giving an audible and visible signal.

Page 1064.

Annunciator Wire. See ELECTRIC WIRE AND CABLE.

Anti-Corrosive Paint. See PAINT.

Anti-Fouling Paint. See PAINT.

Antimony. Described under Metals.

Anvil. An iron or steel block used as a table on which metals are worked or forged. Where an iron block is used the working face is generally made of steel. It is usual to provide a hole about 1¼" square for holding working tools such as hardies, fuller blocks, etc. Anvils are used in a shipyard by blacksmiths, anglesmiths and flange turners.

Apeak. In a vertical direction or nearly so. The anchor is "apeak" when the cable has been hauled into a nearly vertical line and the vessel is then "hove apeak." A yard when raised by one end, until nearly vertical is "apeak."

Aperture. The space provided between the propeller and stern post for the propeller.

Appendages. Such items as shaftings, struts, bossings, docking and bilge keels, propellers, rudder and any other feature, extraneous to the hull and generally immersed.

Apprentice. A learner or student of a trade.

Apron. A reinforcing timber bolted to the after side of the stem.

Page 474, Plate XXV.

Apron Plate. See PLATE, APRON.

Arc, Electric. The luminous vapor of great brilliancy and high temperature between the tips of two electrodes.

Arc, Lamp. See LAMP, ARC.

Arch Piece of Stern Frame. The curved portion of the frame over the screw aperture, joining the propeller and stern posts.

Arching. Occasionally used as descriptive of the same phenomenon as the term "hogging."

Architect, Naval. See NAVAL ARCHITECT.

Ardency. That property of a ship by virtue of which she tends to throw her head up into the wind. Ships having this characteristic must be held on their course by keeping the helm a-weather. The reason for this tendency is found in the resultant lateral resistance of the vessel being before or ahead of her resultant wind pressure.

Area of Sections. The area of any cross section of the immersed part of a vessel, the cross section being taken at right angles to the centerline of the vessel.

Armature. The armature of a generator or motor is that part of the machine containing the winding in which the electromotive force is generated. For direct-current machines, it is usually revolving, while for alternating-current machinery it is usually stationary.

The two essential parts of all generators and motors are the field magnet, which produces the necessary magnetic flux, and the armature on which the conductors are arranged.

Asbestos. Principally a silicate of magnesia combined with water. It is used in varying forms where resistance to combustion is necessary.

A fireproof composition used for insulation, packing, and lagging. See INSULATION.

Ash Chute. A portable iron trough by means of which ashes are discharged overboard clear of the vessel's side.

Ash Ejector. An apparatus for utilizing the discharge water from a pump to convey ashes from the fire-room up and out through the vessel's side above the water-line.

It consists of a metal pipe or chute leading overboard above the water-line. At the lower end in the fire-room a hopper is located, and into this the discharge from the pump is led. With the hopper closed and discharge valve opened the stream from the pump will pass with high velocity. The cover may then be removed and ashes dumped into the hopper from which they will be rapidly conveyed overboard by the water.

Pages 392, 400, 1002, 1003, 1038, Plate XII.

Ash Expeller. An apparatus for the discharge of ashes from the fire-room below the water level. This type is of value in the case of war vessels when it is desirable to make an opening through the side armor.

In this apparatus the ashes are placed in the hopper, from which they pass through a quick-acting valve to an intermediate chamber. An air blast or hydraulic jet expels them from this chamber.

Ash Hoist. Gear for the removal of ashes from the fire-room. It consists of a bucket, usually traveling in guides, a winch for hoisting same to weather deck, and sometimes a trolley track to ship's side.

Pages 678, 681, 787, 851, Plates XIV, XLVII, XLVIII.

Ash Pit, Boiler. See BOILER ASH PIT.

Ashore. Aground (when said of a ship); on shore or land as opposed to aboard or afloat.

Asphalt Solution. See PAINT.

Assemble. To collect and place in the proper positions, the various members or fabricated parts entering into construction.

Astern. Signifying position, in the rear of or abaft the stern; as regards motion, the opposite of going ahead; backwards.

Astracal. A small molding placed on the front of one of a pair of doors near the inside edge to cover the joint where the two doors come together when closed.

Asynchronous Generator. See GENERATOR, ASYNCHRONOUS.

Athwart, Athwartship. In a transverse direction; from side to side at right angles to the fore and aft centerline of a vessel.

Auditors. Individuals who check up accounts and certify as to their accuracy.

Page 1107.

Augmentor, Vacuum. An apparatus consisting of a steam ejector and a small condenser with suitable connections and designed to diminish the condenser pressure and enhance the vacuum. A steam jet is installed in an air suction pipe leading from the top of the main air pump suction or from an independent connection to the condenser. The air and vapor entrained are delivered to a small condenser in which the pressure is higher. Circulating water for the augmentor condenser is taken from a by-pass on the circulating pump discharge to the condenser, or from a connection to the front head of the main condenser. The ejector steam and the vapor drawn from the main condenser are densified in the augmentor and a water seal is interposed between the augmentor suction and the air pump to prevent the air and vapor from escaping back to the main condenser.

Automatic Reclosing Battery Charging Switch. See SWITCH, AUTOMATIC RECLOSING BATTERY CHARGING.

Automatic Reclosing Circuit Breaker. See CIRCUIT BREAKER, AUTOMATIC RECLOSING.

Auto-Transformer. A transformer in which a part of the primary winding is used as a secondary winding, or conversely. Sometimes called a Compensator and used for starting alternating current motors.

Auxiliary Circulating Pump. See PUMP, AUXILIARY CIRCULATING.

Auxiliary Feed Pump. See PUMP, AUXILIARY FEED.

Auxiliary Foundations. See FOUNDATION, AUXILIARY.

Auxiliary Machinery. As its name implies, it includes all machinery except the boilers and engines constituting the propelling machinery proper, and the deck machinery.

Under this heading are included such items as Air Pumps, Ash Ejectors, Blowers, Bilge Pumps, Circulating Pumps, Condensers, Distillers, Evaporators, Fans, Feed Heaters, Feed Pumps, Filters, Injectors, Lubricating Oil Pumps, Oil Pumps, Sanitary Pumps, Transfer Pumps, Water Pumps, etc.

Avast. A command to cease pulling on a rope. Stop, cease.

Avast-heaving. A term used on shipboard as a command to stop pulling in the anchor chain.

Awning. A canvas canopy spread over a vessel's decks bridges, etc., for protection against rain and sun.

Awning Deck. See DECK, AWNING.

Awning Deck Sheerstrake. The strake of outside plating adjacent to the awning deck.

Awning Deck Stringer. See STRINGER, AWNING DECK.

Awning Deck Stringer Bar. See STRINGER, BAR.

Axis, Neutral. See NEUTRAL AXIS.

Azimuth Circle. A graded ring attached to a compass and fitted with vanes, screws and other apparatus.

It is used in taking the bearings of the sun, stars and terrestrial objects.

Page 1093.

B

Back-Board. A portable back support nicely designed and fitted on the after side of the stern thwart in a small motor or row boat.

Backbone. A term applied to the keel of a ship and sometimes to the center vertical keelson.

Backing. Making speed or having motion astern.

Back-Firing. See GAS ENGINE, BACK-FIRING.

Back Hand Rope. See ROPE, BACK HAND.

Backstays. Stays which extend from all mast levels, except the lower, to the ship's side some distance abaft the mast. They serve as additional supports to prevent the mast from going forward and at the same time contribute to the lateral support, thereby assisting the shrouds.

Baffle Plate, Boiler. See BOILER BAFFLE PLATE.

Baffle Plate, Condenser. See CONDENSER, BAFFLE PLATE.

Balanced Rudder. See RUDDER, BALANCED.

Bale Measure. A term used where the capacity of a cargo hold is measured to the inside of the frames or cargo battens

Ballast. Any weight carried solely for the purpose of making the vessel more sea-worthy. Ballast may be either portable or fixed, depending upon the condition of the ship. Permanent ballast in the form of sand, concrete, scrap or pig iron is usually fitted to overcome an inherent defect in stability or trim due to faulty design or changed character of service.. Portable ballast, usually in the form of water pumped into or out of bottom, peak or wing ballast tanks, is utilized to overcome a temporary defect in stability or trim due to faulty loading, damage, etc.

Ballast Port. See PORT, BALLAST.

Ballast Pump. See PUMP, BALLAST.

Ballast Tank. See TANK, BALLAST.

Ballast, Water. Sea water confined to double bottom tanks, peak tanks or other designated compartments for use in obtaining satisfactory draft, trim or stability. In the days of the sailing vessel this object was attained by the use of solid ballast such as sand, gravel, rock, etc.

Ballasted Condition. A condition in which it becomes necessary to fill all or part of the ballast tanks in order to secure proper immersion, stability, and steering qualities. This condition may be the result of the consumption of fuel, stores, and water; or the absence of part or all of the designed amount of cargo.

Ball Joint. See FLEXIBLE JOINT.

Balsa. A name used in South America to designate rafts made of light wood. Page 822.

Baluster. Small upright pillar or column supporting the hand rail around a staircase.

Band Saw Filing Machine. See SAW, BAND, SETTING AND FILING MACHINE.

Band Saw Setting and Filing Machine. See SAW, BAND, SETTING AND FILING MACHINE.

Banjo Frame. A device for handling the propeller of an auxiliary screw steamer.

Bank. An elevation in the sea's bottom which, if of sufficient height, forms a shoal.

Bar, Boring. See BORING BAR.

Bar Furnace. See FURNACE, BAR.

Bar Iron. Rolled bars having various forms of cross section.

Bar Keel. See KEEL, BAR.

Bar Stringer. See STRINGER, BAR.

Barbettes. Cylindrical structures built up of armor plates extending from the protected deck of a war vessel to the lower side of the turret shelf plate. They form protective enclosures in which are located the turret stools, shell stowage flats and ammunition hoisting gear for the turrets.

Bare Poles. The condition of a sailing ship with no sails hoisted. "Not a rag set."

Barge. A craft of full body and heavy construction designed for the carriage of cargo but having no machinery for self propulsion.

Pages 463 to 466.

Bark. A vessel having three masts, fore, main and mizzen. The two forward are square rigged and the after or mizzen is fore-and-aft rigged.

Barkentine. A vessel having three masts, fore, main and mizzen. The fore mast is square rigged and the main and mizzen fore-and-aft rigged.

Barnacles. A cirriped crustacean which adheres in clusters to the under water portion of vessels, piles, piers, etc.

Bars, Boiler Grate. See BOILER GRATE BARS.

Basic Carbonate. See PAINT.

Basic Open Hearth Steel. See STEEL AND IRON.

Basic Sulphate. See PAINT.

Basin. A natural or artificial berthing place in which ships may safely float at any stage of the tide.

Basin Dry Dock. See DRY DOCK, GRAVING.

Bath Brick. A calcareous or siliceous earth preparation compressed into bricks and used for cleaning bright-work; so named for having first been made near Bath.

Batten (noun). A thin strip of wood, usually tapered, used in laying down lines. A strip of wood or steel used in securing tarpaulins in place. (Verb) To secure by means of battens, as to "batten down a hatch."

Battening Down. Making the hatches watertight by means of tarpaulins firmly secured to the hatch coamings with battens, wedges, etc.

Battens, Cargo. A term applied to the planks that are fitted to the inside of the frames in a hold to keep the cargo away from the shell plating. These battens are not necessary in concrete ships, as the sides do not sweat.

Battens, Hatch. See HATCH BATTENS.

Battens, Sheering. Long strips of wood which are clamped to the frames of a ship to locate the edges of the strakes of the shell plating in relation to the sheer of the ship's deck.

Battery, Electric Primary. The apparatus for transforming chemical energy into electric energy is known as a *primary cell.* Two or more of these cells connected together form a *primary battery,* although the term "battery" is frequently applied to the single cell as well. There are two general types of primary batteries, wet and dry.

Wet batteries consist of two different metals or one metal and a carbon electrode immersed in a chemical solution contained in a glass or porcelain jar.

The dry cell or dry battery is the type most commonly used in marine work. The negative pole is a hollow zinc cylinder and serves as a container. The positive pole is a carbon rod. The rod is surrounded by a deplorazing agent which is separated from the zinc by some absorbent material saturated with electrolyte. The electrolyte usually consists of sal-ammoniac and zinc choloride, and the top of the cell is sealed.

The dry cell is more convenient, is portable, requires less space, and is cheaper than the wet cell, but has the disadvantage of deteriorating whether used or not, and it cannot be recharged.

Battery, Electric Storage. Secondary or storage batteries are devices which transform chemical into electrical energy and the energy of which can be restored by passing an electric current through the battery from some outside source. During the process of restoring or charging the battery the electrical energy is transformed into chemical energy.

Page 1080.

Battle Cruiser. A naval vessel of the first class having great speed, carrying guns of the largest size and range and having good protection against gun fire and torpedo attack. She must be so designed as to be capable of keeping the sea in all weathers and have a maximum radius of action. Ships of this class are intended to sink an enemy and under some circumstances to lie in the main line of battle.

Battleship. A naval vessel of the first class carrying maximum armament and protection, both against gun fire and torpedo attack, and having good speed. She must be so designed as to be capable of keeping the sea in all weather and must have a large radius of action. Ships of this class are intended to lie in the regular line of battle and bear the brunt of the fighting.

Bead. A reinforcing ridge on a pipe or tube.

Beam. The extreme width of a ship. A transverse, horizontal member supporting a deck or flat.

Pages 165, 166, 167, 175, 176, 183 to 186, 193 to 199.

Beam Angle Bar. An angle bar used in the construction of a deck beam or an angle bar composing a deck beam.

Beam, Awning, Anchor, Main, Lower, Shade, Shelter, etc. The deck beams are given the name of the deck that they support.

Beam Bracket. See BRACKET, BEAM.

Beam, Cant. A term applied to any of the beams supporting the deck plating or planking in the overhanging portion of the stern of a vessel. These beams radiate in fan shaped formation from the transom beam to the cant frames.

Pages 496, 497.

Beam Carlines. A term applied to beams either of timber or steel running fore and aft or diagonally between deck beams.

Beam Clamp. A device for attaching to the lower flange of a deck beam for hooking on a purchase, lead block, etc. It is made of metal in two parts, one of which has a sharp bend and hooks over the flange, the other, a straight flat piece, fits against the back of the web of the beam, the two parts being securely bolted together. In the lower end is a worked eye extending through both parts into which a ring is usually fitted.

Beam, Deck—Molding of. Its vertical dimension.

Beam, Deck—Siding of. Its horizontal dimension.

Beam, Hold. A term applied to any one of a tier of athwartship beams spanning the hold from frame to frame, and upon which no deck is fitted.

Beam, Intermediate. A term applied to a beam that is fitted in between, and running parallel to, the regularly spaced deck beams.

Beam Knees. A block of wood having a natural angular shape or a block cut to a bracket shape and used for connecting the deck beams to the frames in a wooden vessel.

Also applied to the ends of steel deck beams that are split, having one portion turned down and a piece of plate fitted between the split portion, forming a bracket end.

Pages 440, 445, 447.

Beam, Main. A term applied to the deck beam fitted at the point of maximum breadth of the vessel.

Beam Mold. See MOLD, BEAM.

Beam, Molded. The width over the widest portion of the ship measured to the outside of the frame angle or channel but inside the plating.

Extreme: the greatest width outside the plating, armor or any part of the hull proper. Sometimes, but not always, taken over guards or fenders.

Beam, Panting. A term applied to an athwartship beam fitted in the bow or stern of a vessel, to panting stringers or to the under side of decks, for the purpose of preventing in and out motion of the sides of the vessel.

Beam, Transom. A strong deck beam situated in the after end of a vessel directly over the stern post, and connected at each end to the transom frame. The cant beams which support the deck plating in the overhang of the stern radiate from it.

Page 497.

Beam and Structural Shape Bender. See PRESS, BENDING.

Beams, Deck. A term applied to any of the main beams upon which the plating or planking of a deck is supported. These beams usually run athwartship from side to side of a vessel and are fastened to the frames. In the way of hatch openings they run from the side to the opening and are bracketed or clipped to the casing or coaming as the case may be.

In fore and aft framing the beams run longitudinally and are bracketed to the bulkheads and also supported by heavy transverse web or belt beams.

Pages 370 to 466, 487 to 497, 522 to 527. Plates XXXIX, XL, XLI, XLII.

Bear-a-hand. A command to give assistance at whatever is being done. Same as "Lend-a-hand."

Bearding. A term applied to the line of intersection of the plating and stem or stern post.

Bearers. A term applied to foundations and particularly to those having vertical web plates as their principal members. Also the vertical web plates of foundations are called bearers.

Bearing. The ship's bearing is the direction of her course as indicated by the compass. The bearing of an object from the ship is the direction of the object expressed in points of the compass from the ship's course, one point equalling 11°-15′.

Bearing, Rudder. See RUDDER BEARING.

Bearings, Roller. See ROLLER BEARINGS.

Bearings, Spring. See SPRING BEARINGS.

Beat to Windward. To work up against the wind by means of a series of tacks.

Becalmed. (Applied only to sailing vessels.) That condition in which there is insufficient wind to give steerage way even though all sail is set.

Becket. A small grommet used for various purposes, as for reefing a sail with toggles; the extension of the cheek straps of a block together with the bolt and thimble or eye bolt to which is secured the standing part of the fall.

Bed Plate. A structure, consisting of a series of transverse girders connecting fore-and-aft members or girders. It is usually made of cast iron or steel, the girders having box or L-shaped sections. It may be either cast in one piece or built up of several castings bolted together.

The bed plate is fitted for the support of the feet of the engine columns, as well as to provide for the support of the crank shaft bearings. Further, it assists in the distribution of the engine weight and stresses to the ship structure to which it is attached by holding down bolts.

Bees. Strips of wood or iron fastened to each side of the bowsprit.

Beetle. A heavy long-handled wood mallet with metal hoops, sometimes called a reaming beetle or hawsing beetle, used by calkers for striking a reaming or horsing iron.

Before. Toward the stem or in front of the vessel.

Belay. To secure a rope or line about a cleat or belaying pin by winding it back and forth in the manner of the figure eight.

Belaying Pin. A small iron or tough wood pin consisting of a head, shoulder and shank. The pin, being securely fitted in a rail, is used for belaying the hauling parts of light running gear, signal halyards, etc.

Page 350.

Bell Crank. A bent lever used to alter the direction of application of a force.

Bell Mouth. A term applied to an expanded, trumpet-shaped fitting, used on the ends of voice tubes, etc.

Bell, Ship's. A bell and clapper of the usual shape used aboard ship as a means of denoting the time at regular intervals by day and by night; viz., 12 o'clock, midday or midnight, 8 bells; 12.30, 1 bell; 1 o'clock, 2 bells; 1.30, 3 bells; 2 o'clock, 4 bells; 2.30, 5 bells; 3 o'clock, 6 bells; 3.30, 7 bells; 4 o'clock, 8 bells; 4.30, 1 bell; 5 o'clock, 2 bells; 5.30, 3 bells; 6 o'clock, 4 bells; 6.30, 5 bells; 7 o'clock, 6 bells; 7.30, 7 bells; 8 o'clock, 8 bells; 8.30, 1 bell; 9 o'clock, 2 bells; 9.30 3 bells; 10 o'clock, 4 bells; 10.30, 5 bells; 11 o'clock, 6 bells; 11.30, 7 bells.

Ship's bells are also used as a signal when anchored in a fog and as an alarm in emergencies.

Below. Underneath the surface of the water. Underneath a deck or decks.

Bend. The act of securing one thing to another; as, an anchor to a cable; a sail to a yard, one line to another, or to a buoy, boat, etc.

Bend. A term applied to a pipe that is bent through an angle of from 45° to 180°.

Bend, Return. A U-shaped pipe fitting for the purpose of connecting the ends of two parallel pipes, thus providing for a return flow.

Bender, Portable Frame. See FRAME BENDER, PORTABLE.

Bending Machine, Portable Hand. See HAND BENDING MACHINE, PORTABLE.

Bending Moment. Any beam, girder or structure subject to bending is acted upon by a "bending moment." The bending moment at any point in the structure is the sum of the products of the force acting to produce bending and the perpendicular distances from the lines of action of the forces to the point under consideration.

Bending Press. See PRESS, BENDING.

Bending Rolls. See ROLLS, BENDING.

Bending Rollers. Men who operate rolls which put a permanent set in sheets and plates when cold, in order that they may conform to the required shape.

Bending Shackle. The heavy shackle which connects the chain cable to the ring or shackle attached to the shank of an anchor.

Bending Slab or Block. A cast iron slab usually about five feet square, perforated with holes 2″ square arranged in a manner similar to a checker board. The slab is generally about 2″ thick except around the edges where it is about 8″ deep. The floor in front of the furnace in the plate and angle shop is made up of a number of these slabs raised to the level of the furnace door. Such work as furnacing plates and bending and beveling is done on these slabs, the holes being used for setting pins around which to bend frames and providing a means for dogging down the work and any forms used.

Bending and Forming Machine. See PRESS, FORGING.

Bending and Straightening Machine. See PRESS, BENDING.

Berth. A term applied to a bed or a place to sleep. Berths, as a rule, are permanently built into the structure of the staterooms or compartments. They are constructed singly and also in tiers of two or three, one above the other. When single, drawers for stowing clothing are often built-in underneath. Tiers of berths constructed of pipe are commonly installed in the crew space.

Pages 589, 590, 1100.

The term berth is also used to designate a stateroom or cabin, and also to specify a position; for example, he has the berth of captain.

Still another use of the term is to designate the place where a ship is docked or tied up.

Bessemer Steel. See STEEL AND IRON.

Between Decks. The space between any two, not necessarily adjacent, decks. Frequently expressed as "'Tween decks."

Betwixt Wind and Water. At or near the water line at which a ship is floating.

Bevel Board. See BOARD, BEVEL.

Bevel, Closed. A term applied where one flange of a bar is bent into an acute angle with the other flange.

Bevel Gear. A gear designed to transmit power from one shaft to another with which it makes a definite angle. When the shafts are at right angles to each other, the gears are called miters.

Bevel Lines. See LINES, BEVEL.

Bevel, Open. A term applied where one flange of a bar is bent out to an obtuse angle with the other flange. In the bow and stern the frames are given an open bevel so that the inner flange will connect to the transverse beams without making it difficult to rivet the outer flange to the shell.

Bevel-Faced Hammer. A hammer used in riveting having its face set at an angle.

Bevel-Faced Holding on Hammer. A large hammer with its face sloped. It is held against the head of a rivet while it is being driven.

Beveling Machine. A machine used for beveling steel angles and other shapes. A set of steel discs is operated by an electric motor and set to any desired angle by a mechanism attached to a threaded shaft operated at one end by a hand wheel. The bars are heated in a bar furnace and run through the beveling machine while hot.

Page 742.

Bibb. The bent outlet of a cock.

Bight (of a rope). A loop or bend in a rope, though, strictly considered, any part between the two ends may be termed the bight.

Bilge. (Noun.) The rounded portion of a vessel's shell which connects the bottom with the sides. (Verb.) To open a vessel's lower body to the sea.

Bilge and Ballast System. A system of piping generally located in the hold of a vessel and connected to pumps. This system is used for pumping overboard accumulations of water in holds and compartments, and also for filling ballast and peak tanks.

Pages 600 to 605. Plate XLIII.

Bilge Discharge Pipe. A pipe on the discharge side of a bilge pump for discharging water pumped from the bilges or bottom of the vessel overboard.

Bilge Ejector. An apparatus designed for the expulsion of the water accumulated in a vessel's bilges.

Bilge Injection. The suction from the bilges to the main circulating pumps which permits discharging bilge water overboard or through the condensers in case of a leak of sea water into the bilge.

Bilge Injection Water. The water pumped from the bilges by the main circulating pumps.

Bilge Inlet. The suction side of a bilge pump or circulating pump which can be used for pumping water from the bilges.

Bilge Keel. See KEEL, BILGE.

Bilge Keelson. See KEELSON, BILGE.

Bilge Pump. See PUMP, BILGE.

Bilge Strake. See STRAKE, BILGE.

Bilge Stringer. See STRINGER, BILGE.

Bilge Suction Pipe. See PIPE, BILGE SUCTION.

Bilge Water. Drainage water which accumulates either in the bottom or bilge.

Bilge and Fire Pump. See PUMP, FIRE AND BILGE.

Bilgeways. The timbers or part of the launching ways directly under the bilge of a ship.

Bill-board. The inclined anchor bed fitted at the intersection of the forward weather deck and shell. On some ships a tripping device is fitted on the bill-board so that by turning a rod the anchor will slide off into the water.

Bind. To secure the end of a rope against unlaying by taking turns of twine or small-stuff around it. The term is synonymous with whip.

Binnacle. A stand or case for housing a compass so that it may be conveniently consulted. Binnacles differ in shape and size, according to where used and the size of compass to be accommodated.

A binnacle for a ship's navigating compass consists essentially of a pedestal at whose upper end is a bowl-shaped receptacle having a sliding hood-like cover. This receptacle accommodates the gimbals supporting the compass.

Compensating binnacles are provided with brackets or arms on either side, starboard and port, for supporting and securing the iron cylinders or spheres used to counteract the quadrantal error due to the earth's magnetization of the vessel.

This type of binnacle is usually placed immediately in front of the steering wheel, having its vertical axis in the vertical plane of the fore-and-aft center-line of the vessel.

Pages 1085, 1091, 1092, 1093.

Binoculars, Marine. A form of telescope designed for the use of both eyes at the same time.

Page 1085.

Bismuth. Described under Metals.

Bitter-end. The extreme inboard end of a chain cable which is secured in the chain locker.

Bitts. A term applied to short metal or wood columns extending up from a base plate attached to a deck or bulwark rail, timbers produced through and a short distance above a deck, or columns fitted to a windlass for the purpose of securing and belaying ropes, hawsers, cables, etc. Also called bollards.

Page 545.

Bitts, Mooring. A term applied to the bitts to which the mooring lines are attached.

Page 545.

Bitts, Towing. A term applied to the bitts fitted on the deck of a vessel for the purpose of belaying or fastening the towing hawsers.

Pages 545, 859.

Bitumastic. A black tar-like composition largely of bitumen or asphalt and containing such other ingredients as rosin, Portland cement, slaked lime, petroleum, etc.

It is sold under various trade names in the form of a solution, an enamel, and a cement, the exact composition being kept more or less a secret by the manufacturers. All three forms adhere well to steel when properly applied and are practically impervious to water. The solution is applied cold with a brush and is used as a priming coat for either the enamel or cement. The enamel is applied hot, after the solution is nearly dry or set, by being poured, where practicable, or otherwise spread over the surface, forming a fairly elastic surface after hardening and cooling.

The cement is also applied hot, but being more difficult to apply than the enamel is used generally only on horizontal surfaces. The solution and enamel or cement is used as a protective coating in ballast and trimming tanks, chain lockers, reserve feed and fresh-water tanks, coal bunkers, engine and boiler foundations, shaft alleys and below floor plates in vessels and as a damp-proof coating on the walls of cold storage spaces.

Page 804.

Bituminous Solution. See Paint.

Black Balls. A vessel which from any accident is not under command shall carry by day in a vertical line, one over the other, not less than six feet apart, where they can best be seen two black balls or shapes, each two feet in diameter. A vessel employed in laying or picking up a telegraph cable shall carry in the daytime, in a vertical line, one over the other, not less than six feet apart, where they can best be seen, three shapes, not less than two feet in diameter, of which the highest and lowest shall be globular in shape and red in color and the middle one diamond in shape and white in color.

These balls are to be taken by other vessels as signals that the vessel showing them is not under command and cannot therefore get out of the way. They are not signals of distress.

For corresponding light signals, see Lights, Special.

A steam vessel proceeding under sail only, but having her funnel up, shall carry, in daytime, forward, where it can best be seen, one black ball or shape, two feet in diameter.

Blacksmiths. Workmen engaged in heavy forging, pressing, stamping, case hardening, annealing, tempering, tool dressing, etc.

Blade Friction. See Turbine, Blade Friction.

Blades, Turbine. See Turbine Blades.

Bleeder. A term applied to a cock fitted to a pipe line for the purpose of drawing off condensation.

Bleeders. A term applied to plugs screwed into the bottom of a ship to provide for drainage of the compartments when the vessel is in dry dock.

Blind Pulley. A circular block of hard wood with rounded edges perforated by several holes having grooves running from them to one side of the block. One of these blocks is secured to an end of a part of the standing rigging, as a shroud, and another to some part of the ship, they are then connected to one another by a lashing passing through the holes. These wooden blocks are commonly called dead eyes.

Blinker Signals. An electrical appliance used for signaling by the Morse code, consisting of two lanterns and two controllers. The lanterns are secured at the ends of the signal yard, while one controller is located on either side of the bridge.

Block. A device used in applying power to move heavy weights by means of tension in a cable. It consists of a frame made of wood or metal containing one or more pulleys or sheaves, set side by side and turning on the same axis. If more than one sheave is fitted, the sheaves are separated by divisions of the same outline as the sides or cheeks of the block. In referring to blocks the words single, double or triple are prefixed to tell the number of sheaves they carry in their frames. The position a block occupies in the tackle of which it is a part determines what its fitting should be, that is, whether or not it should have affixed eyes, hooks or beckets.

The block on the stationary end of the tackle has on its end a hook or an eye by which it is fastened. The becket is a fitting on one end of a block to which is secured one end of the tackle rope or "fall," and may be either on the stationary or movable block.

Blocks derive their names from the purposes for which they are used, the places which they occupy or from distinctive features of their form or construction.

Pages 351, 842, 844, 871.

Block and Block; Two Blocks; Chock-a-block. The name given the condition of a tackle when the two blocks have been drawn together so that no more power can be derived from them.

Block, Cheek. A block made with one of the sides or cheeks formed so that it can be secured to a spar.

Block, Clump. A short, thick, single block with a large swallow.

Block Coefficient. See Coefficient, Block.

Block, Fiddle. A block with two sheaves of different diameters, placed one above the other.

Block Fittings. Swivel, loose, stiff, side or sister hooks, regular or upset shackles, swivel jaws or eyes, stiff eyes, links, etc., mounted on various blocks to adapt the block for purposes required.

Page 843.

Block, Jewel. The block fastened to a yard to take the studding sail halyards.

Block, Snatch. A single block with a hook having one end of the frame arranged so that it can be hinged up to allow the bight of a rope to be placed on the sheave, doing away with the inconvenience of passing one end of the rope through the swallow. Snatch blocks are used to lead ropes around obstructions which prevent straight leads to a winch or a capstan.
Pages 843, 844.

Block Stopper. A short piece of rope attached to a stationary block and used to temporarily secure the running part of a fall.

Block, Swivel. A block having a swivel attachment to its supporting hook or shackle, thus allowing it to revolve.
Page 351.

Blocks, Bilge. Short heavy pieces of timber similar to the keel blocks. They are placed at intervals on both sides of the keel as supports for the bottom of a ship both when building and in dry dock.

Blocks, Gin. Sometimes called Gins. Single blocks with a metal frame having a sheave of large diameter for ease in overhauling and used where the operation of hoisting by a single part is to be performed many times in succession as in hoisting cargo.
Page 843.

Blocks, Keel. Short heavy timbers about twelve inches square in section, placed one above the other, up to a height of about five or six feet, and used to support the keel of a vessel when building and when in dry dock. They are placed under keel from bow to stern and are spaced a sufficient distance apart to allow access to the work.
Plate XXXII.

Blocks, Secret. Single blocks with the sheave completely enclosed by the frame. Two holes are left on one end for the rope to pass in, around the sheave and out again They are used to prevent the fouling of any rigging with which they come in contact.

Blocks, Sister. Two single blocks joined together at their ends by a swivel.

Blow, Bottom. See Boiler Blow, Bottom.

Blow, Surface. See Boiler Blow, Surface.

Blowers. Mechanical devices used for artificial air supply to machinery or other enclosed spaces and forced draft.

The centrifugal type is in almost universal use at the present time. It consists of a series of vanes mounted on radial arms supported on a central revolving shaft. Air is taken in at the center and discharged by centrifugal force from the blade tips.

Blowers are driven by reciprocating or turbine steam engines or electric motors.

In the location of blower and design of supply leads, great care must be taken as to economical use of space and the securing of a satisfactory point of intake.

Pages 391, 393, 399, 425, 952, 953, 970, 1008, 1009, 1011, 1015, 1016, 1017, 1018, 1053, 1055.
Plates XII, XIV, XLVII, XLVIII.

Blow-off Valve, Blow-through Valve. See Valve, Blow-off.

Blue Light. See Light, Blue.

Blue Peter. A blue flag having a white square in its center hoisted as a signal that the ship is ready to begin her voyage.

Board, Bevel. A wooden board upon which is drawn the bevels applying to some part of the ship's structure such as the frames, and given to the workmen in the yard for ready reference where a paper plan or sketch would not stand rough usage.

Boarding. The act of going on board a ship.

Boat Deck. See Deck, Boat.

Boat Deck Stringer. See Stringer, Boat Deck.

Boat Deck Stringer Bar. See Stringer, Boat Deck.

Boat Hook. A metal fitting in the form of one or more hooks and a prong, attached to the end of a pole. They are used for catching, holding and steadying small boats.
Page 823.

Boat Stowage. The provisions made aboard a ship for stowing and launching life boats.
Pages 688, 689.

Boat Tanks. Air tight compartments in ship's small boats to provide buoyancy when a boat is filled with water.

Boatswain (Bo's'n). One of the lower officers on shipboard who has immediate charge of the deck force, deck gear, boats, rigging, cordage, etc.

Boatswain's Call. A small silver whistle or pipe used by a boatswain or his mates to summon men to their stations and direct them in their duties.

Boatswain's Chair. A piece of plank forming a seat hung in two straps on which a man may be hoisted aloft or lowered over the ship's side.

Bobstay Piece. A term applied to the forward projecting edge timber of the stem directly below the bowsprit.
Page 599.

Bobstays. The chains or ropes attached underneath the outer end of a bowsprit and led to the stem to prevent the bowsprit from jumping. Frequently two or three bobstays are fitted; when three, they are designated as **inner, middle,** and **cap** bobstays; when two, as **inner** and **cap** bobstays.
Page 599.

Body, After. That portion of a ship's body aft of the midship section.

Body Plan. A plan consisting of a pair of half transverse elevations or end views of a ship, both having a common vertical middle line, so that the right hand side represents the ship as seen from ahead, and the left hand side as seen from astern. On the body plan appear the forms of the various cross sections, the curvature of the rail and deck lines at the side, and the projections as straight lines of the waterlines, bow and buttock lines, and the diagonal lines.
Pages 470, 471. Plate XXX.

Body-post. See Propeller-post, Stern Post.

Boiler. Any vessel, container or receptacle that is capable of generating steam by the internal or external application of heat. There are two general classes of boilers, i. e., fire tube and water tube.
Pages 966, 968, 971, 972, 973, 974, 975, 976, 978.

Boiler Acidity. A term used when the feed water is acid.

Boiler, Air Required. The amount of air that should be supplied to a furnace may be calculated from a flue gas analysis and the weight of carbon remaining in the ashes.

Boiler Alkalinity. A term used when the feed water is alkaline and has the power of neutralizing acids.

Boiler, Analysis of Flue Gas. A determination of the quality of the gases passing up the stack for the purpose of ascertaining how complete the combustion of the fuel is.

Boiler Ash Pit. The space underneath the grate bars in a furnace which has the double function of receiving ashes and providing air space for combustion of the fuel.

Boiler Baffle Plate. A plate perforated with small holes and used in the top drums of water tube boilers to separate the steam from the water. Plates in fire tube boilers to induce the circulation of water in the proper direction are also called baffle plates.

Boiler Bearers. See Boiler Foundation.

Boiler Blow, Bottom. A valve located near the bottom of the boiler for the purpose of blowing off the mud, sediment or dense water. Also sometimes used for emptying a boiler when examination and cleaning are required. The better practice for emptying, however, is to let the boiler cool down and either draw or pump the water out.

Boiler Blow, Surface. A valve with pipe connections to the interior of the boiler and overboard, used for the purpose of blowing off the scum and grease that collect on the surface of the water.

Boiler Bracing. The stay rods, stay bolts and stay tubes used in supporting the flat surfaces in a boiler. A cylindrical surface requires no bracing for internal pressure, but ring stiffeners, ribs or corrugations are necessary for external pressure.

Boiler Bracket. A bracket connected to both the boiler and ship structure.

Boiler Capacity. The highest number of boiler horse power that can be generated in a boiler. The rated horse power is commonly based on 10 square feet of heating surface per horse power.

Boiler Chocks. Brackets to prevent fore and aft motion of the boiler.

Boiler Circulation. The continuous circulation of water established in a boiler, with a view to increasing its efficiency, durability and safety. Proper circulation adds to the ability of the water to take up heat, reduces the tendency toward violent boiling which causes excessive priming, and prevents in a large measure the formation of deposits on the heating surfaces. It also adds to the durability and safety of the boiler by keeping all parts at a nearly uniform temperature, thereby reducing the liability of unequal strains due to expansion and contraction.

Page 1018.

Boiler Combustion Chamber. A chamber or space adjacent to the furnace in a boiler designed for the purpose of completing the combustion of the gases from the fuel.

Boiler Compounds. Substances, generally having a soda or tannic content, that are injected into the boiler with the feed water or through a soda cock. These compounds should be used to prevent scaling, rather than to break it up after it has already occurred. Care should be taken to suit the compound to the water used rather than to use the compound as a cure all.

Boiler Corrosion. Destruction of the steel parts due to the oxidizing properties of the feed water. It may result from galvanic action, the presence of air or acidity of the water.

Boiler Covering. See Insulation.

Boiler Crown Sheet. The plate over the furnace in a Locomotive type or the plate over the combustion chamber in a Scotch type of boiler.

Boiler, Donkey. A small boiler placed aboard ship for operating auxiliary and deck machinery, heating plant, etc., when the fires are drawn from the main boilers.

Boiler Door, Ash Pit. A single plate door fitted over the ash pit and serving as a damper.

Boiler Door Frame. See Boiler Furnace Front.

Boiler Door, Furnace. A door consisting of a steel plate with a cast iron inner plate perforated with small holes and so fitted that there is an air space between the two plates. In addition to the hinges and opening bar the door usually has a peephole which is large enough to allow a bar to be used for stirring up the fire.

Boiler Drum. A rectangular or cylindrical container into which headers are connected or nests of pipes expanded. They provide space for steam, and in most cases for sufficient water to prevent foaming when steam is separating from the water.

Boiler Drum Head. A circular plate flanged for connection to the sides of the drum and pressed to a convex shape. It is used to close the end of the drum.

Boiler Dry Pipe. A pipe running along the top of the steam space in which slots are cut in the top or sides for the purpose of admitting only dry steam to the line. One end of the pipe has a blank ending and the other end is connected to the steam outlet. Drainage holes are drilled along the bottom of the pipe.

Boiler Economizers. See Boiler Feed Water Heater.

Boiler Efficiency. This depends principally on having sufficient area and proper arrangement of the grate and heating surfaces combined with sufficient combustion space to insure complete combustion of the gases before they enter the stack. Good draft and circulation of water, and clean heating surfaces are also important items that are necessary to obtain the greatest efficiency.

Boiler Electrolysis. See Boiler Galvanic Action.

Boiler Evaporation. A measure of the amount of water evaporated per pound of coal or per square foot of heating surface per hour.

Boiler Feed Check Valve. See Valve, Check, Boiler Feed.

Boiler Feed Pipe, Internal. A pipe with a blank end and perforated with numerous small holes through which feed water is delivered to the boiler.

Boiler Feed Water. The feed water should be as free from the carbonates and sulphates of lime and magnesia as possible. Hard or salt water should never be used except in an emergency. Due to the fact that water loses its solubility at high temperatures these substances are deposited in the form of scale upon the heating surfaces.

Boiler Feed Water Heater. A container used for heating the feed water before it is injected or pumped into the boiler. The feed water may be heated by passing it through tubes around which the exhaust steam, or in some cases live steam, circulates, or by allowing the water to circulate around tubes through which exhaust or live steam passes. Other types which are frequently called economizers utilize the heat from the waste flue gases.

The advantages of a feed water heater are as follows, viz.: They utilize heat that would otherwise be wasted. They increase the steam capacity by shortening the time necessary to bring the water up to steaming temperature. They also prevent strains in the boiler due to the introduction of cold water, and they

retain a large portion of the scale that would otherwise be deposited in the boiler.

Pages 391, 400, 401, 425, 656, 657, 658, 659, 885, 995. Plates XII, XIV, XLVII, XLVIII.

Boiler, Fire Tube. If the hot gases from the furnace or combustion chamber are led to the uptake through tubes around which water circulates the boiler is of the fire tube type. Fire tube boilers have the advantage over the water tube boilers in the following points, viz.: Less damage is done when it becomes necessary to use salt water. Not so much attention need be given to the regulation of the supply of feed water. Less trouble with the tubular elements. Better adapted for handling by firemen who are transient or below the average in intelligence. Not so sensitive.

Boiler Firing. No general rule for firing can be given. as the desirable thickness of the fire and methods used depend on the quality of the fuel, draft and numerous other conditions With bituminous coal there are two common methods, called spreading and coking. In the spreading method the coal is thrown evenly in a thin layer over one furnace at a time. This method requires frequent firing. In the coking method the coal is thrown in the forward end of the furnace, allowed to coke and then spread out over the entire furnace. The ashes are sometimes removed by pulling the good coal from the back of the furnace, then dumping the ashes in the back end. The good coal in the forward end is then pushed back and the ashes in the forward end dumped.

Steam jets may be used in the ash pit to soften the clinkers.

Boiler Flue. A large tube used to convey hot gases through a boiler.

Boiler Flue Gas. The gases passing up the stack. See Boiler, Analysis of Flue Gas.

Boiler, Flue Type. In this type the furnace is below one end of the boiler. The flames and hot gases pass along the sides and underneath the shell and return through flues inside the boiler to the uptake.

Boiler, Flue and Return Tube Type. This type has a rectangular-shaped furnace located in the front. The flames and hot gases pass through a flue or flues to a combustion chamber in the back and return through small tubes to the uptake which is located at the front end.

Boiler Foaming. When there is a scum or suspension of particles on the surface of the water in a boiler, the steam has difficulty in freeing itself and foaming occurs. This condition may be due to the presence of organic matter or excess of boiler compounds used for treating the water.

Boiler Forced Draft. An artificial means for increasing the rate of combustion in a boiler by creating an excess of pressure under the fuel or a suction above it and at the same time provide for the proper supply of air to the grates as required by the rate of combustion desired. Blowers and fans are used to accomplish these results.

Page 970, 1008, 1009, 1015, 1016, 1018, 1053.

Boiler Foundation. The structure upon which the boiler is secured. It generally consists of girders built up from plates and shapes and securely fastened to the boiler and riveted to the ship structure. With a cylindrical boiler the athwartship girders are often called saddles.

Page 533.

Boiler Front. The front head of a fire tube boiler. Water tube boilers generally have an ornamental front which is fitted to the forward supporting frame. Large doors for access to the front headers and the frames for fire and ashpit doors are fitted to it.

Boiler Fuel. The most common solid fuels are anthracite and bituminous coal, although peat, lignite, wood and many kinds of refuse are used. The liquid fuels are generally crude oil or petroleum.

Boiler Fuel Consumption. The rate of fuel burned expressed in pounds per square foot of grate surface, heating surface, or I. H. P. per hour.

Boiler Funnel. See Smoke Stack.

Boiler Furnace Front. A steel plate attached to the front of the furnace which serves as a door frame and as a support for a cast iron protection plate on the fire side. The cast iron plate is perforated with a large number of small holes to prevent it from burning, and has an air space between it and the front plate.

Boiler Gage, Steam. An instrument which indicates the difference between the steam pressure in a boiler and the pressure of the atmosphere.

Boiler Gage, Water. A gage containing a glass tube, about 12″ to 15″ long, in which the water level in the boiler is indicated.

Metal fittings, containing stop valves, ball non-return valves, or a combination of both, are attached to the ends of the glass tube, and these in turn are attached to small metal pipes, the upper one of which should be connected to the steam space of the boiler near the top and the lower one to the water space near the bottom. A drain cock is also provided at the bottom for blowing out the glass.

On large boilers the gage glass is attached to a large pipe which is direct connected to the steam and water spaces. This prevents fluctuations in the water level in the glass.

The glass tubes used in water gages are usually about ⅝ to ¾ inches in diameter and about ⅛ inch thick. They are frequently broken, and, therefore, as an added precaution, tell-tale or gage cocks are provided. Where the glass is connected to the water and steam spaces direct these cocks are attached to the boiler, but in large boilers where the glass is attached to a pipe column, the tell-tale cocks are attached to this pipe covering the range of the glass reading.

Boiler Galvanic Action. To prevent galvanic action in a boiler, zinc plates are installed. They should have as good metallic connection with the steel as possible. In addition to preventing electrolysis, they take up oxygen more readily than steel, thus preventing corrosion.

Boiler Girder. A plate girder usually consisting of two plates about ⅝″ to ¾″ thick, connected together by rivets passing through thimbles or short pieces of pipe and used to support the top of the combustion chamber in a fire tube boiler. The stay bolts forming the connection between the girder and the crown sheet pass between the plates making up the girder and are fitted with nuts and retaining washers at the top.

Boiler Grate Surface. The area of the grate.

Boiler, Gunboat Type. This boiler is somewhat similar to the Scotch boiler, having a furnace and combustion chamber, but instead of the hot gases returning to the front end they continue through tubes to the rear end of the boiler where the up-

take is situated. This gives a smaller diameter but longer boiler and is suitable where low head room is desired.

Boiler, Hand-Hole. A small elliptical hole in a boiler fitted with a cover on the inside which is held in place by a clamp or strong back on the outside. The purpose of hand holes is to provide access for cleaning.

Boiler Hatch. See HATCH, BOILER.

Boiler Heads. Plates used to close the ends of the boiler shell in fire tube boilers. They are usually flanged around the edge for connection to the shell.

Boiler Heating Surface. The area of the surfaces of the boiler that is subject to the heating action of the flames and hot gases. In fire tube boilers there should be from 2 to 5 square feet of heating surface for each I. H. P. required.

Boiler, High Pressure. A boiler designed for working pressures greater than 150 lbs.

Boiler Horse Power. One boiler horse power is conventionally taken as being equal to an evaporation of 34.5 lbs. of water per hour from and at 212° Fahrenheit. As the efficiency of a boiler depends on many things, it follows that the accuracy of its capacity can only be determined by a boiler test.

Boiler Incrustation. See SCALE.

Boiler Lagging. See INSULATION.

Boiler, Leg Type. See BOILER FLUE AND RETURN TUBE.

Boiler, Locomotive Type. In this type there is a rectangular furnace in the front with fire tubes leading to the back end and uptake. In way of the firebox the sides are flat and the top flat or rounded. The remainder of the boiler is cylindrical.

Boiler, Low-Pressure. A boiler designed for working pressures of 50 lbs. or less.

Boilermakers. Workmen engaged in the construction and erection of the component parts of boilers, condensers, and uptakes.

Boiler Manhole. A hole in a boiler or drum large enough to allow a man to enter for the purpose of examining and cleaning out the interior. Specially designed covers are made for manholes with bolt and dog fastenings.

Boiler Manhole Ring. A reinforced ring of metal fitted around the manhole to provide local stiffness.

Boiler, Medium-Pressure. A boiler designed for working pressures from 50 to 150 lbs.

Boiler Mud Drum. Either a cylindrical or rectangular container, located at the bottom of the boiler as remote as possible from the fire, for the purpose of catching impurities deposited from the water. It is provided with access holes for cleaning out.

Boiler Pitting. Corrosion of isolated spots in a boiler.

Boiler Priming. The amount of moisture suspended in the steam generated.

Boiler Room. Used to designate a compartment in a ship or building in which one or more boilers are installed.

Boiler Room Bulkhead. See BULKHEAD, BOILER ROOM.

Boiler Room Casing. See CASING, BOILER ROOM.

Boiler Saddle. See BOILER FOUNDATION.

Boiler, Safety Valve. See VALVE, SAFETY.

Boiler, Scotch. This type consists of a cylindrical shell with internal circular furnaces which are generally corrugated to enable them to withstand external pressure. Grate bars subdivide the furnaces into two parts, the upper part for the fire and gases and the lower part for the ash pit. The hot gases pass to a combustion chamber in the back of the boiler and from there return through tubes to the front end and uptake. The water should be kept to a level above the top of the tubes and combustion chamber and occupies all the space not taken up by the furnaces, combustion chamber, tubes, stay rods, stay bolts and steam space. Large Scotch boilers have as many as four furnaces. These boilers are sometimes made double ended in which case they may be a common or two combustion chambers. For advantages, SEE BOILER, FIRE TUBE.

Pages 386, 387, 392, 393, 400, 401, 425, 653, 655, 657. Plate XII.

Boiler Seating. See BOILER FOUNDATION.

Boiler Shell. The outside plating of the boiler with the exception of the end plates.

Boiler Space. A term applied to the compartment or compartments in which the boilers are installed.

Boiler Stack. See SMOKE STACK.

Boiler Stays. Steel rods or tubes used to brace flat plate surfaces in fire tube boilers.

Boiler Stop Valve. See VALVE, STOP, BOILER.

Boiler, Sub-Division. A term applied to the manner in which the interior of a boiler is sub-divided by partitions for the purpose of separating the fire and hot gases from the water. The circulation of the water and the heating efficiency depend largely on the manner in which this is done.

Boiler Throat Sheet. A plate connecting the cylindrical and flat sided portion in the locomotive type of boiler.

Boiler Tube Cleaners. Contrivances used for removing the scale and soot from boiler tubes.

In fire tube boilers the scale on the outside of the tubes is generally removed by scaling tools or chisels and scrapers.

The scale on the inside of the tubes in water tube boilers is removed by wire brushes or by revolving scrapers or cutter heads attached to a small air or water driven turbine.

Pages 975, 998, 1000.

Boiler Tubes. Their use is described under water tube and fire tube boilers. Seamless drawn steel is the best material.

Page 982, 983.

Boiler Tube Expander. A tool used to expand the tubes into the tube sheets, and also to bead over the ends.

Boiler Tube Sheets. The plates in a fire tube boiler into which the ends of the fire tubes or flues are expanded. The front tube sheet is usually that part of the boiler head which supports the forward end of the tubes and the back tube sheet is usually the plate forming the front end of the combustion chamber.

Boiler Wagon Top. A form of flat sides and rounded top in the way of a fire box or front end of some types of boilers.

Boiler Water Bottom. The space underneath the furnace occupied by water in an internally fired boiler.

Boiler Water Column. See BOILER GAGE, WATER.

Boiler Water Leg. The space occupied by water around the sides of a furnace in a boiler of the locomotive type and around the sides and back of a combustion chamber in a Scotch boiler.

Boiler, Water Tube. If the flames and hot gases act on the outside of tubes through which water circulates the boiler is of the water tube type. In connection with the tubes horizontal drums are installed at the top and bottom. The feed water

generally enters the top drum or drums and flows down through tubes to the lower drum or drums. It then returns through tubes about which the hot gases pass to the upper drum, where steam separates. The water level may be below the upper drum or at about half its depth. When the water level is below the top drum the tubes are called dry and when the water level is above the entrance of the tubes into the drum they are called wet. The tubes may be straight, curved, or bent, but in any case the fire grate is situated below so that the flames and hot gases may pass through them in rising. Surrounding the furnace, tubes and part or the whole of the drums, a casing is fitted to prevent radiation. The water tubes have the advantage over the fire tubes in the following points, viz.: The weight of the boiler and the contained water is less. Steam may be generated more quickly. The danger from bad explosions is less. Less trouble from the ship's structure in installation and in renewing worn or defective portions. High pressures are more easily provided for.

Pages 966, 968, 971, 972, 973, 974, 975, 976, 978.
Plates XIV, XLVII, XLVIII.

Bollards. A term applied to short metal columns extending up from a base plate which is attached to a wharf or dock and used for securing the lines from a ship. Also, applied to timber posts extending above the level of a wharf for the same purpose.

The bitts on a ship are frequently called bollards.

Bolster. A term applied to a piece of timber used as a support. A temporary foundation.

Bolt. A rod, usually of iron or steel, used as a fastening. With a few exceptions, such as drift bolts, a head or shoulder is made on one end and a screw thread is cut on the other.

Pages 774, 798, 800.

Bolt, Carriage. Bolt with round head and square neck used on miscellaneous work.

Bolt, Clinched. A term applied to a bolt having one or both ends hammered over, after it is in place.

Bolt Cutter. A machine used to cut threads on bolts or rods. The work is held in a vise mounted on a carriage which travels along the bed of the machine while the die-head holding the cutting die revolves around the work. Bolt cutters are made with single or multiple head.

Bolt, Deck. A flat head bolt with square neck (plain or slotted head), used principally for securing deck planking through deck beams and plating.

Bolt, Eye. A rod of metal with one end having the shape of a torus or doughnut, and the other end having a screw thread cut on it or left smooth for riveting over. They are made with and without shoulders at the eye end.

Bolt Forcer. A machine designed to force in or start "driving fit" bolts such as those used in shaft couplings, etc.

Common types of bolt forcer consist of a hydraulic cylinder and ram to which are attached side plates shaped in the form of a hook.

Page 748.

Bolt Hanger. A bolt cut with machine thread at one end and with lag screw thread at the other end, used on miscellaneous work.

Bolt Heading Machine. A machine used for upsetting bar stock to form bolt heads. Upsetting and heading machines are divided into two general classes, stop-motion and continuous-motion headers. The stop-motion headers have the greatest range and are primarily used for heading bolts, but are also used for all kinds of upset forgings. The continuous-motion headers are used only for heading rivets, carriage bolts, and short lengths of hexagon and square-head machine bolts; they produce these parts at a much faster rate than is possible with a stop-motion header, but their range of work is limited.

Pages 752, 753.

Bolt, Holding Down. Also called tie rod. A rod of metal with a head on one end and a machine thread on the other, or a thread on both ends.

They are usually used in the sides of deck houses, where they extend through the sill, up the sides between the ceiling and outside planking and through the top plates. Their purpose is to hold the deck house to the ship's structure and prevent it from being carried away. Also applied to bolts used in securing machinery to their foundations.

Bolt, Lock. See LOCK BOLTS.

Bolt Pointer. A machine used for rounding or pointing the ends of bolts preparatory to cutting the thread. Its operation is similar to that of a bolt cutter.

Bolt, Rail. A bolt threaded at both ends.

Used principally in fastening the ends of wood rails or planks together.

Bolt, Ring. An eyebolt having a ring worked through the eye. Ring bolts are made with lag screw ends for attachment to wood, with plain ends for riveting, and with ends fitted with a screw thread for nuts. They are also made with and without shoulders at the eye end.

Bolt Rope. See ROPE, BOLT.

Bolt, Stay. See STAY BOLTS.

Bolt, Stemson. A term applied to a bolt used to fasten a stemson to a stem or stern post.

Bolts, Stove. A small bolt with either a flat or round countersunk head and used for miscellaneous light work.

Bolt, Stud. A bolt threaded on both ends, one end of which is screwed into a hole drilled and tapped in the work for it.

It is generally used where there is not sufficient access to use through bolts and where it is not practicable or possible to drill through the work.

Bolt, Through. A metal rod used as a fastening, with heads upset at both ends, after it is fitted in place. Also applied to bolts passing through the work as a distinction from stud bolts.

Bolt and Nut. A metallic pin threaded over a portion or all of its length and having one end upset or forged to form a head. The nut is a piece of metal drilled and threaded to fit and travel along the helical threads on the bolt by turning or revolving.

Pages 774, 798, 800.

Bolt and Nut Machines. Machines designed to forge and thread bolts and nuts are known as bolt cutter, bolt forging or bolt header, bolt pointer, nut tapper, etc. Page 752.

Bolted Plate. See PLATE, BOLTED—PORTABLE OR DETACHABLE.

Bolter Up. A workman who fastens the steel work in place with bolts, preparatory to and in order to facilitate its permanent fastening or riveting up.

Bolting Up. Securing parts of a structure in proper position by means of bolts and nuts preparatory to riveting.

Bone in Her Mouth. An expression used in speaking of a ship making considerable speed. It refers particularly to the foam on the bow wave.

Bonjean Curves. Curves of areas of transverse sections and curves of moments of the same above the base line.

Bonnet, A term applied to a valve cover. In most valves the bonnet is designed to enclose and guide the valve stem.

Booby Hatch. See HATCH, BOOBY.

Boom. A term applied to a spar used in handling cargo, or as the lower piece of a fore-and-aft sail.
Pages 320, 332, 333, 338, 340, 341, 813.

Boom Chock. See CHOCK, BOOM.

Boom Crutch. A term applied to a structure built up from a deck to support a boom when it is not in use.
Pages 321, 335, 336.

Boom Mountings. All metal bands, collars and other gear secured to a boom to connect it to a mast or for attaching ropes to the boom.
Pages 321, 332, 333, 335, 336, 337, 338, 340, 341, 843.

Boom Stowage. Provision for stowing the booms when not in use and consisting essentially of boom crutches or chocks.
Pages 321, 335, 336, 346.

Boom Table. An outrigger attached to the mast or a structure built up around a mast from the deck to support the heel bearings for booms. Boom tables are necessary to provide proper working clearances when a number of booms are installed on one mast.
Pages 320, 343.

Booster Pump. See PUMP, TRANSFER.

Boot-Topping Paint. See PAINT.

Borer, Vertical. See VERTICAL BORER.

Boring Bar. A portable, heavy duty tool used for boring and facing where true alignment is of prime importance. These tools usually consist of a heavy shaft which is passed through the part to be bored and supported by bearings which are adjusted to the proper alignment. A cutter head which holds the cutting tools is fitted to slide along the shaft on a feather and the travel or feed of the cutter head is regulated by a feed-screw recessed into the shaft. The shaft is rotated by mechanical means and the feed is regulated by hand or automatically depending on the type of tool.

Boring bars are used in a shipyard for boring, re boring, facing or grooving rudder post gudgeons, stern tube bearings, cylinders, turbine engine casings, etc.

Pages 766 to 768.

Boring Machine. Boring machines may be divided into two general classes, vertical and horizontal. The standard designs of these machines are not intended exclusively for boring, as the name indicates, and very often boring constitutes a small part of the work. For instance, vertical boring machines are very generally used for turning cylindrical, flat and tapering surfaces, whereas many machines of the horizontal type may be used for drilling, milling and flange facing. Because of this fact, the names vertical, boring and turning machines, and horizontal boring, drilling and milling machines, are frequetly applied to these two classes of machine tools.
Pages 715, 722, 726, 731, 732, 733.

Boring Machine, Radial Wood. See DRILLING MACHINE.

Boring Machine, Rod. A two-spindle drilling and boring machine, specially designed for drilling and boring holes which must have centers an exact distance apart.

Boring Mill, Horizontal. See BORING MACHINE.

Boring Mill, Vertical. See BORING MACHINE.

Bosom Piece. A short piece of angle bar used as a butt strap or connecting piece. Unlike the heel piece, its flange projects in the same direction as the bars it connects and it is fitted in the bosom or between the flanges of the bars it joins.

Boss Barrel. A term applied to the plating around the boss and stern tubes.

Boss Frame. See FRAME, BOSS.

Boss Plate. See PLATE, BOSS.

Boss, Propeller. See PROPELLER BOSS.

Boss, Propeller-Post. That portion of the propeller post that is swelled out to receive the stern tube.

Bottom. That portion of a vessel's shell between the keel and the lower turn of the bilge. In Bottomry used with reference to the ship as a whole.

Bottom, Outer. A term applied to the bottom shell plating in a double bottom ship.

Bottom Strake. See STRAKE, BOTTOM.

Bottomry. The business of leasing or mortgaging ships.

Bound. Confined, Destined.
Outward Bound. Bound for the sea.
Homeward Bound. Bound for the vessel's home port.
Tide Bound. Unable to progress because of adverse tide.
Wind Bound. Unable to make progress because of adverse winds.

Bow. The sides of a vessel at and for some distance abaft the stem, designated as the right hand, or starboard bow, and the left hand, or port bow.

Bow Chock. See CHOCK, BOW.

Bow Chock Plate. A plate fitted for the purpose of taking a bow chock. This plate is fitted near the stem and above the forecastle deck.

Bow, Clipper. A long, curved overhanging bow, such as was characteristic of the fast wooden sailing ships built in the United States during the middle of the nineteenth century.

Bow Grace. A term applied to the fenders suspended over the bow of a ship as protection against ice.

Bow Ornament. A figurehead or ornament fitted on the bow or bobstay piece.

Bow Plate. See PLATE, BOW.

Bow Plating. A term applied to the shell plating in the bow of a vessel.

Bow Port. See PORT, BOW.

Bow Rope. A rope leading from a vessel's bow to another vessel or to a wharf for the purpose of hauling her ahead or securing her. Also known as "bow-line" or "bow-fast."

Bow Wave. The wave thrown up at the bow of a vessel as she plows through the water.

Bower Anchors. See ANCHOR, BOWERS.

Bowlines. Ropes connected by bridles to the leeches of square sails and leading forward for use in hauling the weather leech well forward in order to hold the wind when sailing close-hauled. When sailing in this manner a vessel is said to be on a bowline, that is, close to the wind.

Bowsprit. A spar projecting forward over the bow for the purpose of holding the lower ends of the head sails.
Pages, 599, 813.

Bowsprit Cap. An iron band fitted on the forward end of the bowsprit.

Box Keelson. See KEELSON, BOX.

Boxing the Compass. The enumeration, in regular sequence, of the points and fractional points of the mariners' compass.

Box, Starting. See STARTING BOX.

Brace. A rope attached to the yard arm. By means of this rope the position of the yard arm may be altered in a horizontal plane. This operation is known as trimming sail.

Bracing, Boiler. See BOILER BRACING.

Bracket, Boiler. See BOILER BRACKET.

Bracket, Frame. A bracket connecting the side frame to the margin plate of a double bottom.

Pages 370 to 466, 487 to 497, 522 to 527.

Bracket, Plate. A plate, usually of triangular shape, provided for the purpose of rigidly connecting structural members.

Brackets, Beam. A term applied to small steel plates, usually of triangular shape, used to fasten the deck beams to the frames at the side of a vessel. Also used to fasten deck half beams to fore and aft bulkheads, casings or coamings.

Pages 370 to 466, 487 to 497, 522 to 527.

Brake, Solenoid. See SOLENOID BRAKE.

Brails. Ropes rove through blocks fastened to a spar and attached to the leech of the sail. The overhauling of these ropes gathers the sail up against the spar.

Braze. The joining of certain metals by the use of a hard solder.

Brazed. A term applied to a joint made with a solder of copper and zinc. When making the joint a flux of borax is generally used and the parts are brought to a red heat.

Breadth, by American Bureau of Shipping Rules. The breadth is the greatest molded breadth taken over the frames, in feet

Breadth (extreme). The maximum breadth measure over plating or planking, including beading or fenders.

Breadth, Molded. The greatest breadth of a vessel, measured from the heel of frame on one side to the heel of frame on the other side.

Breadth, Register. The breadth of the broadest part on the outside of the vessel shall be accounted the vessel's breadth of beam, and should be taken either by plumb lines let full so as to touch the sides of the vessel or by other practical means.

Breaker. A wave breaking violently over or against a reef, rock, etc., lying at or below the surface of the water; a small water cask. In the U. S. Navy casks of eight gallons or less capacity are known as breakers.

Break in. To produce a deformation in the plating at a seam by driving the calking edge down too hard.

Break of Poop or Forecastle. The point at which the partial decks known as the poop and forecastle are discontinued.

Breakwater. A term applied to plates or timbers fitted on a forward weather deck to form a V-shaped shield against water that is shipped over the bow.

Breast. Rounded bows are sometimes called the breast of a vessel. To breast the sea is to meet the waves bows on.

Breast Hook. See HOOK, BREAST.

Breeches Buoy. A life saving contrivance for rescuing persons from a wreck. It consists of a ring buoy fitted with a canvas trunk similar to the upper part of a pair of breeches.

Bridge. A high transverse platform, often forming the top of a bridge house, extending from side to side of the ship, and from which a good view of the weather deck may be had. An enclosed space called the pilot house is erected on the bridge in which are installed the navigating instruments, such as the compass and binacle, the control for the steering apparatus and the signals to the engine room. While the pilot house is generally extended to include a chartroom and sometimes staterooms, a clear passageway should be left around it. As the operation of the ship is directed from the bridge or flying bridge above it, there should also be clear open passage from one side of the vessel to the other.

Bridge, Connecting. A narrow walkway fitted between the poop and bridge decks or between the bridge and forecastle decks. This walkway is common on oil tankers on account of the slippery condition of the upper deck and is particularly desirable where bulwarks are not fitted.

Bridge Deck. See DECK, BRIDGE.

Bridge Deck Stringer. See STRINGER, BRIDGE DECK.

Bridge Deck Stringer Bar. See STRINGER, BAR.

Bridge Gunwale. See GUNWALE, BRIDGE.

Bridge House. A term applied to an erection or superstructure fitted about amidship on the upper deck of a ship. The officers' quarters, staterooms and accommodations are usually located in the bridge house.

Bridge House, Closed in. A bridge house having bulkheads at both the forward and after ends.

Bridge House Frame. See FRAME, BRIDGE HOUSE.

Bridge House, Open. A bridge house having the forward and after ends open.

Bridge, Long. See BRIDGE, CONNECTING. A fore and aft walkway between deck houses.

Bridge, Navigating or Flying. The uppermost platform erected at the level of the top of pilot house. It generally consists of a narrow walkway supported by stanchions, running from one side of the ship to the other and the space over the top of the pilot house. A duplicate set of navigating instruments and controls for the steering gear and engine room signals are installed on the flying bridge so that the ship may be navigated in good weather from this platform. Awnings erected on stanchions and weather clothes fitted to the railing give protection against sun and wind.

Page 581.

Bridge Piece. See ARCH PIECE.

Bridge, Pilot. See BRIDGE, NAVIGATING OR FLYING.

Bridge Sheerstrake. The strake of outside plating adjacent to the bridge deck.

Bridge Warping. A platform erected at the after end of a vessel for the use of the navigating officers when docking.

Brig. A vessel having two masts, fore and main. Both of these are square rigged but the main mast has in addition a gaff main sail.

Brigantine. A vessel having two masts, fore and main. The foremast is square and the main mast fore-and-aft rigged.

Broach. To suddenly veer into the wind laying the sails aback, thus exposing the vessel to danger of

capsizing; said usually of a vessel running with the wind quartering.

Broken Backed. Said of a vessel when, owing to insufficient longitudinal strength, grounding, or other accident, her sheer is reduced or lost, thereby producing a drooping effect at both ends. (See HOGGED.)

Brow. A small curved angle or flanged plate fitted on the outside of the shell of a ship over an air port to prevent water running down the ship's side from entering the open port.

Bronze. Described under Metals.

Bucket, Pump. See PUMP BUCKET.

Bucket Valve, Pump. See PUMP BUCKET VALVE.

Bucklers. Generally, though not exclusively, applied to devices designed to close chain pipes, hawse pipes, and turret gun port openings.

Built-in Furniture. See FURNITURE, BUILT-IN.

Built-up Frame. Described under FRAME.

Bulb Angle Bar. An angle bar having a bulb or swell worked along the edge of one flange.

In ship work it is used for frame bars, light bulkhead stiffeners and deck beams.

The size is denoted by dimensions of cross section and weight per running foot.

Bulb Angle Frame. See FRAME, BULB ANGLE.

Bulb Plate. A narrow plate, generally of mild steel, rolled with a bulb or swell along one of its edges.

In ship work it is used for bilge keels, hatch coamings, built-up beams, etc.

Bulb, Tee. A rolled shape, generally of mild steel, having a cross section shaped like the letter T, with a bulb formed along the outer edge of the web.

In ship work it is used for bulkhead stiffeners, deck beams, etc.

The size is denoted by dimensions of cross section and weight per running foot.

Bulk Cargo. Cargo made up of commodities such as oil, coal, water, grains, etc.

Bulkhead. A term applied to any of the partition walls used for subdividing the interior of a ship into the various compartments. The main partition walls also serve as strength members of the ship's structure and as a protection against water passing from one compartment to another.

Pages 437, 488, 493, 497, 502 to 514, 516 to 519, 521, 579, 580, 581, 591.

The American Bureau of Shipping requires that all vessels should have complete transverse bulkheads which extend continuously to the Strength Deck and are so spaced that no compartment is more than 100 feet long; where this is impracticable the transverse strength and stiffness of the hull is to be as effectively maintained by means of partial bulkheads. The scantlings and arrangements of strength bulkheads are to be based upon the requirements for watertight bulkheads.

The American Bureau of Shipping requires that collision bulkheads are to be fitted in all Vessels; they are to be placed at a distance which is not less than .05 length abaft the stem; this distance is to be measured on the load line. These bulkheads are to extend to the weather deck in flush deck Vessels and to the Freeboard Deck in Vessels having partial superstructures.

The scantlings and arrangements are to be as required for deep tank bulkheads having a head of water to the top of the bulkhead. The stiffeners are to be at least 25 per cent stronger than is required for other bulkheads; the thickness of the plating is to be as required for 6 inches more spacing than is adopted.

The American Bureau of Shipping requires that after peak bulkheads are to be fitted in all Steamers; they are to be arranged to shut off shaft tubes from the rest of the Vessel, in a watertight compartment; they should extend to the Strength Deck or efficient partial bulkheads are to be fitted to that height. The scantlings and arrangements of the watertight bulkhead are to be as required for deep tank bulkheads having a head of water to the load line; they are to be specially strengthened and stiffened in way of shaft tubes. In Sailing Vessels, which have sea connections to after pumps, similar arrangements are to be made so that the after pumps may be shut off from the rest of the Ship in a watertight compartment.

The American Bureau of Shipping requires that machinery spaces are to be enclosed by bulkheads which are watertight to the Freeboard Deck. Where the machinery space is in the midship body and its length exceeds .15 length in association with a freeboard which is less than .15 draft, the bulkheads should extend to a superstructure deck or an intermediate bulkhead should be fitted; where the length of the machinery space exceeds .2 length in association with a freeboard less than .25 draft and in cases where the proportions are intermediate, the bulkheads should extend to a superstructure deck or an intermediate bulkhead should be fitted. Where the machinery space is in the after body and its length exceeds .15 length in association with a freeboard which is less than .2 draft, the bulkhead at the fore end of the space should extend to a superstructure deck or an intermediate bulkhead should be fitted.

The American Bureau of Shipping requires that cargo spaces in Vessels 285 feet long and above, should be subdivided by a watertight bulkhead between the collision bulkhead and the fore end of a midship machinery space; two watertight bulkheads should be fitted between the collision bulkhead and an after machinery space; the forward bulkhead in each case should not be more than .25 length abaft the stem.

In Vessels 335 feet long and above, a watertight bulkhead should be fitted between the after peak and the after end of a midship machinery space about .25 length forward of the after post; three watertight bulkheads should be fitted between the collision bulkhead and an after machinery space. Where the freeboard is less than .15 draft in Vessels 335 feet long, .2 draft in Vessels 435 feet long and above, and where the ratios are proportionally intermediate in Vessels between 335 and 435 feet length, the cargo space bulkheads should extend to a superstructure deck, or an additional bulkhead should be fitted in the fore body and after body respectively. In Vessels which have less sheer than the ordinary freeboard standard sheer, the arrangement of the bulkheads should be adjusted to provide not less effective subdivision than is obtained under the above requirements.

Bulkhead, After Peak. A term applied to the first transverse bulkhead forward of the stern post. This bulkhead forms the forward boundary of the after peak tank and should be made watertight.

Page 510.

Bulkhead Bounding Bar. A bar used for the purpose of connecting the edges of a bulkhead to the tank top, shell, decks, or to another bulkhead. Angle bars are generally used for this purpose as both flanges are easily caulked.

Bulkhead, Boiler Room. A term applied to a bulkhead bounding the boiler space.

Bulkhead, Cargo Hold. A term applied to a bulkhead bounding a cargo hold.

Bulkhead, Center Line. A fore and aft or longitudinal bulkhead erected on the center line or in the same plane as the keel. Also a reference line scrived on a transverse bulkhead to indicate the center of the ship.

Bulkhead, Coal Bunker. A term applied to a coal bunker partition wall. These bulkheads, when they serve no other purpose than enclosing coal bunkers, need not be made watertight.

Bulkhead Coaming. See COAMING, BULKHEAD.

Bulkhead, Collision. The foremost transverse watertight partition in a ship that extends from the bottom of the hold to the freeboard deck. The principal object of this bulkhead is to keep the water out of the forward hold in case of a collision or damage to the bow.

Page 510.

Bulkhead, Corrugated. A bulkhead made from plates of corrugated metal or by flat plates alternately attached to the opposite flanges of the bulkhead stiffeners. Corrugated metal bulkheads are used around staterooms and quarters. Corrugated cargo hold bulkheads are generally constructed of flat plates alternately attached to opposite flanges of the stiffeners, but they are weak in compression.

Bulkhead, Deck. The uppermost continuous deck to which all transverse watertight bulkheads are carried. The term is used in connection with the method of subdividing merchant ships described in the Report of the Committee appointed by the president of the British Board of Trade.

Bulkhead, Engine Room. A term applied to a bulkhead bounding the machinery space.

Bulkhead, Fireproof. The International Convention for the Safety of Life at Sea defines a fireproof bulkhead as one capable of resisting, intact, for one hour, a fire having a temperature of about 1,500 degrees Fahrenheit. The Bulkhead Committee decided that steel watertight bulkheads, not lined with inflammable material, may be regarded as fire resisting. Fireproof bulkheads should be fitted above the cargo holds at intervals not exceeding 131 feet.

Bulkhead, Fore Peak. The bulkhead nearest the stem, which forms the after boundary of the fore peak tank. When this bulkhead is extended from the bottom of the ship to the weather deck it is also called the collision bulkhead.

Page 510.

Bulkhead Frame. See BULKHEAD BOUNDING BAR.

Bulkhead Liners. See LINERS, BULKHEAD.

Bulkhead, Longitudinal. A partition wall of planking or plating running in a fore and aft direction. Oil tankers are required to have at least one fore and aft bulkhead in the cargo oil space. Fore and aft bulkheads are very common on warships.

Pages 511, 512, 521, 579, 580, 581.

Bulkhead, Oil Tight. A partition of planking reinforced where necessary with stiffening bars and capable of preventing the flow of oil under pressure from one compartment to another. The riveting must be closer spaced than in watertight work and special care must be taken with the calking.

Bulkhead, Partial. A term applied to a bulkhead that only extends to a portion of the way across a compartment. They are generally erected as strength members of the structure.

Bulkhead Plate. This term may be applied to any plate in any strake of bulkhead plating.

Bulkhead, Poop. The wall erected at the forward end of the poop running between the upper and poop decks.

Bulkhead, Recess. A bulkhead bounding a compartment that is recessed off from a main compartment. This is frequently done at the after end of the machinery space to accommodate the thrust block.

Page 507.

Bulkhead, Screen. A term applied to a light non-watertight bulkhead fitted between the engine and boiler rooms. This bulkhead is fitted to keep the dust and heat out of the engine room, and is often constructed around the after ends of the boilers.

Page 511.

Bulkhead Stiffeners. A term applied to the beams or girders attached to a bulkhead for the purpose of supporting it under pressure and holding it in shape. These stiffening beams are usually spaced from about two to four feet apart and are attached to the shell, tank top and decks by brackets or lugs.

Vertical stiffeners are most common on bulkheads, but horizontal stiffeners or a combination of both may be used.

Bulkhead Stringer. A term sometimes applied to horizontal bulkhead stiffeners. A horizontal girder running across and riveted to a bulkhead for stiffening purposes. The stringer is connected at the ends by a gusset bracket to the side stringers or shell.

Bulkhead, Structural. A partition wall that is designed to perform the work of a strength member of the ship's structure. Most all of the main water tight bulkheads are strength members.

Bulkhead Stuffing Box. See STUFFING BOX, BULKHEAD.

Bulkhead, Temporary. Any partition wall erected to temporarily divide a compartment or for the purpose of keeping out water until a permanent bulkhead is repaired or installed.

Bulkhead, Transverse. A partition wall of planking or plating running in an athwartship direction across a portion or the whole breadth of a ship. The principal function of transverse bulkheads is to divide the ship into a series of watertight compartments so that any rupture of the shell will not cause the loss of the vessel.

The best practice is to fit transverse bulkheads near enough together so that the admission of the sea to any two adjacent compartments will still leave the ship enough reserve buoyancy to float. Transverse bulkheads also serve as efficient strength members and are important in preserving the transverse shape of a vessel.

These bulkheads also serve the purpose of subdividing the cargo space and quarters into compartments of desirable length.

Pages 233 to 236, 437, 488, 493, 497, 502 to 513, 516 to 519, 521, 579, 580, 581, 591.

Bulkhead, Trunk. A term applied to the casings or partition that forms an enclosure running from deck to deck and surrounding hatch openings.

Pages 493, 515.

Bulkhead, Wash. A non-watertight divisional bulkhead usually erected on the center line of deep tanks and peak tanks. The peak tanks are generally narrow at the bottom and the wash bulkheads installed in them need not be constructed but a few feet down from the tank top. They should be strongly built to withstand the flow of liquid caused by the motion of the ship.

Bulkhead, Watertight. A partition of planking or plating reinforced where necessary with stiffening bars and capable of preventing the flow of water under pressure from one compartment to another

To do this all seams, butts or connections of the plating or planking must be efficiently calked and the strength of the structure must be sufficient to stand up under pressure.

Bulkhead, Wire Mesh. A partition built up of wire mesh panels.

Page 514.

Bulldozer. A machine for bending heavy steel or wrought iron bars, plates, etc. Its operation is similar to that of a vertical press except that it has horizontal or inclined ways on which the cross head or ram travels. There are two general types of bulldozers, electric and hydraulic.

The hydraulic type is generally used in a shipyard for bending frames, etc. This work is done cold and the table of the machine is arranged so that the ram travels across the centre, the rest of the table being perforated with holes into which pins are set. By setting the pins close to the ram or farther away the bend can be made sharp or easy as desired.

Page 749.

Bull Ring. See Follower Plate, Junk Ring, etc.

Bull Riveting. See Riveting, Bull.

Bulletin Board. A board installed in a convenient location on board ship upon which are posted various bills, such as fire, collision, abandon ship, coaling, messing, etc., general and special orders, notices, etc. The simpler form consists of boards glued together, cut to the proper size, and surrounded by a molding, while the more modern and elaborate ones are constructed of either wood or metal in the form of a shallow locker having a hinged glass front fitted with a lock and metal guards to protect the glass front.

Bull's Eye. An annular piece of hard wood with a large hole for a bowline or other rope to pass through and a score or groove around it for slicing into a strap. It is frequently termed a lizard; the name of a lantern, particularly its lens; the center of a target.

Bulwark. A term applied to the strake of shell plating or the side planking above a weather deck. It helps to keep the deck dry and also serves as a guard against losing deck cargo or men overboard. Where bulwarks are fitted it is customary to provide openings in them which are called freeing ports, to allow the water that breaks over to clear itself. Bulwarks interfere with the rapid handling of cargo as care must always be taken to hoist everything clear of its top.

The American Bureau of Shipping Rules require that bulwarks are to be of ample strength in proportion to their height and efficiently stiffened at the upper edge; bulwark plating on Freeboard Decks is not to be less than .25″ in thickness; it is to be supported by efficient stays not more than 6 feet apart in steamers, nor more than 5 feet in sailing vessels. The bulwark stays should be bulb or flanged plates riveted to angle stiffeners extending from the sheerstrake to the rail and attached to the stringer plate by large clips having at least four rivets through the stringer plates; where round spur stanchions are used there are to be at least two rivets in the spur attachment to the bulwark stiffener; the deck palm should be fastened by at least four ⅞″ bolts tapped into the stringer plate and secured by grummetted nuts; the holes for stanchion palms are to be drilled after the stanchions are fitted in place.

Bulwark Frames. See Frames, Bulwark.

Bulwark Plate. Any plate used in a bulwark strake of plating.

Bulwark Port. See Port, Bulwark, Clearing or Freeing.

Bulwark Stanchions. See Stanchions, Bulwark.

Bumboat. A boat employed in carrying supplies for sale to vessels, the term being a corruption from **bombard,** the vessel in which beer was formerly carried to soldiers on duty.

Bumped. A term applied to a convex head on the end of a water tank or boiler.

Bung Starter. A heavy bat or stave used for striking casks or barrels on either side of the bung in order to start or loosen the bung.

Bunk. A built-in berth or bed. The term is usually applied to a berth in the sailor's or steerage quarters.

Bunker Frame. See Bulkhead Bounding Bar.

Bunker, Hold. See Hold, Bunker.

Bunker, Side. See Side Bunker.

Bunker, Thwartship. See Thwartship Bunker.

Bunkers. Stowage spaces for either oil or coal fuel.

Bunkers, Coal. The spaces or compartments of a ship in which is stowed the coal used as fuel for the boilers.

Buntlines. Ropes toggled to the foot of square sails some distance from the center for use in hauling the foot of the sail up to the yard for convenience in furling. They reeve through blocks at the masthead and thence down to the deck forward of the sail.

Buoy. A term applied to a floating object that is moored or anchored so that it remains at one place. Buoys are used for marking the place on the water where a ship is sunk, where reefs are below, where the edges of the channel are or to provide means for mooring a ship at a desired position.

Buoy, Life. See Life Buoy.

Buoy, Life Ring. See Life Ring Buoy.

Buoy Rope. See Rope, Buoy.

Buoy Mooring. A term applied to a floating object that is anchored in a harbor or roadstead for the purpose of providing a mooring for a vessel. These buoys are commonly made in the shape of rectangular steel tanks having a heavy ring fitted on the top.

Buoyancy. The supporting effort exerted by a liquid (usually water) upon the surface of a body, wholly or partially immersed in it.

Buoyancy Reserve. The floating or buoyancy power of that part of a vessel's hull which is above the load water-line.

Buoyancy, Working. The buoyancy acting at any given time to support a vessel in her floating condition. The term is used in contrast to reserve buoyancy, a portion of which becomes working buoyancy in the event of increased load or of damage resulting in the admission of water to the hull below the waterline.

Burden. A vessel's carrying capacity expressed in long tons.

Burgee. A triangular or swallow-tailed flag used as a distinguishing pennant by yachts and merchant vessels. In some cases it bears the name of the vessel, in others the initials or some device of the company or firm owning or operating the vessel.

Burners. Men who operate gas torches which sever or trim material by burning it away or which heat the edges of a joint so they flow together and unite to form one piece.

Burners, Boiler Oil. See Oil Burners.

Burring Machine. A machine designed to remove burrs from hot pressed nuts.

Burton. A tackle used for various purposes, as for hoisting a topsail aloft, supporting a yard, etc. A topburton is hooked to a topmast pendant and used for setting up rigging, for securing lower yards when rigged for handling weights, and for any other purpose requiring a tackle placed aloft. It is usually rove as a luff, with a fall of sufficient length to be led out on deck when the lower block is at the deck. The fall of the main top-burton is the longest piece of running rigging on a vessel.

Bus Bar. An electrical conductor. A metal bar of low electrical resistance commonly used on the rear of power switchboards for carrying current between electrical apparatus.

Bushelled Steel. Described under Steel and Iron.

Bushelled Steel Bars. Described under Steel and Iron.

Bushelling. Described under Steel and Iron.

Bushing, Stern Tube. See Stern Tube Bushing.

Butt Joint. See Joint, Butt.

Butt Plate. See Plate, Butt.

Butted Frames. See Frames, Butted.

Butterfly Valve. See Valve, Butterfly.

Buttocks. The traces formed by the intersections of longitudinal vertical planes parallel to the central longitudinal vertical plane of the ship, with the forward and after surface of the ship's hull. These traces when occurring in the forebody are called bow lines, and when in the afterbody, buttock lines. However, the term buttocks is often used to denote both bow and buttock lines.

Pages 470, 471, 473; Plates XXX, XXXI.

Butts, Shift of. A term applied to the arrangement of the butt joints in plating. These joints in shell plating should be so shifted that the adjacent strakes of plating have their butts at least two frame spaces apart. Also the butts in any frame space for the complete number of strakes should be made as few as possible, say every six or seven strakes.

Butt Straps. A term applied to a strip of plate serving as a connecting strap between the butted ends of plating. The strap connections at the sides are called seam straps.

Butted Frames. See Frames, Butted.

Buttock. The rounded portion of the lower stern. This term is also applied to fore and aft sections on the line plan.

By-Pass Valve. See Valve, By-Pass.

By the Board. Overboard, over the side, off the decks and into the water.

C

Cabin. The interior of a deck house, usually the space set aside for the use of officers and passengers.

Cabinet, Metallic or Wood. A piece of furniture used for holding clothing and other objects. When made of metal it is generally finished off to resemble wood.

Cable. See Rope Definitions.

Cable-Laid Rope. See Rope, Cable-Laid.

Cable Length. A rough measure of distance equal to about six hundred feet.

Cable Molding. A molding often used in decorating a vessel's stern. It is carved to simulate the appearance of a rope.

Cables, Electric. See Electric Wires and Cables.

Cadmium. Described under Metals.

Caisson. A watertight structure used for raising sunken vessels by means of compressed air.

Calibre. A term applied to the inside diameter of a cylinder, tube or pipe.

Calipers. A gauge having two arms of equal length operating on a hinged joint, and used to measure and transfer dimensions, without the use of figures, on machine or wood work.

Calked Deck. See Deck, Calked.

Calkers. (Steel.) Workmen who secure the water- and oil-tightness of joints in steel ships by swaging the metal into the openings between plates or other parts. (This work is generally done with suitable tools driven by compressed air.)

(Wood.) Workmen who open the seams between the planks and drive in oakum or cotton to make them watertight.

Calking. To make watertight by swaging the sight edges or shapes or plates riveted in place. In wood work to make watertight by filling the seams with oakum.

Pages 781, 784, 788, 790.

Calking Box. A calker's kit box.

Calking Iron. A tool used for driving oakum into seams.

Calking Hammer, Pneumatic. A light machine operated by compressed air, in which a calking tool with its shank having a sliding fit in the bore of the machine is given very rapid, short and powerful strokes.

Pages 781, 784, 788, 790.

Calking Mallet. A wooden mallet used for striking the calking tool when calking a wooden vessel.

Calking Pitch. See Glue, Marine.

Calling Systems, Code. See Code Calling Systems.

Calorimeter. An instrument used to determine the moisture content of steam.

Cam. A surface made up of a series or combination of inclined planes to which rotary motion is imparted by means of the shaft on which carried.

The cam action may take place either in a plane perpendicular to the shaft axis or in a plane parallel thereto.

Cams are generally constructed of hard steel to insure good wearing qualities.

Cam Shaft. A shaft designed to carry and actuate cams.

Camber. Round of Beam. The weather decks of ships are rounded up or arched in an athwartship direction for the purpose of draining any water that may

fall on them to the sides of the ship where it can be led overboard through scuppers.

This arching or rounding up is called the camber or round of beam and is expressed in inches in connection with the greatest molded breadth of the ship in feet, thus "the main deck has a camber of 10" in 40'-0"."

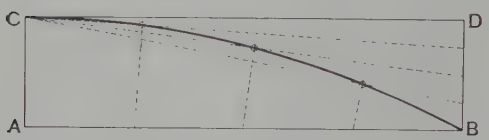
It is measured at the center line of ship at the greatest molded breadth and is the distance from the chord to the top of the arch.

The amount of camber is a varying quantity. The Rules of American Bureau of Shipping give the camber as two one hundredths of the molded breadth, while those of Lloyd's Register say the camber should be about one-quarter of an inch per foot of length of beam.

The camber for the shorter beams is similar to that of the longest and is found by applying the length of the shorter to that of the camber curve of the longest with their center line spots coinciding, that is, one half of the shorter is on each side of the center of the longest. When so applied the ends of the shorter are a certain distance above the chord of the arch and this tends to lift the line of the deck at side at the ends of the ship a distance equal to the camber. This explains why a cambered deck with no sheer along its center line will have sheer at the sides.

The camber may be laid off as the arc of a circle or as part of a parabola.

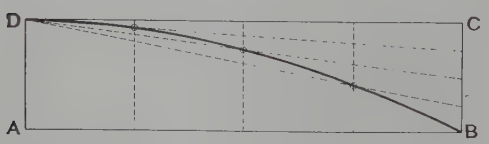
The following are given as examples of each method:



1. To lay off a circular camber.

Let AB represent the half beam, and AC the camber; complete the rectangle ABCD; divide AB and BD into the same number of equal parts; draw straight lines from C to the points of division on BD; from the points of division of AB draw lines perpendicular to the lines from C; the points of intersection on the lines from C will be points on the desired curve.

2. To lay off a parabolic camber.



Draw AB equal to the half breadth and AD equal to the camber; complete the rectangle ABCD; divide AB, DC and BC into the same number of equal parts; from D draw straight lines to the points of division on BC; join the points of division of AB and DC; then a curve drawn through the points of intersection as shown will be the desired curve.

Camel. A float used for helping vessels over sand bars and the like. The process of usage is as follows: the camel is flooded and sunk alongside the vessel to be raised. In its sunken position it is secured to the vessel, after which the water is pumped from the camel, thus supplying additional buoyancy which raises the vessel.

Candle-power. The practical unit of the luminous intensity of sources of light. The unit of Candle Power is derived from the standard maintained by the Bureau of Standards at Washington, D. C.

Cant. A term in general use by shipwrights signifying an inclination of an object from a perpendicular; to turn anything so that it does not stand perpendicularly or square to a given object.

Cant Beam. See Beam, Cant.

Cant Body. That portion of a vessel's body either forward or aft in which the planes of the frames are not at right angles to the center line of the ship.

Cant Frames. See Frames, Cant.

Cant Hook. A lever fitted with a hook, used for turning or slewing heavy articles, especially timbers. The lower end of the lever is sometimes shod with pointed metal.

Canvas Covered Deck. See Deck, Canvas Covered.

Canvas Preservatives. See Paint.

Cap Screw. See Screw, Cap.

Capacity. The measure of power to receive or contain or the measure of ability to exert power. Illustrations: A hold of five hundred tons "capacity." A crane of ten tons "capacity."

Capacity, Boiler. See Boiler Capacity.

Capacity, Current Carrying, of Wires. See Current Carrying Capacities of Wires.

Capacity, Electrostatic. The capacity of a condenser is the quantity of electric charge, measured in coulombs, that it will hold per volt pressure. The unit of capacity is the Farad.

Capacity Plan. A plan of a vessel outlining the spaces available for cargo and containing capacity lists for such spaces and a gage showing deadweight capacities for the vessel at varying drafts and displacements.

Pages 406, 407, 408, 414, 415, 441.

Capping or Nosing. A term applied to a molding used in covering over the joints in joiner work.

Capstan Bar. A hard wood or steel bar used in turning a capstan by hand.

Capstan, Electric. See Capstan, Steam. A power driven capstan in which the electric motor replaces the steam engine. The motor may be connected directly or by means of reduction gearing to the capstan shaft.

Pages 851, 854, 959.

Capstan Foundation. A term applied to a seating prepared for a capstan. This seating is usually constructed by reinforcing the deck with a thicker or extra plate with bars worked between the deck beams beneath.

Capstan, Steam. A vertical drum or barrel operated by a steam engine and used for handling heavy anchor chains, heavy hawsers, etc.

The engine is usually non-reversing and transmits its power to the capstan shaft through a worm and worm wheel. The drum is fitted with pawls to prevent overhauling under the strain of the hawser or chain when the power is shut off. The engine may be disconnected and the capstan operated by hand through the medium of capstan bars.

Pages 391, 854, 855, 862, 863.

Carbon Black. See Paint.

Carbon Tool Steel. See Steel and Iron.

Carbureter. See Gas Engine, Carbureter.

Careen. To incline from the upright either by the elements or mechanically for the purpose of making repairs.

Cargo. Merchandise or goods accepted for transportation by ship.

Cargo, Deck. See Deck, Cargo.

Cargo Hatch. See Hatch, Cargo.

Cargo Hoist. See Winch.

Cargo Hold Bulkhead. See Bulkhead, Cargo Hold.

Cargo Mat. A mat, usually square in form, used to protect the deck covering, locally, when taking stores, ammunition, etc., on board. In its construction, manila rope is generally used. The strands being unlaid are hung over a jackstay on either side, carried around, tied, and tucked to conform to the contour of the mat. The surface then is thrummed to produce a cushioning effect.

Cargo Net. A square net made in various sizes of manila rope or chain and used in conjunction with the vessel's hoisting appliances such as davits, boat cranes, etc., together with the necessary tackles, in hoisting stores, ammunition, etc., aboard ship. The outer edges of rope nets are formed by a continuous jackstay around the net with a bight or sling formed at each corner by seizing the two parts together. The meshes are made by crossing two sets of ropes at right angles to each other and to the jackstay, the ends stuck through the jackstay, a round turn taken and spliced into its own part. At the crossings one rope is pulled through the other under one strand and alternately hitched to right and left.

Pages 825, 879.

Cargo Port. See Port, Cargo.

Cargo Reflector. See Reflector, Cargo.

Carlines. A term applied to short fore and aft beams running under the deck beams or intercostal between them.

Carlines, Beam. See Beam Carlines.

Carlines, Hatch. See Hatch Carlines.

Carpenter (Ship). A woodworker who does the heavier and rougher wood work. In steel shipbuilding he sets the keel blocks and ribbands, builds stages, places the launching ways and packing.

Carrier, Rudder. See Rudder Carrier.

Carrying Dog. A tool with its end so shaped that it can be slipped over the edge of a plate or shape to facilitate its handling.

Casemate Armor. An armored bulkhead or belt fitted on a naval vessel. It may be pierced by gun ports. Ordinarily this armor is of less thickness than the main side belt and is fitted above the latter.

Casing, Boiler Room. The partition or walls enclosing the space above the boiler room in the way of the boiler hatch. This casing should form a trunk of sufficient size to allow the installation and removal of the boilers, and also, when the boilers are in position, to accommodate the smoke stack and ventilator cowls that lead to the boiler room.

Doors are fitted in the casing at the deck levels which give access to gratings and ladders leading down into the boiler room.

The top of the casing should project well above the weather deck where there is no superstructure and should be carried up through the superstructure where one is erected.

Page 515.

Casing, Deck Piping. Covering plates built over exposed deck piping for protection.

Pages 638 to 642.

Casing, Engine Room. The partitions or walls enclosing the space above the engine room in the way of the engine room skylight and hatchway. The casing forms a trunk suitable for access, light and ventilation. At the top of the casing a skylight with hinged covers is fitted through which the heat from the engine room escapes. Doors are fitted in the casing at the deck levels which give access to gratings and ladders leading down into the engine room.

Care should be taken that the engine room casing encloses a space sufficiently large to provide for installing the engines and for lifting the cylinder covers where reciprocating engines are used. Portable strong beams are fitted in the casing trunk to compensate for the opening and for convenience in lifting covers, etc.

The top of the casing should project well above the weather deck where there is no superstructure and should be carried up through the superstructure where one is erected.

Page 515.

Casing, Turbine. See Turbine, Cylinder or Casing.

Cast Iron. Described under Steel and Iron.

Cast Steel Wire Rope. See Rope, Cast Steel Wire.

Casting Bow. See Stem.

Casting, Stern. See Stern Frame.

Castings. Metal frames, gears, housings, etc., made by pouring molten metal into forms and allowing to cool. Stems, stern frames, struts, stern tubes, bitts, chocks, turbine casings, cylinders, gear wheels, etc., are some of the castings common in ship work.

Pages 823, 890, 873.

Castors, Plate. A plate castor is essentially a wheel mounted in such a manner on a post, about two feet high, that it is free to turn on its own axis or around the axis of the post. On a series or bed of such plate castors, ship plates in the course of construction can be easily rolled and handled by a small number of men during the shearing, punching and forming operations.

Plates may be handled with these castors without the use of overhead cranes, thus materially reducing the labor required. The use of plate castors as a means of handling steel plates has been customary in large steel mills for the past twenty-five years, but they have only been recently applied to shipyard use.

To perform its function properly, the head of a plate castor must turn very easily in the direction the plate is moving and the wheel must operate with a minimum of effort. For this reason the head and wheel of plate castors are mounted on small but strong roller bearings.

They are economical and if properly constructed are a material aid in reducing the labor necessary for manipulation of ship plates of all sizes.

Page 739.

Cat Davit. See Davit, Cat.

Cat Head. A term applied to a short beam or support projecting over the sides of a vessel at the bow for the purpose of taking the cat tackle.

Cat Hook. A term applied to a hook used in picking up an anchor after it is brought to the surface.

Cat Tackle. A tackle used in raising an anchor from the surface of the water or from under the hawse pipe.

Cavil. A large piece of timber fastened to the forward or after bitts about midway between the base and top forming a cleat.

Cavitation. The breaking down of the continuous stream lines flowing through a propeller. Cavitation takes place at high speed due to the inability of the water to flow into the wheel as rapidly as it is forced astern.

Ceilers or Plankers. Wood workers, carpenters who fit the planking on the inside and outside of the frames of a wooden vessel.

Ceiling. A term applied to the planking with which the inside of a vessel is sheathed. Also applied to the sheet metal or wood sheathing in quarters and storerooms.

Ceiling, Floor. Planking fitted on top of the floors or double bottom in the cargo holds.

The American Bureau of Shipping requires that close ceiling in vessels with single bottoms is to be fitted on the floors and up to the upper turn of bilge; the ceiling should not be less than 2″ thick in vessels under 200 feet length, 2¼″ from 200 to 250 feet, nor 2½″ in vessels of greater length. The ceiling is to be laid in hatches on the flat floors, or other convenient arrangements are to be made for easy removal when required for cleaning, painting and inspection of the bottom. In vessels with double bottoms, close ceiling is to be laid from the margin plate to the upper part of bilge, so arranged as to be readily removed for inspection of limbers; ceiling is to be laid under all hatchways or the thickness of the plating is to be increased .10″ in thickness. Ceiling on top of double bottom plating is to be laid on top of 1½″ battens, for drainage purposes, or is to be bedded in a substantial body of mixed tar and cement or other suitable covering.

In vessels regularly engaged in trades where the cargo is handled by grabs, steam shovels, and similar mechanical appliances, it is recommended that flush tank top plating be adopted throughout the cargo spaces; that the plating be increased .20″ in thickness; that the least thickness be .50″ in association with 24-inch frame spacing and .74″ with 36-inch frame spacing; intermediate minima should be adopted for intermediate spacings.

Ceiling Hold. A term applied to thick strakes of planking fastened to the inside flanges or edges of the framing in the cargo holds.

Cementing. The American Bureau of Shipping requires that the bottom, including the lower turn of bilge, is to be protected with Portland cement or other approved material, efficiently covering the plates, frames and rivet heads. Portland cement is to be mixed with sharp, fresh water sand, or other satisfactory substance, in the proportion of about one part of cement to two of sand; free exposure to the air should be provided while setting; the thickness at edges is not to be less than three-quarters of an inch.

Cement washing inside of tanks may be adopted instead of painting, if the owners approve; in which case at least two coats are to be given to all the material inside the tank; the first coat is to be moderately thin and applied carefully, so as to thoroughly cover every part.

The top plating of tanks, where ceiled, is to be covered with Stockholm tar put on hot, and well sprinkled with cement powder.

Center Board. A heavy slab of wood or metal fitted in a vertical slot on the center line of a sailing boat. It can be raised or lowered and when lowered it projects below the keel keeping the boat from slipping to leeward.

Center Line Bulkhead. See Bulkhead, Center Line.

Center of Buoyancy. The geometric center of gravity of the immersed volume of the displacement or of the displaced water.

It is determined solely by the shape of the underwater body of the ship and has nothing to do with the center of gravity of the ship.

Center of Buoyancy, Longitudinal. The location longitudinally of the center of buoyancy is usually stated as a distance either forward or aft of the middle perpendicular.

Center of Buoyancy, Vertical. The distance in a vertical direction of the center of buoyancy measured from a given reference line, frequently the bottom of the vessel's keel, though sometimes the plane of the designed water line.

Center of Effort. Term generally used in connection with sails, meaning the center of the application of wind pressure against the sail area. Ordinarily no allowance is made for variation in wind pressure over the sail and the center of effort is assumed to be the center of gravity of the sail area.

Center of Floatation. That point about which a vessel rotates when slightly inclined in any direction from her free position of equilibrium by the action of an external force without change in her displacement. The center of floatation is coincident with the center of gravity of the water plane of the vessel in her initial condition.

Center of Gravity. The point at which the combined weight of all the individual items going to make up a vessel's total weight may be considered as concentrated.

Pages 161, 162.

Center of Gravity, Longitudinal. The location of the center of gravity as regards its longitudinal position, usually stated as a distance either forward or aft of the midship frame or the middle perpendicular.

Center of Gravity, Vertical. The location of the center of gravity as regards its vertical position, usually stated as a distance above the base line or bottom of keel.

Center of Lateral Resistance. That point through which a single force could act producing an effect equal to the total lateral resistance of the vessel. The center of lateral resistance is ordinarily assumed to be coincident with the center of gravity of the central immersed longitudinal plane.

Center of Pressure. That point in a sail or an immersed plane surface at which the resultant of the combined pressure forces act. The center of pressure on a sail is the point at which the resultant of the wind pressure acts and the center of pressure on a rudder is a point at which the resultant of the water pressure acts.

Centering Machine. A machine designed to drill and ream centre of work for a lathe or grinder.

Central Lateral Plane. The immersed longitudinal vertical middle plane of a vessel.

Centrifugal Pump. See PUMP, CENTRIFUGAL.

Chafe. To destroy or wear away by rubbing or abrasive action.

Chafing Plate. A plate worked around the lower edges of hatch beams or carlines to prevent wear on the hoisting ropes. Also applied to plates fitted on the forecastle deck under the anchor chains.

Chain. See EQUIPMENT.

Chain, Cast Steel. The American Bureau of Shipping permits the use of cast steel stud link chain when made in accordance with the specifications given in their rules.

Page 882.

Chain, Close Link. Sometimes known as short link chain. Chain in which the links are so short relative to their width that studs cannot be fitted.

Pages 350, 876, 877, 880.

Chain Compressor. A forging fitted below the upper deck and pinned at one end to the deck casting at the head of the chain pipe or to the ship's structure near by. At the other end of the shank an eye is worked for the attachment of a tackle. The controller is so located that the application of force by tackle or other means at the eye controls or stops entirely the passage of the chain by forcing it against the chain pipe.

Chain Controller. A device located on deck between the windlass and the hawsepipe in line with the anchor chain. The compressor consists of a heavy cast or forged bed shaped to receive a link of the anchor chain and a lever so arranged as to force the chain into the bed at the will of the operator.

This device is termed a chain compressor in the merchant service.

Chain Hoist. A differential block and chain fall operated by an endless chain. Chain hoists are used for raising heavy weights about a shop and weights like cylinder heads, auxiliaries, etc., aboard ship.

Page 797.

Chain Lockers. Spaces or compartments intended for stowage of the anchor chains. They are usually located in the fore hold directly underneath the windlass with chain pipes connecting them to the anchor deck under the wildcats.

Page 486.

Chain Pipe. A pipe generally of cast iron, though sometimes of wrought iron or mild steel, leading from the upper deck bolster to the chain locker for the purpose of handling the anchor chain. At its lower end it is fitted with a half round or so shaped as to prevent the chafe of the chain when running out.

Chain pipes are usually set at an angle to the vertical in order to minimize the noise made by the chain swinging against the chain pipe with the vessel's roll.

Chain, Stud Link. Chain in which each link has a short distance piece (known as a stud) worked at its mid-length at right angles with its major axis. This is done in order to maintain the link shape.

Pages 872, 874, 875, 880, 881, 882.

Chain Stopper. A device used to secure the chain cable when riding at anchor, thereby relieving the strain on the windlass and for securing an anchor in the housing position in the hawse pipe.

Stoppers differ widely in construction. For the smaller cables they are of rope, usually hemp, with a stopper knot or an iron toggle in the outer end and a lanyard for lashing to the cable. For larger cables wire rope is used in lieu of hemp, while for the largest cables the stoppers are of heavy chain fitted with slip hooks and turnbuckles for adjusting and for equalizing the strain when more than one stopper is attached to a cable.

According to its use a chain stopper is termed a "riding stopper" or a "housing stopper." The inner end of the stopper is attached to a deck pad by means of a shackle or lashing.

Pages 691, 859.

Chain Tierers. The men who stow the chain cables as they are paid down into the chain locker. The chains are arranged regularly in symmetrical long flakes in a fore and aft direction. The tierers use chain-hooks and hook-ropes and in some cases tackles in performing their work. Some cables are too heavy to be handled by tierers and are stowed in deep and narrow lockers, where the chain is allowed to assume any position as it is paid down.

Chamfer. To bevel.

Channel Bar. A rolled shape, generally of mild steel, having a cross section shaped like that of an I-beam from which both flanges on the same side of the web have been cut even with that face of the web.

In ship work it is used for frames, deck beams, bulkhead stiffeners, etc.

The size denoted by dimensions of cross-section and weight per running foot.

Channel Bar, or Channel Frame. See FRAME, CHANNEL BAR.

Charlie Noble. The hood of the galley smoke pipe, sometimes used to mean the entire smoke pipe including the hood.

Page 582.

Chart. In general, a map showing the contour of coasts, the location of shoals, rocks, soundings, etc.

There are many charts which do not fall strictly within the above definition, such as

Charts of the Inclination,
Great circle charts,
Heliographic charts,
Physical charts,
Selenographic charts,
Variation charts.

Chart House. A house on or near the bridge, provided with stowage for navigation charts and facilities for their use.

Pages 585, 586.

Chasers. A term sometimes applied to assistants to the yard or shop superintendent. Their functions are to see that the work is promptly started, that the proper sequence of the steps involved is taken, and that the work is not interrupted. Also called Runners. See PROGRESSMAN.

Check Line. An auxiliary line used only for checking dimensions.

Check Pin. A pin designed for securing the crank pin against turning. It is usually of steel and fitted into the crank web.

Check Ring. A protective ring. Usually fitted to prevent the working loose of another part.

Check Rope. See ROPE, CHECK.

Check Valve. See VALVE, CHECK.

Checks. A term applied to cracks or openings in the grain of wood caused by shrinkage of the material in the process of drying. The checks are not continuous and vary in depth from about one sixteenth of an inch to the entire thickness of the wood.

Cheek Block. See BLOCK, CHEEK.

Cheeks of a Block. The outer sides of the frame.

China Wood Oil. See PAINT.

Chine. The line formed by the intersection of side and bottom in ships having straight or slightly curved frames.

Plate XXX.

Chinese Blue. See PAINT.

Chinsing. The inserting of oakum or cotton between plank edges of boats.

Chipper. A workman who cuts or trims away the edges of plates, shapes, castings or forgings, either by hand or by pneumatic tools.

Chipping may be necessary in order to secure a good calking edge or for fitting or finishing purposes.

Chipping Hammer, Pneumatic. A light machine operated by compressed air, in which a chipping tool with its shank having a sliding fit in the bore of the machine is given very rapid, short and powerful strokes.

Pages 781, 784, 788, 790.

Chisel Mortising Machine. See MORTISING MACHINE.

Chock. A term applied to oval shaped castings, either open or closed on top, and fitted with or without rollers, through which hawsers and lines are passed.

Also applied to blocks of wood used as connecting or reinforcing pieces, to blocks of wood used as filling pieces, and to supports for life boats.

Pages 546, 688, 689.

Chock, Boiler. See BOILER CHOCK.

Chock, Boom. A block of wood shaped to receive a boom and used as a rest when the boom is stowed and not in use.

Pages 335, 337.

Chock, Bow. A wedge shaped piece of timber used as an abutment for the bowsprit.

Chock, Closed. A term applied to oval shaped castings, through which hawsers or lines are passed, having no opening in the top.

Chock, Open. A term applied to an oval shaped casting used for passing hawsers or lines through and having the top open.

Chock, Roller. A term applied to an oval shaped casting fitted with one or more rollers and used for the purpose of passing hawsers and lines through.

Chock, Rolling. See KEEL, BILGE.

Chocks, Filling. Timber filling in the triangular space between the bobstay piece, the gammoning piece and the stem.

Chrome Green. See PAINT.

Chrome-Nickel Steel. See STEEL AND IRON.

Chromium Oxide. See PAINT.

Chronometer, Marine. A timepiece mounted on gimbals in a glass-covered case to keep it horizontal and to preserve it from vibration, dust, drafts, and fluctuations of temperature. The mechanism is of a superior construction, having adjustments and compensations for temperature. While generally designed to run 56 hours, it is wound daily at a stated hour and is not regulated.

The instrument is set as accurately as possible and its accuracy observed in an observatory. A certificate of rating is issued, showing its rate of gain or loss and this cumulative error must be considered when observing the time.

Page 1005.

Chuck, Tapping. A tool attached to a lathe or drill press to secure or hold the shanks of drills.

Chuck and Collet Equipment. Tool holding equipment used on drill presses, lathes, screw machines, etc., for adapting the machines to various size tools.

Page 698.

Circuit Breaker. An electric switch equipped with a carbon break and a trip for opening.

Page 950.

Circuit Breaker, Automatic. A circuit breaker, designed for automatically opening an electric circuit when a predetermined abnormal condition exists in the circuit in which the circuit breaker is connected.

Circuit Breaker, Automatic Reclosing. A circuit breaker which will automatically open the circuit in which it is connected when a predetermined abnormal condition exists in that circuit and which will close the circuit automatically when the condition ceases to exist.

Page 1075.

Circular Saw. See SAW, CIRCULAR.

Circulating Pump, Auxiliary. See PUMP, AUXILIARY CIRCULATING.

Circulating Pump, Distiller. See PUMP, DISTILLER CIRCULATING.

Circulating Pump, Main. See PUMP, MAIN CIRCULATING.

Circulating and Air Pump. See PUMP, AIR AND CIRCULATING.

Circulation, Boiler. See BOILER CIRCULATION.

Clack. A simple form of check consisting of a flap suspended vertically or nearly vertically from hinges at top. Purpose to limit flow of liquids to one direction only.

Clack Box. The casing enclosing the clack, the whole forming a clack valve. Box usually a casting similar to other valves.

Clack door. Cover providing access to interior of clack box.

Clamp. A device for holding two or more pieces of material together. It is generally operated by hand.

Clamp. A metal fitting used to grip and hold wire ropes. Two or more may be used to connect two ropes in lieu of a short splice or in turning in an eye.

Clamp, Deck Beam. A wood ship term applied to the fore and aft timber fastened to the frames and reinforcing the shelves which support the deck beams.

Pages 440, 445, 447.

Clamp, Rudder. A term applied to the timbers that are fitted on both sides of the rudder and after portion of the stern to keep the rudder in a fore and aft position during the launching.

Clapper. See TUMBLER.

Clasp Hook. Two hooks or one hook in two parts each forming a mousing for the other, and suspended from the same link or eye; or a pair of hooks whose jaws overlap and are held in place by a sliding ring. Also known as clip hook. See SISTER HOOKS.

Classification. Certification by a classification society as to the character of construction and outfitting of the vessel classed.

Classification Society. An institution that supervises the construction of vessels throughout under established rules, tests all materials for Hulls, Machinery and Boilers; Proof tests all Anchors and Anchor Chains and issues Certificates of Classification which are a builder's receipt, and owner's guarantee, an underwriter's authority and a shipper's business guide.

Claw Off, Claw. To work a vessel off a lee shore to windward; especially when the performance is attended with great difficulty.

Cleaners, Boiler Tube. See BOILER TUBE CLEANERS.

Clearance. The distance between the face of the piston, at the end of the stroke, and the inner face of the cylinder head, also the volume between the face of the valve and the face of the piston, the latter being at the end of the stroke, plus the volume of the steam port to the valve seat. It is frequently expressed as the percentage which the above volume makes of the volume swept by the piston.

Clearance is allowed in order to avoid the possibility of knocking the head off in case of the accumulation of water in the cylinder.

The clearance volume must be filled with steam at each stroke before the piston can be moved. This steam is not effective for work before expansion begins. A great portion of the loss due to this cause may be made up by cushioning the piston which consists of compressing the exhaust steam before the end of the stroke is reached. Cushioning assists in gradually stopping the piston, in restoring the temperature of the sides of the cylinder, which tend to cool during exhaust, and in producing uniformity in the tangential effort on the crank pins especially in high speed engines.

Clear Hawse. A vessel is said to have a "clear hawse" if when moored her cables lead off to the anchors on their respective sides clear of each other, i. e., without a cross in the hawse.

Clear Hawse Pendant. A strong pendant used in clearing hawse, consisting, usually, of a wire rope tailed with about six fathoms of chain and fitted with a pelican hook for connecting to the chain cable.

Clearing Port. See Port, Bulwark, Clearing or Freeing.

Cleat, or Cavil. A wood or a metal fitting having two projecting arms or horns to which a sheet, halyard or other rope is belayed. The deck, side plating, a stanchion, or other convenient structure serves as a support for securing the cleat. The term cavil is sometimes applied to a cleat of extra size and strength.

Page 335.

Clew. Either lower corner of a square and the lower after corner of a fore and aft sail; the nettles of light line woven into a sword mat at each end of a hammock by which it is suspended; the ring, heart, spectacle, or other shaped iron worked into the corner of a sail; to haul, by means of the clew garnets and clew lines, a sail up to the yard for furling; also to force a yard down by hauling on the clew lines.

Clinch. The end of a rope half-hitched around the standing part and stopped; to spread or rivet the point of a pin or bolt upon a plate or ring to prevent it from pulling out.

Clinch Ring. An oval shaped, heavy ring similar to a washer used under the heads of bolt and spikes where they pass through wood.

Page 823.

Clinching Plate. A small piece of plate used in the mold loft for backing up the nails or tacks used to hold a wood template together. After nailing the pieces of a template together it is turned over and the connections placed over the plate, while clinching the points of the tacks.

Clinker Built. See Plating, Clinker System.

Clipper Bow. See Bow, Clipper.

Clips. Short lengths of bars, generally angles, used to attach and connect the various members of the ship structure.

Clock, Time Stamping. See Time Stamping Clock.

Club-Foot. A fore foot in which displacement or volume is placed near the keel and close to the forward perpendicular. Its use results in forward sections with a marked tumble home at and below the load water line. It results further in very full forward endings for the lower water lines and a relatively fine entrance for the load water lines. A club foot may be used with advantage in vessels designed for speed length ratios below 1.1 particularly where such vessels have good draft.

Clump Block. See Block, Clump.

Clutch. A device designed to permit connecting and disconnecting two adjacent lengths of shafting in as expeditious a manner as possible.

Clutches may be of various types depending upon the method of operation employed. Some of the principal types are as follows: mechanical, frictional, pressure and magnetic.

Coal Bunker. See Bunker, Coal.

Coal Bunker Bulkhead. See Bulkhead, Coal Bunker.

Coal Bunkers. The spaces allotted for stowage of coal for ships' use.

Coal Forge. A forge in which coal is used as fuel. See Forge.

Coal Passer. A member of a ship's boiler room force who removes the coal from the bunkers and supplies it to the firemen or stokers.

Coaling Hatch. See Hatch, Coaling.

Coaling Port. See Port, Coaling.

Coaming, Bulkhead. A term applied to a strake of plating running across the top and bottom of tween deck, poop, bridge and forecastle bulkheads. The coamings are usually made thicker than the remaining plating and serve the function of top and bottom supports.

Coaming, Hatch. A frame bounding a hatch for the purpose of stiffening the edges of the opening and forming the support for the covers. In a steel ship it generally consists of a strake of strong vertical plating completely bounding the edges of a deck opening. In wood ships this coaming consists of heavy timber forming a frame around a hatch.

Coaming, House. A term applied to the narrow vertical plates bounding the top and bottom of a deck house. These plates are made somewhat thicker than the side plating and form a frame for the base and top of the house. Also applied to the heavy timber forming the foundation of a wood deck house.

Coaming, Man Hole. A frame worked around a man hole for the purpose of stiffening the edges of the opening and providing a support for the cover.

Coaming, Skylight. See Skylight, Coaming.

Cock. A valve which is opened or closed by giving a disc or tapered plug a quarter turn. When a plug is used it is slotted to correspond with the ports in the valve.

Pages 1035, 1037.

Cock, Air. A cock for the control of air entry or escape from pump, condenser, etc.

Page 1035.

Cock, Ash. Cocks for supplying water to the fire room for use in cooling hot ashes, etc.

Cock, Drain. A small cock fitted to cylinders, steam jackets and other chambers so that any water which may collect can be drained away.

Cock, Feed. A cock for the control of the feed water flow.

Cock, Pet. A small cock used to test the working of bilge, feed and other similar pumps, and to indicate,

in lieu of a gage-glass, the height of water or other liquid in a tank or other container. Also used for draining cylinders.

Cockpit. Originally this term applied to a compartment below the gun deck of men of war, devoted during battle to the surgeon and his assistants. Applied to small boats, it refers to a sunken place or pit for the accommodation of the crew.

Cocks, Test. Small cocks either attached to the boiler shell or to a separate mounting for the purpose of indicating the water level within the boiler.

Test cocks are usually three or four in number. The lowest is usually located several inches above the highest heating surface in the boiler and the highest well into the upper part of the steam space.

Code Calling Systems. Code calling systems are used in large shipbuilding plants for the purpose of keeping executives in touch with one another as well as for locating any important man quickly in whatever part of the plant he may be.

Page 1087.

A code calling system consists of a master station containing the code sending instruments—located usually near the switchboard operator—and a system of electric signals which are controlled by the master station. The signals are scattered through the shipyard so that when they are sounded they are heard everywhere. Each man likely to be called is assigned a code number. When a man is wanted, if his code number happens to be 22, for instance, the code sending instrument is set so as to sound all the signals twice in rapid succession and, after a short pause, twice again. No matter where the man is he hears his signal and calls up the switchboard operator to find out what is wanted of him.

The signals that are distributed throughout the plant are varied according to the noise conditions. For noisy departments horns and gongs are used, while for quiet offices soft toned bells, buzzers or lights are effective.

The large area covered by a shipbuilding plant of even moderate size makes a code calling system of great assistance in carrying along the production smoothly and without delays.

Coefficient. A ratio between certain characteristics of a vessel which serves as a means of comparing that vessel with others. See particular coefficient desired.

Coefficient, Admiralty. A coefficient used in power estimating. The Admiralty coefficient is the cube root of the square of the displacement in tons times the square of the speed in knots divided by the indicated or shaft horse power. The valve of the Admiralty coefficient is practically identical for similar ships at corresponding speeds.

Coefficient, Block. The ratio of the immersed volume of a ship to the product of the waterline length x the breadth at waterline x the draft to the top of the keel.

Coefficient, Cylindrical. Same as prismatic coefficient. The ratio of the immersed volume of a vessel to the volume of a circumscribed cylinder. The cylinder may be circumscribed about the midship section with a length equal to the length of the vessel, in which case the longitudinal cylindrical coefficient results; or it may be circumscribed about the load waterline with a length equal to the draft of the vessel, in which case the Vertical Cylindrical Coefficient results. The former is sometimes called the longitudinal coefficient and the latter the vertical coefficient. In case merely the term cylindrical coefficient is used without qualification invariably the longitudinal coefficient is referred to.

Coefficient, Displacement Length. The ratio of a vessel's displacement, in tons, to 1/100 of its waterline length in feet cubed. It is expressed thus:

$$D \div \left(\frac{L}{100}\right)^3$$

It is a criterion of the amount of displacement upon a given length. Similar ships have the same value for this expression.

Pages 155, 157, 158, 159.

Coefficient of Fineness. The ratio of the area of a curve to the area of its circumscribed parallelogram. The coefficient of fineness is sometimes used in relation to a solid, in which case it is the ratio of the volume of the solid to the volume of a circumscribed rectilinear parallelopiped.

Coefficient, Longitudinal. The ratio of the immersed volume of a ship to the product of its waterline length and immersed area of midship section. Also called Prismatic Coefficient.

Pages 167, 168, 200, 201, 224.

Coefficient, Midship Section. The ratio of the immersed area of the midship section to the area of a rectangle having sides equal respectively to the waterline breadth and draft at the midship section.

Pages 160, 161.

Coefficient, Prismatic. See COEFFICIENT, LONGITUDINAL.

Coefficient, Propulsive. The ratio between the Effective Horsepower and the Indicated Horsepower or Shaft Horsepower at any given speed:

$$\frac{\text{E.H.P.}}{\text{I.H.P.}} \text{ or } \frac{\text{E.H.P.}}{\text{S.H.P.}}$$

Coefficient, Waterplane. The ratio which the area of a waterplane bears to its circumscribing rectangle.

Coffee Urn. A large receptacle used for boiling coffee.

Cofferdams. Void or empty spaces separating two or more compartments for the purposes of insulation, or to prevent the liquid contents of one compartment from entering another in the event of the failure of the walls of one to retain their tightness.

Coil. A term applied to a nest of piping. It may be composed of several pipes connected at the ends by headers or return bands, or it may consist of a continuous pipe which has been given a number of turns.

Coir Rope. See ROPE, COIR.

Coke Forge. A forge in which coke is used as fuel. See FORGE.

Cold Saw. See SAW, COLD.

Collar. As applied to machinery and machinery parts. A section of increased diameter in the form of a ring. As applied to ship structure, a piece of plate or a shape fitted round an opening for the passage of a continuous member through a bulkhead or floor plate to secure tightness against dust, water, air, etc.

Collar. See COLLAR, ANGLE.

Applied to pieces of light plating formed to make a close fit around any beam at the point where it pierces a deck or bulkhead. Plate collars are used to obtain semi-watertightness, weather tightness and for finish.

Collar, Angle. Also called a staple. A term applied to a piece of angle bar that is forged or bent to form a close fit around a structural member at the

point where it passes through a deck or bulkhead. An angle collar is a fitting that can be efficiently caulked and should be used where watertightness is necessary.

Collier. A vessel designed for the carriage of coal. It may or may not be fitted with especial appliances for coal handling.

Pages 430 to 437; Plates XX, XXI, XXII.

Collision Bulkhead. See BULKHEAD, COLLISION.

Collision Mat. A large mat used to close an aperture in a vessel's side resulting from collision. The mat is constructed of a double thickness of cotton canvas quilted together, body roped, and thrummed on one side with hemp thrums. Hogging and distance lines used in placing and securing the mat in position are fitted to cringles worked in each corner. The thrummed side of the mat is placed in contact with the skin of the ship.

Columns. See PILLARS.

Columns, Engine. See ENGINE COLUMNS.

Combination Punch and Shear. See PUNCH AND SHEAR, COMBINATION.

Combination Vise. See VISE, COMBINATION.

Combustion Chamber. See BOILER COMBUSTION CHAMBER.

Common Iron. Described under Steel and Iron.

Commutator. A copper cylinder composed of insulated segments mounted on the shaft of an electric motor or generator. The insulated segments are connected to the armature coils and are so arranged as to change the connections of the armature coils with the carbon brushes as the armature rotates.

Companion or Companion Way. A hatch or opening in a flat, deck or house top to provide access; principally for the personnel.

Page 558.

Compass. The American Bureau of Shipping requires that each vessel is to have at least one steering compass for each steering gear, and one standard azimuth compass placed so as to command the horizon under all ordinary conditions of weather. All compasses to have complete fittings, and are to be properly adjusted.

Compass, Gyroscopic. The gyroscopic compass is entirely different from the magnetic compass. The earth's magnetism has nothing to do with its indication of the meridian. The north seeking properties of the gyro-compass are derived from the peculiar properties of rotating bodies which in the case of the gyroscopic compass are electrically driven gyroscopic wheels. Any rapidly rotating body tends to place its axis parallel with that of the earth, which is, of course, North and South.

We must modify the above statement by adding that any rapidly rotating body to do this must be supported so that it will have a freedom of motion in different directions. Such a device is known as a gyroscope.

The gyroscopic compass may have one or more gyroscopes. The most modern type has two gyroscopes of equal size so arranged that when the ship is rolling, they will neutralize each other's tendency for error.

The directive force of a gyroscope, while 100 times more powerful than that of the magnetic needle, is still further amplified by an auxiliary electric motor, which is sufficiently powerful to operate the compass card in azimuth.

Repeater compasses, installed wherever desired about the ship, are operated by the master compass containing the gyroscopes by a simple electric follow-up system. The master compass is usually located at about the rolling axis of the ship in a protected place.

The complete gyroscopic compass equipment consists of master compass, repeaters, control panel, and storage battery.

The motor generator is used to transform the ship's electric current into that suitable for the operation of the compass and the repeaters.

The storage battery is for emergency use only and will store sufficient energy to operate the master compass for several hours in case of the failure of the ship's supply.

The gyroscopic compass is standard in all the navies of the world. It is fast being introduced in the merchant marine service, and has already been adapted by the Cunard Line on some ten of their vessels. It is also in use on the Royal Mail, the Lloyd Sebauda and the Canadian Pacific steamers.

The following characteristics of the gyroscopic compass are of interest:

1. The gyroscopic compass is not affected by magnetism from any source. It points to the True North Pole and not the magnetic North Pole, which is some 800 miles distant from the True North Pole.
2. The reading of the gyroscopic compass is not approximate but is absolutely and immediately correct. It requires no correction for variation or local magnetic conditions. A navigator does not have to make calculations to correct his course.
3. It is never necessary to swing ship to obtain the proper reading on a gyro-compass.
4. Hammering or riveting upon the ship, or moving through magnetic fields will have no effect upon the gyroscopic compass.
5. The gyroscopic compass is not affected by any cargo. Iron ore has no more disconcerting effect than a cargo of cotton.
6. The gyroscopic compass is not affected by temperature changes.
7. There is no heeling error of a gyroscopic compass, neither is there any lag in indicating a change in course. It is possible to steer a straight line.
8. The gyroscopic compass indicates a failure to function properly by ringing a bell.

Page 1094.

Compass, Magnetic. The compass is the most important instrument of navigation in use on board ship, the path of a ship through the waters depending upon the efficient working and use of this instrument.

There are two kinds of compasses, the Dry Card Compass and the Liquid Compass.

The Dry Compass consists essentially of a number of magnetic needles suspended parallel to each other and fastened to the rim of a circular disc that has a paper cover upon which are marked the points of the compass and the degrees. This card rests upon a pivot centered in the compass bowl, which in its turn is suspended by gimbals in the binnacle or stand, the latter having means of lighting the card at night and for the adjustment of compass errors due to the magnetism of the ship.

In the Liquid Compass, the bowl is filled with alcohol and water, or oil. The needles are sealed in

parallel tubes and form a framework which connects the central boss with the outer rim, the whole resting upon a pivot in the compass bowl. Upon the rim are printed the points and degrees.

As regards the relative uses of these compasses, it may be said that the dry compass is the standard in the world's Merchant Marine, while the liquid compass is the standard in Navies, because of its freedom of vibration from the shock of gunfire, etc.

The compass has been used for purposes of navigation since the third or fourth century, and the points of the compass were a natural development of subdivision of the card and have been in use since the fourteenth century. Capt. Flinders, R.N., was the first to investigate the laws of the deviation of the compass, and was the first to introduce the method of swinging ships for obtaining the deviation, in 1814.

The construction of iron vessels and the consequent errors of the compass caused investigation, and in 1838-39 Sir George B. Airy, then Astronomer Royal for Great Britain, at the instigation of the Admiralty, conducted a series of experiments for "the purpose of discovering a correction for the deviation of the compass produced by the iron in the ship." The result of this investigation was immediately given to the world, and the principles then discovered form the basis of our compass knowledge of to-day.

To the late Lord Kelvin, navigators the world over are indebted for his untiring work in the interests of practical navigation, and through his researches we have accurate knowledge of how a compass, its binnacle and accessories should be made, based upon scientific and mathematical formulae, and compasses so made are "Standard" for that instrument.

Lord Kelvin laid down two fundamental principles:

1. In order that a compass may be capable of adjustment so as to be correct on all courses at any one part of the world, it is essential to use short needles.

2. In order that the compass so adjusted may be correct on all courses at all parts of the world, it is essential that the magnetic strength of the needle be small.

An efficient compass, therefore, embodies within itself the principles of construction as laid down by the late Lord Kelvin, and also means to carry out fully the principles of adjustment laid down by Sir George B. Airy, the whole being an instrument of rugged construction made to withstand the vibrations and shocks incidental to the movements of a ship, and, at the same time, so constructed as to keep from the delicate parts of the instrument the effects of these movements. As an accessory to the compass, means must be supplied for the taking of Azimuth or bearings of celestial and terrestrial objects. This is generally accomplished by means of a sight vane accurately centered on the compass and free to move in any direction. With this instrument, it should be possible to obtain an accurate bearing even though the vessel is yawning for several degrees each side of her course.

The magnetic compass, when once installed and adjusted, is the only instrument used in the equipment of a vessel whose proper working does not depend upon human agencies and which will perform its proper functions for years without human aid.

Pages 1091, 1092, 1093.

Compass, Radio. An apparatus designed to determine the direction from which a radio wave is sent and the location of the station sending the wave.

It consists of a coil of wire wound around a frame which is mounted on a vertical shaft. A dial graduated like a compass into 360 degress is attached to the bottom of the shaft which with the aid of an indicator fixed in the north and south direction gives the direction in which the axis of the coil is pointing.

Two wires lead from the coil to a sound receiver worn by the operator who turns the shaft by a hand wheel.

It is found that a radio wave will set up the greatest noise when the axis of the coil is at right angles to the wave and that all noise will cease when the axis is parallel to the direction of the wave.

As it is easier to determine when the noise ceases than to decide when it is loudest, the axis of the coil is brought to point in the direction from which the radio message is sent. Two stations are necessary to determine the location of a ship and the operator from one must telegraph the direction the message is coming from to his station to the other who can proceed to solve the triangle and send a message to the ship giving its location. A radio compass installed on a vessel will enable the operator to determine the direction from which a message is coming. He will, however, have to estimate the distance from the magnitude of the sound.

Compensator. See Auto-Transformer.

Compounds, Boiler. See Boiler Compounds.

Compounding of Stresses. The superimposing, one upon another, of the various stresses acting upon a member. In compounding stresses the directions in which the various components act must be considered.

Compressor, Acetylene Gas. A pump, usually horizontal acting, used to charge storage tanks with acetylene gas under pressure.

Page 779.

Compressor, Air. See Air Compressor.

Compressor, Oxygen. A pump used to charge storage tanks with oxygen under pressure.

Page 779.

Condensate Pump. See Pump, Condensate.

Condenser. A chamber of rectangular or cylindrical shape whose function is to convert the exhaust steam from the engine, turbines, and auxiliary machinery into water.

Pages 425, 885, 907, 933, 1024.

Condenser Air Cock. An air cock is usually installed on the front or back head to allow any accumulation of air to escape.

Condenser, Augmentor. A supplementary condenser installed between the main condenser and air pump. It is used in connection with a steam ejector to densify the air vapor and ejector steam and to increase the pressure in the air pump suction.

Condenser, Auxiliary. A condenser for the auxiliary machinery such as pumps, refrigerating machine, turbo generator engines, winches, steering engines, windlasses, etc.

Page XIV.

Condenser Auxiliary Feed Connection. A short pipe line including a valve for the purpose of taking circulating water from the front head to the steam chamber. As the circulating water is usually salt, it should be used only in emergencies.

Condenser Back Head. A water chamber on the back end of the condenser. When the front head has one

dividing wall there is none in the back head. Where there are two or more dividing walls in the front head there is always one less in the back head. Where there is an odd number of dividing walls for the front head the discharge chest for the circulating water is on that head. Where there is an even number of dividing walls in the front head the discharge chest must be in the back head. Bosses for inspection and hand holes should be fitted on the back head for such compartment therein.

Condenser Baffle Plate. Also called Diaphragm Plate. A thin plate fitted in the way of the exhaust steam inlet and perforated with numerous holes, the object being to fill the whole condenser with steam and to protect the tubes nearest the inlet.

Condenser Boiling Out Connection. A connection for the admission for live steam to the condensing chamber. See CONDENSER SODA COCK.

Condenser Cover Plate. A plate for covering the hand and inspection holes.

Condenser Diaphragm Plate. See CONDENSER BAFFLE PLATE.

Condenser Doors and Hand Holes. Openings for inspection which are closed by cover plates.

Condenser Dry Suction. A pad or flange for connection to an air and vapor pump or to an air and vapor ejector. It is located on the side of a condenser and above the wet suction.

Condenser End Plate. A liner plate to which the tube sheets, front and back heads are attached.

Condenser Exhaust Nozzle. A casting, boss, or fitting attached to the shell of the condenser for the purpose of making a connection to the steam exhaust line from the engines or their auxiliaries.

Condenser Ferrule. See CONDENSER TUBE FERRULE.

Condenser Foundation. A term applied to the foundation supporting the condenser. There are usually two supports, one for the main and one for the auxiliary condenser.

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Condenser Front Head. The chamber that receives the circulating water. It has one or more dividing walls causing the water to pass back and forth through the condenser tubes. Bosses for two or more hand and inspection holes should be fitted on this head. The front head is generally a casting.

Condenser Hanger. A hanging support for a condenser. Most commonly used to support the auxiliary condenser.

Condenser, Jet. A chamber usually of cone shape in which the steam and cold condensing water are mixed. The condensing water, upon entering the condenser, is forced to pass thrugh a plate perforated with a large number of small holes. This forces the water into small jets and causes a more intimate mixture with the steam. This type is practicable only on fresh water or where a fresh supply of feed water is easily obtained. A better vacuum is obtained with the surface condenser.

Condenser, Keel. Pipes near the keel on the outside of the hull used for condensing steam. It is necessary that these pipes should be of a material that will not set up electrolysis with the shell, struts, stern frame and propeller.

Condenser, Main. A condenser for the main engines.

Condenser, Rotary. A synchronous motor or converter with over excited fields. This type of condenser is used when large capacity effect is desired.

Condenser Saddle Plate. See CONDENSER FOUNDATION. The saddle plates are connected to the outside shell of the condenser forming its support.

Condenser Shell. The outside wall of the condenser chamber. When the condenser is part of the engine frame the shell is generally rectangular in shape and made of cast steel or cast iron. When independent of the engine the shell is generally cylindrical, oval, or heart shaped and made of sheet steel or sheet brass.

Condenser Soda Cock. A connection for admitting soda or potash dissolved in water into the condenser. The object is to remove grease and dirt from the outside of the tubes. This is accomplished by boiling out this mixture with live steam.

Condenser, Static. A pair of electric conductors slightly separated by a dielectric. Two types of Electric Condensers are the flat type and the Leyden Jar. The Flat Type Condenser consists of tinfoil conductors separated by thin flat dielectric sheets (usually of Mica). The Leyden Jar consists of a glass jar, coated within and without two-thirds of its height with tinfoil, and a metallic rod protruding through the stopper of the jar and connected to the inner coat of tinfoil by means of a small chain.

Condenser Stay Rods. Steel rods running parallel to the tubes in the condenser chamber and serving the purpose of staying the flat tube sheets.

Condenser Suction Pads. Pads to provide connection for pumping the air and condenser steam from the condenser. .

Condenser Supporting Plates. See CONDENSER TUBE REST PLATES.

Condenser, Surface. A chamber in which steam is condensed by contact with the outside surface of a large number of thin brass tubes through which cold water is circulated. This produces a condensate of exhaust steam without the addition of any circulating water which is usually salt.

Condenser Tubes. The numerous small tubes closely fitted in a surface condenser. Thin brass tubes from about 5/8" to 3/4" outside diameter which run through the condenser chamber between tube sheets. The circulating water passes through them and the exhaust steam condenses on their outside surfaces.

Page 1025.

Condenser Tube Ferrule. A cylindrical brass fitting used to secure the tubes in the tube sheets, threaded on the outside to fit the counterbore in the tube sheet and bored on the inner end to make a sliding fit over the condenser tubes. The outer end of the ferrule is tapered down so that its inside diameter is about the same as the inside diameter of the tubes. A slot is cut in the outer end for the purpose of screwing the ferrule down on packing which is placed between the bottom of the counterbore in tube sheet and the inside end of the ferrule. This method allows the tube or ferrule to be readily renewed.

Page 1025.

Condenser Tube Plate. See CONDENSER TUBE SHEET.

Condenser Tube Rest Plates. Also called Supporting Plates. These plates serve the purpose of intermediate supports for the condenser tubes between the tube sheets.

Condenser Tube Sheet. A brass plate into which ends of condenser tubes are fastened. These sheets, one at each end of the condenser, serve as end boundaries for the steam space and supports for the tubes. They are made of brass and counterbored for a brass ferrule.

Condenser Vacuum Gauge. A tube graduated in inches of mercury for obtaining the absolute back pressure in the condenser.

Condenser Vanes. Thin sheet steel plates placed among the condenser tubes and running between tube sheets. The object is to secure as near a uniform distribution of the steam to the tubes as possible.

Condenser Water Chest. A casting fitted to the front head of the condenser to which the discharge line from the circulating pump is attached.

Condenser Water Inlet. The circulating water inlet on the front head. See CONDENSER WATER CHEST.

Condenser Water Outlet. A boss, chest or fitting on the front or back head of the condenser, as the case may be, for connection to the overboard discharge line.

Condenser Wet Suction. A pad or flange for connection to a condensate pump or to a combined air and water pump. It is located in the lowest part of the condenser.

Condenser Zincs. Zinc plates fitted in the front and back head to offset galvanic action. They should have good metallic contact.

Conduit. Wrought iron pipe, fibre pipe, tile or other hollow products specially prepared to accommodate and protect electric wire and cable.

Conduit Box. A metal box so designed that one or more conduits may be connected to it and so arranged as to make the electric wire or cable in the conduit easily accessible. A conduit box for marine work is usually made water tight.

Pages 1064, 1071.

Conduit Pipe. A pipe enclosing and protecting electric wiring.

Condulet. A conduit fittings so arranged as to allow the wires or cables in the conduit to be connected, pulled through, or brought out of a conduit in accordance with the Underwriters' Rules.

Pages 1064, 1071.

Connecting Bridge. See BRIDGE, CONNECTING.

Connecting Rod. That part of the reciprocating engine by means of which the reciprocating straight line motion of the piston is transformed into the rotary motion of the crank.

It consists essentially of a metal rod having a head forged at its upper and a foot at its lower end for the purpose of taking the cross head and crank pins respectively. The openings in these end forgings are fitted with brasses and caps.

Marine connecting rods generally increase in area of cross section from top to bottom, the section being sometimes circular and sometimes flattened in the plane vertical to the shaft line.

Connecting Rod, Gas Engine. See GAS ENGINE CONNECTING ROD.

Conning Towers. Protective structures built up of armor plates and having various shapes and sizes. They are designed for the protection of the commanding officers of war vessels during naval actions. They are so located and designed as to command the best possible unobstructed view, while at the same time affording satisfactory protection.

Continuous Floors. See FLOORS, CONTINUOUS.

Contline (of a rope). The sunken space or groove following the lay of the rope between the strands.

Contracting Ship-fitter. A ship-fitter who takes a contract to lay out the material for some structural feature of the ship, as a keel, a deck, or the shell plating, and to set it up on the ship ready for riveting.

Controller, Motor. Controllers for electric motors include such apparatus as starting rheostats, speed regulating or controlling rheostats and such devices as compensator or auto-transformer types of motor starting apparatus, which are used for alternating current motors. There are also special types of switches, such as float and tank switches, magnetically-operated switches, star-delta switches used with squirrel-cage induction motors, and various other styles used for controlling the motor. Automatically operated motor starters, regulators and controllers are also included under this heading. A motor of very small power can be started without the need of a starting rheostat, but for most motors used aboard ship and in the shipyard, starting or regulating devices of some kind are required.

Converter, Synchronous. See SYNCHRONOUS CONVERTER.

Cooler, Gas Engine. See GAS ENGINE COOLER.

Cooler Pump. See PUMP, COOLER.

Coping Machine. A machine designed to cut away the flanges and corners of beams.

Copper. Described under Metals.

Copper Sheathing. See SHEATHED.

Coppers. Galley steam kettles. These always used to be made of copper, hence the name.

Coppersmith. A workman who fashions or fabricates the various fittings or parts, which are made from copper piping, tubing or sheets.

Cordage. A comprehensive term for all ropes of whatever size or kind on board a ship.

Pages 825, 826, 839.

Core Oven. See OVEN, CORE.

Cork Paint. See PAINT.

Corn Oil. See PAINT.

Cornice. An interior or exterior projection fitted along the upper edge of a deck house to form an ornamental appearance.

Corresponding Speeds. Speeds which bear the same relation to each other as that of the square roots of the linear dimensions of the ships involved. The foregoing presupposes the existence of similarity between the ships so that the wave formations resulting are similar.

Corrosion. Described under Steel and Iron.

Corrugated Bulkheads. See BULKHEADS, CORRUGATED.

Corrugated Furnace. See FURNACE, CORRUGATED.

Cotton Rope. See ROPE, COTTON.

Cotton Seed Oil. See PAINT.

Coulomb. The practical unit of quantity of electricity. It represents the quantity of electricity that passes through the cross section of a conductor per second, when the current strength is 1 ampere. It is also equal to the quantity of electricity contained in a condenser with a capacity of one farad, when the same is subject to an electric motive force of one volt.

Counter. That part of a ship's after body extending aft from the after perpendicular (usually above the water line).

Counterbore. A tool used for enlarging a hole without changing its relative position; also a term applied where a hole is rebored to a larger diameter for part of its length.

Counter Electromotive Force. The induced electromotive force in the armature circuit of an electric motor which tends to cause the current to flow in the opposite direction to the current in the line.

Countersink. A term applied to the operation of cutting the sides of a drilled or punched hole into the

shape of a frustrum of a cone. This shape provides a shoulder for a rivet or a bolt and allows a flush surface to be maintained. Also applied to the tool doing the work.

Countersinkers. Men who operate hand or power tools which taper or countersink holes in material.

Countersinking Machine. A drilling machine becomes a countersinking machine when a countersink is used instead of a drill. See DRILLING MACHINE.

Countersinking Machine, Portable. A portable pneumatic drilling machine becomes a countersinking machine when a countersink is used instead of a drill.

A small truck built in the form of a box and weighted with pig or scrap metal. Small wheels are fitted to one end and a pneumatic machine with a countersink attached to the other end. Handles are fitted to the machine end. By raising the handles the truck may be rolled along plates laid on the floor. The machine is started and run continuously from beginning operation until a job is finished, the holes being countersunk by rolling the truck into position and lowering the handles until the desired depth of countersink is reached.

Countersinking Machine, Radial. See DRILLING MACHINE, RADIAL.

Countersunk. A term applied where the end of a hole is chamfered off, the usual slope being 45°.

Counter Timbers. See TIMBERS, COUNTER.

Coupling. A device intended for securing together adjoining ends of piping, shafting, etc.

A flange coupling, used for line shafting, consists of an enlargement of the shaft end in the form of a disc or flange, the two flanges which terminate the adjoining shaft sections being securely attached to each other by body bound bolts.

A socket coupling, used in twin screw vessels for the section of line shaft just inboard of shaft tube stuffing box, consists of a tapered end on the forward end of the outward section inserted in a socket worked in the after end of the inboard section, both being secured to each other by a key and locking ring.

A flexible coupling, used sometimes with reciprocating engines, is similar to the flange coupling except that the face of one flange is given the shape of a spherical segment, centered on the face of the other by a ball and socket joint, and secured to the other flange by bolts, the nuts of which bear on springs so as to take up lost motion.

Piping is joined by flange couplings similar to those described above and by threaded sleeves.

Page 549.

Coupling Bolts. Bolts intended for use with couplings. Their form varies with the type of coupling from the body bound bolt secured with nut and pin in a rigid flange coupling to the tap bolt of the socket coupling or the bolt and nut of the flexible coupling.

Page 549.

Coupling Bolt Forcer. See BOLT FORCER.

Coupling, Pipe. A wrought iron sleeve, having an inside thread used to make a joint between two pipes. Where it is not desirable to disturb the position of the pipes in making the joint, unions should be used.

Coupling, Rudder. See RUDDER COUPLING.

Course. The path over which a vessel proceeds. Some courses used habitually are known by name. This applies especially to measured mile courses, where trial trips are conducted and to racing courses. In the open sea the course is designated by the point of the compass toward which the vessel is headed.

Cover, Boat. A piece of canvas used as a cover for a small boat when it is not in use.

Cover, Hatch. See HATCH COVER.

Covering Board. A term applied to the plank fitted horizontally on top of frames and waterway board at the weather decks of wood ships.

Covering, Deck. See DECK COVERING, DECKING.

Cowl. See VENTILATORS, BELL-MOUTHED OR COWL.

Coxswain. A petty officer or sailor, who steers or has charge of a small boat.

Crab Winch. See WINCH, CRAB.

Cradle. The structure of wood or wood and steel with its lashings that is built between the top of the sliding ways and the shell of a ship. The part adjacent to the shell is carefully fitted in order to distribute evenly the stresses due to launching.

Cradle, Launching. A timber frame work built up to support and partly incase a vessel when it is launched.

Craft. A vessel of any type.

Crane. A machine used for hoisting and moving pieces of material or portions of structures or machines that are too heavy to be handled by hand or that are heavy enough to make handling by hand uneconomical.

Pages 738, 791, 793 to 796, 855.

Crane, Bridge. An overhead type of crane usually installed in shop buildings. This type generally consists of one or more girders mounted on trucks with wheels which run along tracks supported by the columns of the building. A carriage containing or supporting the hoisting apparatus is designed to travel across the beam providing in this manner for lateral motion.

Bridge cranes designed for small loads are often operated by hand while those designed for the heavier loads are generally operated by electric motors.

Electrically operated cranes are generally operated from a cab attached to the girders.

Pages 791, 794.

Crane, Bucket Handling. A crane designed to operate a bucket for excavating or handling coal, mud, etc.

Page 793.

Crane, Gantry. An elevated structure designed to travel along rails on the ground level and provided with a hoisting gear.

Page 794.

Crane, Jib. A boom or arm fitted to swing in sockets attached to a wall or column. The boom in this type of crane is generally fixed in a vertical direction but free to move horizontally.

Page 795.

Crane, Locomotive. A self-propelling car with a crane mounted upon it.

Page 794.

Crane, Magnet Handling. A crane designed to carry and operate a large electro magnet for lifting and transporting metal scrap, small or large castings, parts, etc., susceptible to magnetic influence.

Crane, Pillar. A swinging boom or arm supported by a pillar or post. Usually no vertical motion is provided for in this type of crane.

Crane, Post, See CRANE PILLAR.

Crane, Traveling. See CRANE, LOCOMOTIVE, and CRANE, BRIDGE.

Crane, Wall. See CRANE, JIB.

Cranemen. Men who operate overhead cranes handling material in the yard or shop.

Crank Arm or Web. That portion of the crank or crank shaft which connects the crank pin and crank axle. It forms the lever by means of which the force exerted on the crank pin by the connecting rod is transmitted to and utilized in turning the shaft in its bearings.

In engines of more than one cyliner the angles which the several crank arms make with each other are matters of careful consideration in order to make possible the obtaining of the most uniform torque possible throughout the entire revolution of the shaft.

Crank Axle. The cylindrical portion or portion of the the crank or crank shaft by means of which all the members of the rotating system of the engine are carried and held in place.

Crank Pin. The cylindrical member, forming part of the crank, to which the foot of the connecting rod attaches and which receives the direct effort of the connecting rod. Its design receives the most thorough consideration because of the character and severity of the strains to which it is subjected.

Crank Shaft. That portion of a reciprocating engine in which rotary as distinguished from rectilinear motion first appears. The term is applied to the portion of the shaft which (depending upon the number of cylinders) is composed of one or more cranks rigidly attached to one another and arranged to work about a common axis viz.: that of the propeller shaft.

Crank shafting may be either built up or forged. Built up crank shafts are composed of a series of crank pins, crank axles, and crank webs formed separately and shrunk and keyed together. This type is common in merchant practice where might is not of first importance. It lends itself readily to fabrication and repair.

Forged crank shafting is cut and machined from a single forging. It effects a saving in weight over the built-up type and is becoming more popular. It is at the present time universally used in naval practice and in high grade work outside naval practice.

Crank Shaper. See SHAPER, CRANK.

Crank or Tender. That quality by which a vessel assumes large angles of heel as a result of the action of comparatively small forces. It is the result of a small metacentric height.

Cribbing. Foundations of heavy blocks and timbers for supporting a vessel during the period of construction.

Cringles. Iron thimbles or grommets worked into or attached to the edge, head, leech, or clew of a sail for making fast the bowline, bridles, earrings, sheets, etc.

Critical Docking Draft. That draft at which a vessel loses her initial stability when being docked. When the draft of a vessel in process of docking or undocking is less than the critical docking draft either bilge blocks or shores must be in place to prevent the development of a list.

Critical Speed. Same as Squatting Speed.

Cross. A pipe fitting composed of four branches, so constructed that one pair is on one axis and the other pair is on another axis, the axes being at right angles.

Cross Beams, Hatch. A term applied to the portable athwartship beams in a hatch that support the fore and afters which in turn support the hatch covers. Also applied where these beams support the hatch covers directly without fore and afters, in which case the hatch covers must run fore and aft.

Pages 379, 412, 418, 422, 559, 560, 561.

Cross Curves of Stability. A series of curves of righting arm plotted to a base of displacement, each curve being drawn for a given degree of heel. In preparing such a series of curves it is customary to assume for all displacements an axis or point of reference at a fixed distance above the vessel's base, and to compute the values of righting arm from this axis.

The ordinary curve of statical stability corresponding to any loading may be derived by correcting the righting arms as taken from the cross curves for the various angles of heel at the proper displacement by an amount equal in each case to the difference between the correct height of the center of gravity and the height of the axis or base assumed for the cross curves multiplied by the sine of the angle of the cross curve.

Cross-Cut Shaw. See SAW, CROSS-CUT.

Crosshead. That part of a reciprocating engine which attaches directly to the outer end of the piston rod and acts at once as the connection between piston and connecting rod and as a guide to the former to keep it in line with the axis of the cylinder in spite of the transverse component set up by the connecting rod due to its angular position.

The crosshead of the usual marine type consists essentially of a body into which the piston rod is set and secured by a nut. From this body extend pins to take the jaws of the connecting rod and at right angles to these pins (termed crosshead pins) extend arms to carry the slides for the maintenance of proper alignment.

There are several types of crossheads, but they are all as above described in principle.

Crosshead Guide Bars. Parallel, fixed members between which the crosshead works, it being held to a straight line reciprocating motion by means of the crosshead guides or slippers bearing against the guide bars.

These members are made of cast iron carefully finished.

Crosshead Nut. A nut intended to secure the piston rod against turning in or out of the cross head.

Crossjack. The lowest yard carried on the mizzen mast of a vessel. Sometimes used with reference to the sail carried by this yard.

Cross-Over. A pipefitting or a pipe, having a double offset which is used to allow one pipe to pass over another.

Cross-Trees. A term applied to athwartship pieces fitted over the trees on a mast. They serve as a foundation for a platform at the top of a mast or as a support for outriggers.

Crown. Term sometimes used denoting the round up or camber of a deck. The crown of an anchor is located where the arms are welded to the shank.

Crown Sheet, Boiler. See BOILER CROWN SHEET.

Crows Nest. A lookout station attached to or near the head of a mast.

Pages 320, 343.

Crucible Steel. See STEEL AND IRON.

Cruiser. A vessel designed to keep at sea for extended periods. Such scantlings are fixed and type of machinery selected as will insure exceptional seaworthiness. A war vessel in which the protection against gun fire is more or less sacrificed for speed or long radius of movement.

Cruising Turbine. See TURBINE, CRUISING.

Crutch. A term applied to a support for a boom. Also applied to the jaw of a boom or gaff.

Cuddy. A galley structure on deck; a small cabin.

Current, Alternating. See ALTERNATING CURRENT.

Current, Direct. See DIRECT CURRENT.

Curve of Areas of Midship Section. A curve indicating the area of midship section below any waterline under consideration.

Curve of Areas of Water Plane. A curve indicating the area of water plane corresponding to any draft.

Curve of Center of Gravity of Water Plane. A curve indicating the longitudinal position of the center of gravity of the ship's water plane for any and all drafts.

Curve of Displacement, Fresh. Same as CURVE OF DISPLACEMENT, SALT WATER; excepting that the ship is considered as floating in fresh water of thirty-six cubic feet per ton.

Curve of Displacement, Salt. A curve which indicates for any draft the corresponding displacement of the vessel, the ship being considered as floating at designed trim in salt water of thirty-five cubic feet per ton.

Page 228.

Curve of Longitudinal Center of Buoyancy. A curve so plotted as to show the variation in value of the distance of the vessel's center of buoyancy from a given reference line (generally the half length) measured in a fore-and-aft direction and corresponding to variations in draft and displacement.

Curve of Longitudinal Metacenter. A curve so plotted as to show the variation in value of the longitudinal metacentric radius or of the height of the longitudinal metacenter above base corresponding to variations in draft and displacement.

Curve of Moment to Alter Trim. A curve which indicates the approximate moment in foot tons which at any draft is required to alter the trim of the vessel by one inch.

Curve of Sectional Areas. A curve, plotted from a straight base line, representing the length of the ship, the ordinates of which represent to scale the areas of the vessel's immersed cross sections at corresponding points. The area under this curve represents to scale the volume of the displacement. The center of gravity of this area represents the longitudinal center of buoyancy of the displacement.

Pages 169, 170, 177, 178, 187, 188, 224.

Curve of Tons per Inch of Immersion. A curve indicating for any draft the number of tons of additional load which would be required to immerse the vessel one additional inch.

Curve of Transverse Metacenter. A curve so plotted as to show the variation in value of the transverse metacentric radius or of the height of the transverse metacenter above base corresponding to variations in draft and displacement.

Curve of Vertical Center of Buoyancy. A curve so plotted as to show the variation in value of the distance of the vessel's center of buoyancy measured vertically above or below a horizontal reference line (generally the molded base or the plane of flotation) and corresponding to variations in draft and displacement.

Cutter. A boat carried by war vessels.

In the United States Navy, these boats are of robust construction, seaworthy, and used for purposes of general utility.

Cutters or Burners. Workmen who operate gas cutting tools to sever, trim or cut away surplus metal.

Cutwater. A timber bolted to the forward side of the stem in wood ships. The forward edge of the stem in steel vessels is also called the cut-water.

Cylinder. That portion of the reciprocating engine in which the steam acts to force the piston from one end to the other and vice-versa. The name is derived from its internal shape inasmuch as its exterior is complicated by various attachments and additions. The cylinder is made of the highest grade of cast iron, the interior being carefully bored to a smooth cylindrical shape for the passage of the piston.

With the barrel of the cylinder are usually cast the lower head, valve casings, chests, ports, passages, etc., also the lugs for the attachment of the columns, braces, etc. The upper head or cover is cast separately and attached to the barrel by means of studs and nuts. The lower cover is fitted with a stuffing box and gland to permit the free passage of the piston rod but to prevent the escape of steam. The interior faces of the piston covers are so shaped as to conform closely to the contour of the piston faces in order to cut down the volume of clearance as much as practicable. Frequently the inner surface of the cylinder barrel is formed by a liner cast of fine grained extra hard iron. It is then possible to replace the liner in case of excessive wear. Such a liner also forms one side of the jacket space in case the cylinder is to be steam jacketed. In case steam jacketing is contemplated all joints must be carefully made in order to avoid steam leaks.

In the ordinary triple expansion engine with three cylinders, the cylinders are known as high pressure, intermediate and low pressure respectively.

Cylinder, Gas Engine. See GAS ENGINE CYLINDER.

Cylindrical Coefficient. See COEFFICIENT, CYLINDRICAL.

D

Davit. A crane used to lower and raise lifeboats and sometimes anchors. The rotary, or most common type, consists of a vertical pillar, round in section, with the upper portion bent in a fair curve and having sufficient out-reach to clear the side of the ship plus clearance. Each lifeboat has two davits, one near its bow and one near its stern; and they both rotate, lifting the boat from its stowage position on the deck, and swinging it clear of the side. This type of davit is usually stepped in a socket attached to the side of the vessel or on the first deck below the boat deck near the side. At the boat deck level it is held in place by a keeper or bearing. Page 689.

The rules of the **American Bureau of Shipping** state that boats' davits should not be less in diameter than given by the following formula, when they are required to carry the boat, its equipment and a sufficient number of men to launch it,

$$d = \frac{\sqrt[3]{L \times B \times D\ (H + 4R)}}{144}$$

d = diameter of davit in inches.
L = length of boat in feet.
B = breadth of boat in feet.
D = depth of boat in feet.
H = height of davit in feet above point of support.
R = outreach of davit in feet.

When it is required that the davits shall carry the

boat, its full load of passengers and equipment, the divisor should be 86 for iron and 104 for solid ingot steel davits having a tensile strength of from 58,240 to 71,680 lbs. per sq. in.

Lloyd's rules state that in the case of boats and davits of ordinary proportions, the diameter d of the davit in inches must be obtained by using the following formula:

$$d = \sqrt[3]{\frac{L \times B \times D\ (H + 4S)}{C}}$$

where L, B and D are the length, breadth and depth, respectively, of the lifeboat. H is the height of the davit above the keeper, and S is the spread or outreach of the davit, each of these dimensions being in feet.

The value of the constant C is to be as follows:

1. When the davit is to be of wrought iron and of sufficient strength to carry the boat and its equipment and a sufficient number of men to launch it, the value of C is to be 144.

2. When the davit referred to in (1) is to be of wrought ingot steel of from 28 to 32 tons per square inch tensile strength, the value of C is to be 174.

3. When the davit is to be of wrought iron and of sufficient strength safely to lower the boat fully equipped and carrying the maximum number of persons for which it is intended, the value of C is to be 82.

4. When the davit referred to in (3) is to be of wrought ingot steel of from 28 to 32 tons per square inch tensile strength, the value of C is to be 99.

When the weight of the boat and its complement is known, the diameter can be calculated by the following formula:

$$f = \frac{My}{I} + \frac{P}{A}$$

where

M = the bending moment, caused by the weight suspended from the davit head, in inch lbs.

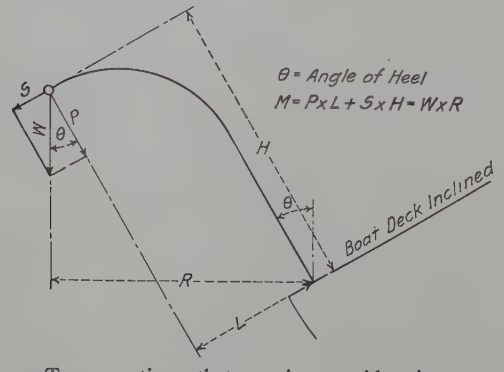
y = the radius of the davit in inches.

I = the moment of inertia of the section of the davit in inches × square inches.

f = the allowable working stress in lbs. per square inch.

P = the downward component of the weight suspended from the davit head that is parallel to the center line of the straight portion of the davit.

A = the area of the section of the davit in square inches.



Two questions that require consideration are the heel of the ship to be taken, and the proportion of the total weight of the life boat including equipment and complement that comes on one davit. The Navigation Laws specify that "the davits shall be of such strength that the boats can be lowered with their full complement of persons and equipment, the vessel being assumed to have a list of 15°."

It is often the case that one end of a life boat is dropped ahead of the other, which causes an unequal distribution of the weight on the davits and also a factor of impact. In addition to this, the inertia of the life boat caused by the termination of a roll of the ship in one direction adds to the strain on the davits. It is, therefore, advisable to allow at least three quarters of the weight of the life boat, equipment and complement as coming on one davit.

Rotary davits are also made of rolled H section, and when so made they should have a sectional modulus equivalent to the round section.

Davit Bearing. See DAVIT KEEPER.

Davit, Cat. A davit used in raising an anchor from the surface of the water or from under the hawse pipe.

Davit Cleat. This cleat is used for fastening the end of the boat falls. It is generally seized or lashed to the davit.

Davit Fairleader. An eye fitting seized or lashed to the davit and used to lead the end of the boat falls from the fixed block to the cleat.

Davit, Fish. A davit used in pulling an anchor on board from under the cathead.

Davit Head. This term applies to the swelled part of the top of the davit to which the boat falls are attached. This attachment is usually done with an eye bolt but sometimes with a yoke and bolt.

Davit Keeper. A ring-shaped fitting whose function is to hold the davit in position and also to serve as a side bearing.

Page 689.

Davit, Mechanical. Mechanical davits are those that are forced outboard by a mechanism.

Pages 819, 822.

Davit Pivot Disc. A circular piece of hardened steel with one side flat and the other side having a convex conical surface. It is set in the bore of the davit socket to form a pivot bearing for the foot of the davit.

Page 689.

Davit Socket. The fitting into which the foot of the davit is set. When used with a keeper or bearing it is a small casting a few inches in height. It is not uncommon to combine both keeper and socket in one piece which requires a much higher casting with a broader base.

Page 689.

Davit Spreader. A spectacle-shaped fitting, fastened, to the davit head for the purpose of attaching the end of the guy rope leading to the deck and the end of the span rope between davits.

Page 689.

Dead Center, Dead Point. Those points during the stroke of a reciprocating engine at which the line of action of the connecting rod and the axis of the crank shaft lie in the same plane.

Dead Eye. A solid oblate or flat circular piece of hard wood having three holes for reeving a lanyard in setting up the standing rigging. Where this method of setting up is employed, the lower dead eye is attached to the chain plate, the upper one to the shroud or stay, the lanyard is then rove through the two dead eyes forming a three-fold purchase.

Dead Flat. The midship portion of a vessel throughout the length of which a constant shape of cross section is maintained.

Dead Light. A term applied to a port lid or cover. A metal shutter fitted to protect the glass in a fixed or port light.

Dead Load, Nautical. A term used meaning the weight of cargo and stores carried by a vessel. A load steadily applied, as the weight of merchandise stored in a warehouse. In computing stresses in any structure the weight of the structure itself, if not moving, is a dead load.

Dead Plate. A flange at the lower edge of the furnace front or a plate which supports the forward end of the grate in a boiler.

Deadrise. The angle which the straight portion of the bottom floor of the midship section makes with the base line. It is expressed by the number of inches rise above the base line in the half beam of the vessel.

Deadweight. The total weight of cargo, fuel, stores and water which a ship can carry when at her designed draft. The term is frequently used as descriptive of the vessel's size. It must not be confused with the volume or cubic capacity of stowage space. See also "Useful Load." Deadweight is usually expressed in long tons.

Pages 155, 156.

Deadweight, Cargo Factor. A constant which if multiplied by the registered tonnage will give as a result the approximate deadweight cargo which the vessel can carry. The factor or multiplier to be used is, according to rule, 1.5.

Deadweight Efficiency. The ratio of the deadweight to the designed displacement.

Deadwood, After. Timbers built up between the keel and keelson in the vicinity of the stern post.

Plate XXV.

Deadwood, Fore or Stem. Reinforcing timbers placed back of the joint of the stem and keel.

Plate XXV.

Dead-works. All parts of a vessel extending above the load water line.

Deck. A deck in a ship corresponds to the floor in a building. It is the plating, planking, or reinforced concrete covering or any tier of beams above the inner bottom, forming a floor, either in the hull or superstructure of a ship.

Pages 496, 521 to 527.

Plates XXXIX, XL, XLI, XLII.

The American Bureau of Shipping requires that Weather Decks are to be thoroughly calked and watertight; decks below the weather deck, which are not protected by watertight superstructures, are also to be calked and watertight; other laid decks which are not watertight will be entered in the Record Book as "n. c." (not calked).

Testing.—Watertight decks are to be subjected to hose-testing after all fittings are fastened in position; the pressure of water in the hose is not to be less than 30 pounds per square inch. Gutter waterways are to be tested by flooding or hose testing before any cement is laid. In passenger spaces the requirement as to hose-testing of decks may be modified.

It is recommended that the weather portion of all Strength Decks be plated throughout the midship half length and the plating gradually tapered from thence to the stringer plates; in Vessels of and over 250 feet length this recommendation becomes a requirement. In Vessels of and over 300 feet length the Strength Deck is to be plated throughout the midship three-quarters length, and the plating gradually tapered from thence to the stringer plates; in Vessels of and over 400 feet length at least one deck is to be completely plated. The portion of deck forming the crown of the machinery space is to be plated in all Vessels.

The area of deck material on each side of the openings within the midship half length, is not to be less than given in the Bureau's tables for the respective decks; the areas in way of openings outside the midship half length are to be proportional to the midship area and the area of the stringer plate at the ends, *i.e.*, at three-quarters length the required area is half the sum of the midship and end areas.

Frames are not to extend through the stringer plates of weather decks. Where frames pass through watertight decks below the weather deck, a continuous stringer angle is to be fitted along the inner edge of the frames; the spaces between the stringer angle and the shell plating are to be filled with close fitting chocks of wood or plate secured in position and covered with a good body of cement, or are to be made watertight by other equally effective means.

Butts of stringer plates, stringer angles and adjoining shell plates are not to be less than two frame spaces clear of one another. Butts of inner stringer angles are to be strapped by efficient angle or plate back pieces, not by bosom pieces.

Wood Decks, where watertight, are to have planks of good quality, thoroughly seasoned, free from rot, sap, and shakes, and reasonably free from knots; satisfactory evidence must be produced to the Surveyors that the planks have been cut and stacked for a sufficient time, or that they have been properly seasoned by approved artificial means. White pine and teak planks may be 6 inches wide; yellow, Oregon, and kauri pine planks are not to be more than 5 inches wide; Oregon pine planks are to be laid with the grain vertical. Thwartship planks are to be laid at hatchway and other coamings on weather decks to protect the plank ends from contact with metal; margin planks, to which stanchions, etc., are bolted, should be teak; those in Sailing Ships are to be teak or greenheart. Deck planks are to be laid directly on top of beams and bedded home on plates to the exclusion of padding; the average thickness of pine weather decks is to be such that individual planks shall not be less than 2½ inches thick, and of teak decks that individual planks shall not be less than 2 inches thick. Fastenings are to be made with galvanized bolts and nuts at each beam where beams are fitted to alternate frames and no steel deck is laid; where planks are laid on tie plates or steel plating the fastenings are to be arranged at the beams and between the beams in such fashion as to secure rigidity in the plates; the bolts are to have white leaded grommets under the heads, and are to be covered with turned dowels bedded in white lead or other suitable substance; ½ inch bolts may be used in pine planks up to 3¼ inches and in teak planks up to 2¾ inches thick; planks of greater thickness are to be fastened with ⅝ inch bolts; planks up to 6 inches in width may have single fastening, broader planks are to be double-fastened. Butts are to be arranged so that there are at least three planks between any two butts in the same beam space; reverse clips or plates are to be fitted on unplated beams within the midship half length to take the butts of planks in weather decks.

Deck End Plates are to be fitted at ends of all deck

openings of sufficient width to provide for the efficient fastening of the deck ends; in way of transverse bulkheads the beams are to be plated over and the deck specially supported and stiffened as may be required to provide rigid support to the bulkhead.

Tie-plates are to be fitted under the coamings of deck houses and alongside all openings in wood decks, of sufficient breadth and thickness to withstand the pressure of the deck calking; these tie plates are also to provide good foundation for the deck houses and effective resistance to lateral movement in way of the deck openings; in the latter case the thickness of the tie-plates at hatchways and other large openings should not be less than that of the stringer plates and the widths not less than one-tenth of the length of the opening; the tie-plates are to extend two or three frame spaces beyond the opening where its length exceeds 13.5. Tie-plates are to be fitted under wood decks at each line of stanchions, they are to be of not less thickness than the stringer plates, and to have a width not less than .025 of the molded breadth.

Diagonal Tie-plates are to be fitted on the wedging deck of Sailing Vessels, in way of each mast; in Sailing Vessels over 200 feet length they are to be fitted over four-fifths of the length of the Freeboard Deck; diagonals are to cross one another at an angle of 90°; they are to have thicknesses not less than those of the stringer plates and breadths not less than .025; of the modeled breadth; they are to be well bolted to the deck planks and their connections are to be so arranged that only one thickness of plate requires to be scored out of the deck planking.

Mast Partner plates on the wedging deck are to be in width not less than two and a-half times the diameter of the mast and in thickness not less than required for the Strength Deck stringer plate amidships; they are to be at least four frame spaces in length and are to be fitted with mast coamings as required by the following paragraph:

Mast Openings on weather and wedging decks are to have coamings formed of bulb plate and angle, or a bulb angle riveted to mast partners or plating; the height of the coamings is to be one-third the diameter of the mast or 9 inches whichever is the less. In all cases where beams are cut, efficient carlings are to be fitted.

Waterway Angles are to be of sufficient depth and thickness to effectively withstand the pressure of the deck calking; the waterways are to be watertight and tested by flooding or hose-testing before any cement is laid.

Coaming Angles are to stand at least half an inch above a laid wood deck; where thick coaming plates are not fitted at the base of houses, casings, etc., the coaming angles on weather decks are to be at least .40″ thick and are to stand 6 inches above the top of the deck.

Compensation at openings, in addition to fulfilling the preceding requirements, is to provide against local stresses by means of doublings, long overlaps, or increased thickness of plating at the corners of all large openings in Rule decks, as may be required. In way of the machinery space special attention is to be paid to the maintenance of lateral stiffness by means of through beams and plating and the provision of thoroughly effective deck support; these arrangements are to be submitted and approved in the initial stages of construction; no departure from the approved arrangements is to be made without having been submitted and accepted as equally effective. Where the continuity of decks is broken every precaution is to be taken to maintain uniformity of stress; where Strength Decks are at different levels, the deck material at each level is to be effectively overlapped and thoroughly tied together by diaphragms, webs, brackets, etc., to the satisfaction of the Committee. Where quarter decks abut upon bridge decks and the change in level is comparatively small, it is recommended that the Quarter Deck be gradually raised at the fore end to the level of the Bridge Deck so as to form a continuous deck. Where the Freeboard and Bridge Decks are the respective Strength Decks, the Freeboard Strength Deck material is to extend well into the bridge, and such strong webs, diaphragms, or other satisfactory arrangements are to be provided as will compensate for the discontinuity in the hull girder; special support which extends effectively to the bottom of the Ship is to be provided below the lower Strength Deck, in the form of stanchions, fore and aft diaphragms, and partial or complete bulkheads.

Deck, After. A term applied to a deck aft of the midship portion of a vessel.

Deck, Anchor. A term applied to the top of a small forecastle that is principally used for storage of anchors or for supporting anchor handling devices.

Deck, Awning. A term applied to a deck fitted from bow to stern on a light superstructure. The space below it is completely closed in and may be used for passengers or for the stowage of small or light cargo.

Deck Beam. See Beam, Deck.

Deck Beam Clamp. See Clamp, Deck Beam.

Deck, Boat. A superstructure deck provided for the stowage of the life boats and also generally used for staterooms or quarters.

Page 521.

Deck Bolts. The bolts that are used in fastening planking to the deck beams.

Page 528.

Deck, Bridge. A term applied to the deck forming the top of a bridge house, or partial superstructure. See Bridge.

Page 522.

Deck, Bulkhead. The uppermost continuous deck to which all the main transverse watertight bulkheads are carried. This deck should be watertight in order to prevent any compartment that is open to the sea from flooding the one adjacent to it.

Deck, Calked. A term applied to a steel deck having the edges of such plating and bars as are necessary to secure watertightness calked.

It is applied to a wood deck when the seams between the planking are filled with cotton or oakum and payed with marine glue. Where planking is laid over a steel deck it is advisable to calk the planking only because any leaks in the wood covering would be held by the steel deck causing the wood to rot.

Deck, Canvas Covered. To secure water tightness wood decks that are not calked and also wood decks within the quarters are often covered with canvas. After the canvas is laid it is given a coat of paint.

Deck Cargo. A term applied to a cargo carried on deck. Lumber or barrels are commonly carried on deck, but in any case the stability of the ship and the liability of having the cargo washed overboard should be given serious consideration.

Deck Covering, Decking. Various compositions and materials have been used for covering decks. The light upper weather decks are commonly covered with canvas and then given a coat of paint.

The heavy steel weather decks, when not planked over, are often covered with a composition which serves as a protection to the steel and makes a better surface for working.

The decks in the living quarters are usually covered with linoleum or some composition with the object of protecting the steel and of providing a surface that is easily kept clean and sanitary. In addition to the above some of the compositions are insulating and fireproof as well as elastic and neat appearing.

The American Bureau of Shipping requires that Deck Compositions may be laid on steel decks which are not exposed to weather, excessive moisture or heat, provided the material is not destructive to steel or is effectively insulated from the steel by a non-corrosive protective covering, which is proof against attack by chlorides. Samples taken from the composition by the Surveyors, while it is being laid, are to be subject to independent analysis at the cost of the manufacturers. The steel plating is to be thoroughly cleaned with alkaline solution before the composition is laid. Large areas of deck are to be divided by cabin sills, angles, etc., or holdfasts are to be fitted not more than 3 feet apart. The steel plating under such compositions is not to have less thickness than required for unsheathed decks by the Bureau tables.

Pages 808, 809, 810, 811.

Deck Dowels or Plugs. Cylindrical plugs used to cover the heads of the bolts fastening the deck planking.

Page 528.

Deck Cable. See Electric Wire and Cable.

Deck Drain. A fitting attached to the deck in washrooms, shower spaces, etc., to which the drain pipes are connected. Page 611.

Deck Erection. A term applied to a forecastle, bridge poop or deck house erected on the upper deck.

Deck Fitting. A fitting attached to a deck where a pipe line penetrates and the water tightness of the deck is to be maintained.

Pages 611, 1055.

Deck, Flush. A term applied to a deck having no poop, bridge or forecastle erection that extends from side to side of the vessel.

Deck, Forecastle. A term applied to a deck worked from the stem aft over a forecastle erection.

Deck, Freeboard. The deck to which the classification societies require the vessel's freeboard to be measured. Usually the upper strength deck.

Deck Girder. See Girder, Deck.

Deck, Harbor. A term applied to the side deck lying close to the water line in a turret deck vessel. It is formed by the reverse curve of the plating lying between the trunk and sides of the vessel.

Deck Heights. The vertical distance between the molded lines of two adjacent decks.

Deck Hook. See Hook, Deck.

Deck House. A term applied to a partial superstructure that does not extend from side to side of a vessel like a bridge, poop or forecastle.

Pages 521, 579, 580, 581, 583, 584.

Deck, Hurricane or Promenade. A term applied to an upper superstructure deck on passenger ships.

Deck Line. A line drawn through the intersection of the molded line of the deck beams and the molded line of the frames. Approximately the intersection of the lower surface of the deck stringer plate with the inner surface of the shell plating.

Deck, Lower. A term applied to lowest deck in two and three deck vessels, and in the next to lowest in vessels having four or more decks.

Deck Machinery. A term applied to capstans, windlasses, winches and miscellaneous machinery located on the decks of a ship.

Deck, Main. A term applied to the principal deck. It is usually the one next below a complete top or upper deck.

Deck, Orlop. A term applied to the lowest deck in a ship having four or more decks.

Deck Paint. See Paint.

Deck Pillar. See Pillar, Deck.

Deck Planer, Portable. See Planer, Wood Portable.

Deck Planks or Planking. A term applied to the wood sheathing or covering on a deck. Oregon, yellow pine or teak are used for this purpose. The seams between the planking should be thoroughly calked.

Page 528.

Deck Plates. Watertight hand or manhole plates usually let in flush with the deck for access to coal bunkers, operating rods, etc.

Deck Plate, Sounding Tube. A fitting attached to a deck and forming the terminal for a sounding tube. A screw plug is provided and is removed when sounding the inner bottom tanks.

Pages 611, 1002.

Deck, Platform. A term applied to a partial deck fitted in the hold of a ship.

Deck Plating. A term applied to the steel plating covering a deck.

Pages 496, 521 to 525.

Plates XXXIX, XL, XLII.

Deck Plug. A wood plug set in over the head of a deck bolt and cut flush with the surface of the planking.

Page 528.

Deck, Poop. A term applied to a deck worked from the stern forward over a poop erection.

Page 496.

Deck, Promenade. An upper superstructure deck on a passenger ship designed as a promenade for the passengers.

Deck, Quarter. A term applied to the after portion of a weather deck. In a warship that portion allotted to the use of the officers.

Deck, Raised Quarter. Term applied to the after portion of a weather or upper deck that is raised a few feet above the forward portion.

Deck Scuppers, Upper. Scuppers for draining water from the upper deck, gutters or waterways.

Deck, Shade. A very light deck fitted from bow to stern to provide protection against the weather. The sides below this deck are fitted with openings.

Deck, Shelter. A deck similar to an awning deck, but built on a very light superstructure.

Deck, Spar. A term applied to a deck fitted from bow to stern on a superstructure having heavier scantlings than those under an awning deck.

Deck, Steel. A deck constructed of steel plating on steel deck beams.

Deck Stringer. See Stringer, Deck.

Deck Stringer Bar. See Stringer, Bar.

Deck, Tongue and Groove. A deck covered with thin machined planks and generally used on the upper light decks of vessels.

Tongue and groove decks are usually covered with canvas after which a coat of paint is applied.

Deck, Tonnage. The tonnage deck in vessels having three or more decks to the hull is the second deck from the keel, and in all other cases it is the upper deck of the hull.

If the second deck from the keel consists of several partial decks extending with breaks from stem to stern, the line of that course of decks must be taken as the tonnage deck; and if the partial decks are at different heights, the line of the lowest will be taken as the tonnage deck and the head room above such line under the higher will be measured.

Deck, Trunk. A term applied to the top of a fore and aft trunk erected on the upper deck.

Deck, Turret. A term applied to the top of a trunk formed by curving in the sides of a vessel to form a side deck close to the water line and then curving the side deck up to form the sides of the trunk. In this way the plating makes a reverse curve from the sides of the ship to the top of the trunk.

Deck, Turtle. A term applied to a weather deck that is rounded over so that it has a shape similar to the back of a turtle. It is used on ships of the whaleback type and on the forecastle decks of torpedo boats.

Deck, 'Tween. A term applicable to any deck below the upper deck. Also the space between decks.

Deck, Upper. Generally applied to the uppermost continuous weather deck. Where this is an awning, shade or shelter deck, these terms should apply and the deck next below may be called the main or upper deck.

Plate XXXIX.

Deck, Weather. A term applied to the upper, awning, shade or shelter deck or to the uppermost continuous deck exclusive of forecastle bridge and poop that is exposed to the weather.

Deck, Wood. A term applied where a deck is constructed of wood planking. Also applied to the wood sheathing on a steel deck. Teak, Oregon or yellow pine are most commonly used for wood decks.

Deep Floor. See Floor, Deep.

Deep Frame. See Frame, Deep.

Deep Tank. A tank extending from the bottom of a vessel or from the top of the inner bottom up to or higher than the lower deck. Deep tanks are commonly fitted either forward or abaft the machinery space in cargo vessels. They are fitted with hatches, so that they may be used for cargo when loaded as well as for ballast water when light.

Deep Water Line. The water line at which a vessel floats when carrying the maximum allowable load.

Delivery Valve. See Valve, Delivery.

Depth by American Bureau of Shipping Rules. The depth is the molded depth in feet; measured at the middle of the Vessel's length on the estimated summer load line, from the top of the keel to the top of the deck beams at side from which the freeboard is estimated. In cases where watertight bulkheads are carried to a deck above the Freeboard Deck and it is desired to have them recorded in the Register as effective, D is to be taken to the Bulkhead Deck.

Depth of Hold. The vertical distance between the top of floor at center or double bottom at side and the top of main deck beam at the vessel's center line amidships.

Depth by Lloyd's Rules. The depth at the middle of length from the top of keel to the top of beam at side of uppermost continuous deck, except in awning or shelter deck vessels, where it may be taken to the deck next below the awning or shelter deck, provided the height of 'tween decks does not exceed 8 feet. When the height of 'tween decks exceeds 8 feet the depth is to be taken from the top of keel to a point 8 feet below the awning or shelter deck.

Depth Molded. The vertical distance from top of beam of uppermost strength deck at side of vessel amidship to top of keel.

Page 160.

Depth Recorder. A device invented by Sir Wm. Thompson, consisting of a composition cylinder containing a piston upon which the water acts against a spring. The distance the spring is compressed is recorded by a marker on the piston stem. As the recorder is brought to the surface, the piston returns to its original position but the marker remains at the point to which it was pushed, thereby indicating the depth to which the recorder was lowered.

Depth, Register. The register depth should be taken from the underside of the tonnage deck plank, midship, to the ceiling in the hold, average thickness, at the side of the keelson, in a direction perpendicular to the keel, which may be done by a square placed upon the upper side of the keelson.

If the vessel has a third deck, then the height from the top of the tonnage deck plank to the under side of the upper deck plank shall be accounted as the height under the spar deck.

Derrick. An apparatus designed to hoist heavy weights. The general design of a derrick is similar to that of a post crane except that the boom is hinged at the heel which allows it to be set at any angle with the post. The post of a derrick usually rotates with the boom.

Page 855.

Derrick, on a Ship. A spar or a boom, one end of which is stepped in a pivot bearing on the lower portion of a vertical post erected on the deck of a ship or on a pedestal fitted to the deck at the foot of the vertical post. A hinged connection fitted to the pivot bearing allows the boom to be inclined at any angle with the post while the pivot permits it to be revolved.

The derrick is fitted with ropes, guys and tackles and is used for transferring cargo from and into the holds. Unlike most derricks on land the derrick post itself does not revolve.

Pages 319 to 352.

Designing Engineers. See Engineers, Designing.

Destroyer. A naval vessel of small displacement and maximum speed having a battery of light rapid-fire guns and heavy deck torpedo tubes. These vessels have a moderate steaming radius and are intended for the protection of capital ships and for convoy and scouting duty.

Destroyer Leader. A war vessel of the destroyer type but larger. Her greater size makes it possible to provide more comfort for the personnel, a slightly heavier battery, slightly more speed, and a considerably greater cruising radius than is possible in a destroyer.

Devils Claw. See Chain Stopper.

Diagonal Plates. A term applied to plates fitted di-

agonally across the deck beams to tie them together. Wood planking is fitted above them.

Diaper Plate. See HORSESHOE PLATE.

Diaphragm, Turbine. See TURBINE DIAPHRAGM.

Die. A tool, having several cutting edges, used for cutting threads. In drop forging work a template tool used to stamp out a piece of work in one operation. Pages 698, 735, 773.

Die Sinkers. Workmen who make the tools by means of which the drop forging machines stamp the articles from the heated material.

Diesel Engine. See ENGINE, DIESEL.

Dipping. The vertical oscillation of a ship resulting from rolling or pitching. A very low position of the vessel's center of gravity or marked changes of the vessel's form in the vicinity of the water-line or a combination of both tend to accentuate dipping.

Direct Acting Pump. See PUMP, DIRECT ACTING.

Direct Current. An electric current which flows in one direction.

Direct Driven Pump. See PUMP, DIRECT DRIVEN.

Disc Sander. See SANDER.

Disc Cutter. A large thin metal circular saw without teeth which revolves at extremely high speed and is used to cut pieces of metal.

Dish Heaters. A warming closet or oven heated by a steam coil for use in heating dishes to prevent the food being rapidly cooled by coming in contact with the dish.

Dished. A term applied to the end of a cylinder or drum when it is concave.

Dismantle. To remove the sails, ropes, blocks and other gear that would become damaged by exposure if left without care.

Displacement. The amount or quantity of water displaced by a floating vessel. It exactly equals the weight of the vessel itself with whatever is on board at the time at which the displacement is recorded.

Displacement may be expressed either in cubic feet or tons; a cubic foot of sea water weighs 64 pounds and one of fresh water 62.5 pounds, consequently one ton is equal to 35 cubic feet of sea water of 35.9 cubic feet of fresh water.

The designed displacement of a vessel is her displacement when floating at her designed draft. In merchant vessels this is generally taken with full cargo, fuel, stores and water on board. In the case of naval vessels it corresponds to the vessel complete with full supply of ammunition, and two-thirds full supply of fuel, stores and water. Page 155.

Displacement Length Coefficient. See COEFFICIENT, DISPLACEMENT LENGTH.

Displacement, Volume of. The volume of water displaced by a vessel. In the English system of units the volume of displacement is given in cubic feet and equals thirty-five times the displacement in salt water or thirty-six times the displacement in fresh water.

Distiller. A chamber in which steam vapor from an evaporator is condensed, forming fresh water for drinking and other purposes. It consists essentially of a chamber into which the steam vapor enters and is condensed by a pipe coil through which cold sea water circulates. Plate XII.

Distiller Foundation. A term applied to the seating supporting a distiller.

Distiller Pump. See PUMP, DISTILLER.

Distortion. Deformation from the natural or original shape of an object.

Ditty Box. A small box fitted with a hinged lid and lock, used by the crew on war vessels to hold thread, needles, combs, brushes, etc.

Dock. A basin for the reception of vessels. Wet docks are utilized for the loading and unloading of ships. Dry docks are utilized for the construction or repair of ships.

Docking Draft, Critical. See CRITICAL DOCKING DRAFT.

Docking Keel. See KEEL, DOCKING.

Docking Plug. See BLEEDERS.

Dockyard. A yard or plant where ships are constructed or repaired.

Dog. A short metal rod or bar fashioned to form a clamp or clip and used for holding watertight doors, manholes, or pieces of work in place.

On watertight doors, it is usually a U shaped fitting composed of two main pieces, one of which is bent to form a right angle, having a handle on one end, the other end being passed through a gland in the door and having a screw thread cut on the end to which the second piece in the shape of a handle is attached. The complete dog provides a handle on each side of the door which when turned works over a wedge on the door frame and compresses a rubber gasket fitted to the door against the toe of the flange of the door frame.

On manhole and hatch covers giving access to compartments in the ship's structure, the dogs usually consist of drop forged fittings riveted to the cover. U shaped openings in the dogs project over the edge of the cover a sufficient distance to allow drop bolts hinged to the manhole or hatch frame to be swung up into the openings and tightened by nuts.

On manholes in boilers and tanks the dog consists of a strong back fashioned to the shape of an arc of a circle and spanning the manhole. A stay bolt passing through the manhole door and through a boss in the center of the dog allows the door to be tightened.

On the floor where the ship's framing is curved to shape, the dog consists of a piece of steel rod bent to somewhat less than a right angle. One leg of the dog is put through a hole in the bending floor and the other end on the frame or piece of work to be bent. A few blows of the hammer near the apex of the angle of the dog is sufficient to clamp the work to the floor.

For holding blocking together, the dog consists of a rod or bar of iron having its ends bent at right angles and pointed. In use the pointed ends are driven into the blocks to be held. Page 814.

Dog, Shore or Dagger. A brace placed in such a position that it holds the sliding ways from slipping until all the necessary shores and keel blocks are removed, when it is itself removed allowing the ship to slide down the ways.

Dolly Bar. A steel bar used to hold the heads of rivets while the points are being clinched. A dolly bar is used where the space is not sufficient to use a holding on hammer conveniently.

Dolphin. A term applied to several piles that are bound together, situated either at the corner of a pier or out in the stream and used for docking and warping vessels. Also applied to single piles and bollards on piers that are used for docking and warping.

Donkey Boiler. See BOILER, DONKEY.

Donkey Pump. See PUMP, DONKEY.

Door. A swinging, sliding or removable part providing entrance or access to staterooms or compartments.
Pages 814, 816.

The American Bureau of Shipping requires that Watertight Doors are to be of ample strength for the water pressure to which they may be subjected; they are to be carefully fitted and should be tested at the Maker's works; the doors are to be designed so that they are not likely to be prevented from closing properly by lodgments of dirt or pressure from coal. The closing gear is to be accessible in all cases and workable from the bulkhead deck; the lead of shafting should be direct, if possible, and the screw should work in a gun-metal nut; there should be an index at the operating position to show whether the door is open or closed, and clearly marked with directions for closing the door. Where stiffeners are cut in way of watertight doors in the lower part of a bulkhead, the opening is to be suitably framed and bracketed so as to maintain the full strength of the bulkhead; a tapered web plate or buttress, stiffened on the edge, is to be fitted at each side of the door, from the base of the bulkhead to well above the door opening. Where stiffeners are not cut in way of 'tween deck doors, but the spacing of the stiffeners has been increased, the strength and stiffness provided at the sides of the doorway are to be such as to provide not less efficiency than the unpierced bulkhead, without taking the door frames into consideration.

Door, Air Tight. A door so constructed that when closed air cannot pass through. They are fitted in air locks and where air ejection of water is desired.

Door, Boiler Ash Pit. See BOILER DOOR, ASH PIT.

Door, Boiler Furnace. See BOILER DOOR, FURNACE.

Door, Cargo. A door, usually composed of two or more parts, fitted in the side or an upper bulkhead of a vessel for the purpose of providing access through which cargo may be trucked.
Pages 552, 553.

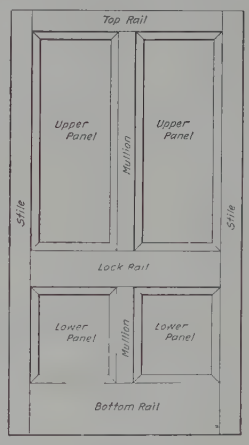
Door, Dutch. A term applied to a door built in two independent sections, one above the other, so that the upper half may be open while the lower half is closed. These doors are commonly used for access to galleys.

Door Frame. A frame enclosing a doorway. It is generally composed of a horizontal piece at the top called a header, a horizontal piece at the bottom called a sill, the vertical sides called stiles and a piece which extends around the inside of the frame for the door to close against called the stop bead.

Door Gangway. A door fitted in the side of a vessel to provide access for a gangway.

Door, Horizontal or Vertical, Sliding. A door so constructed and operated that it can be slid, horizontally into position in the case of horizontal doors and vertically into position in the case of vertical doors. Such doors are usually watertight and so fitted with shafting and bevel gears or other means that they can be closed from the weather or upper deck.
Pages 554, 555.

Door, Joiner. A light door fitted for access to staterooms and quarters where watertightness is not required. These doors are made of wood, light metal plating and also of light metal plating on wood frames. Metal joiner doors are extensively used.
Pages 591, 816.



JOINER DOOR

Door, Metallic. A term applied to a hollow metal joiner door. They are fitted in the living quarters aboard ship.
Page 816

Door, Non-Watertight. A term applied to a door that is not constructed to prevent water under pressure from passing through.

Door, Screen. A wooden door frame over which single or double wire mesh is stretched.

Door, Slat or Blind. A door composed of a frame fitted with slats or blinds. They are fitted in conjunction with joiner doors to state rooms and also independently to some compartments.
Page 585

Door, Watertight. A door so constructed that when closed it will prevent water under pressure from passing through.

A common type consists of a steel plate, around the edges of which a frame of angle bar is fitted, having a strip of rubber attached to the flange that is parallel to the door plate. The strip of rubber is compressed against the toe of the flange of an angle iron door frame by dogs or clamps.
Pages 551, 552, 553, 814.

Door, Weathertight. A term applied to outside doors on the upper decks which are designed to keep out the rain and spray.

Double Acting Pump. See PUMP, DOUBLE ACTING.

Double Bottom. A term applied to the space between the inner and outer skins of a vessel. Also applied to indicate that a ship has a complete inner or extra envelope of watertight plating. A double bottom is usually fitted in large ships extending from bilge to bilge and nearly the whole length fore and aft.

According to the **American Bureau of Shipping,** Double Bottoms should be fitted all fore and aft in Vessels of ordinary design having lengths of 300 feet and above; it is recommended that the inner bottom be arranged to protect the bilge as much as possible, and that it be extended to the sides of the Vessel forward of the midship three-fifths length. The scantlings and arrangements of double bottoms are not to be less than required by the Bureau's rules and tables. Details of the construction of all double bottoms, including proposed arrangements for the scarphing of keelsons, etc., at the ends of partial double bottoms, are to be clearly shown on the plans

submitted for approval. The sub-division of double bottoms should coincide approximately with that of the holds; where the depth of the double bottom exceeds 36 inches, the tank end floors are to be stiffened with angles 3 feet apart; the thickness of the division plate is not to be less than required for tank bulkhead plating and the sizes of stiffeners are to be in accordance with the requirements for tank bulkhead stiffeners. Where their distance from the Freeboard Deck or Bulkhead Deck exceeds 35 feet the boundary anglers are to be double-riveted.

Center Girders are to have the thicknesses and the depths required by the Bureau's tables. They are to extend as far forward and aft as practicable and are to overlap the fore end of propeller frame forgings; the plates and top angles may be fitted intercostally between floors abaft the midship three-quarters length. The bottom angles are to be fitted in accordance with the rules for flat plate keels, the extent of the top angles is to be governed by the same conditions with the exception that they need not be doubled forward of the midship half length in Vessels under 350 feet length. Manholes should be cut for access to each frame space outside the midship three-quarters length; they may be cut in alternate frame spaces elsewhere in ships under 300 feet in length, provided the depth of the hole does not exceed one-third of the depth of the center girder; in Vessels of 300 feet length and above, necessary manholes within the midship three-quarters length are to be specially approved and compensated.

Intercostal Girders are to be fitted on each side where the distance from the center girder to the middle of the margin plate exceeds 15 feet or the Vessel's breadth exceeds 34 feet; where the spacing between girders exceeds 15 feet, or the Vessel's breadth exceeds 64 feet, two intercostal girders are to be fitted on each side. Forward of the midship half length intercostal girders are to be spaced not more than 7 feet apart, and forward of the midship three-fifths length lines of half intercostals, efficiently connected to the floors, are to be fitted between the full intercostals and extended as far forward as possible; the shell clips in Vessels over 300 feet length are to be of the sizes required for fore-end frames. Intercostal girders are to be fitted in the neighborhood of the main lines of bolting for the machinery and thrust block, in such number and positions as will insure effective distribution of weight and sufficient rigidity of structure. Plans showing the proposed arrangements in relation to the bolting plan of the engine seat are to be submitted for approval. Double angles or single angles of equal efficiency are to be fitted on the upper edges of all intercostals under the engines and thrust block, and also to the shell in cases where the engines are of high power. Connecting angles are not to be less than required by the Bureau's table or by the sizes of the rivets which are used; flanged connections may be used on one edge (except in the machinery space and on the shell plating forward of the midship half length) where the circumstances appear to the Bureau's Committee to justify its adoption, upon the case being specially submitted.

Where the engines are placed aft or the Vessel is of very full form forward, the strength of the structure forward of the midship half length is to be further re-inforced, to the satisfaction of the Bureau's Committee.

The engine bed plate and thrust block should be fastened direct to the tank top; the top plating in way of same is not to be less than .75" thick and is to be increased according to the size and power of the engines; the double bottom is to be efficiently stiffened under the thrust block, to the approval of the Bureau's Committee. Holding down bolts for the main engines are to pass through angle flanges or are to be kept as close to the angle bars as possible; if they pass through the flanges of the bars, the flanges are to be of sufficient breadth to take the nuts.

The American Bureau of Shipping states that in view of the rapid corrosion which may occur in material which is in close proximity to the boilers, it is important to have a clear space of at least 18 inches between the top of tank and the lowest part of boiler; when the clear space is necessarily less than 18 inches, the thickness of the tank top plating below the boilers is to be increased beyond the tabular requirements, to the approval of their Committee. The distance between the boilers and tank top is to be stated on the plans submitted for approval.

Air pipes are not to be less than 2 inches in diameter, they are to be fitted at each corner of each tank, or on each side of the center girder if the top is packed; in the case of small compartments at the ends of the Vessel, the number of pipes may be modified; the total area of the pipes should always be greater than that of the supplying pipes. Arrangements are to be made to permit of the air getting freely to the pipes while the tanks are being filled, by means of air holes in plates and shortening the liners on upper edge of floors, or other efficient method. Air pipes which are not accessible at all times are to extend to the Freeboard Deck or the Bulkhead Deck.

Wells.—Efficient arrangements are to be made for draining water which may gather above the inner bottom, and it is recommended that, with the exception of the after tunnel well, any wells which may be provided for this purpose should not extend downwards for more than half the depth of the double bottom. A thick steel plate is to be securely fixed below each sounding pipe for the rod to strike upon.

Testing.—Before the Vessel is launched, and before the cement is laid at the tank ends or outside the margin angle, double bottoms are to be tested with a head of water up to the Freeboard Deck, the Bulkhead Deck or the overflow from the air pipes, whichever is highest. Where engines are bolted direct to tank tops, the tanks in way of same are to be finally tested after the engines are fixed in place.

Double Bottom Cellular. A term applied where the double bottom is divided into numerous rectangular compartments by the floors and longitudinals.

Double Bottom Plating. See PLATING, DOUBLE BOTTOM.

Double End Punch. See PUNCH, DOUBLE END.

Double Ported Slide Valve. A type of slide valve in which the ports are so arranged that for a given movement of valve twice the area of steam port is uncovered as would be the case in a simple slide valve of ordinary type.

Double Riveting. See RIVETING, DOUBLE.

Double Spindle Lathe. See LATHE, DOUBLE SPINDLE.

Double Whip. A rope rove through two single blocks,

having the standing part made fast to a fixed object near the upper block or to the block itself.

Doubling Plate. See PLATE, DOUBLING.

Doubling Shell. See SHELL, DOUBLING.

Doubling Strake. See STRAKE, DOUBLING.

Douse. To cover suddenly with a liquid; to lower quickly as a sail; to extinguish suddenly.

Dowel, Butt. A cylindrical pin used in making end joints in timbers. A hole of the same diameter as the dowel is bored in the end of each timber and the pin is inserted in one timber and then the joint made by forcing it into the other.

Dowels, Joint. Rectangular blocks inserted in grooves cut in the sides of a pair of frames or timbers for the purpose of making them work together.

Downton Pump. See PUMP, DOWNTON.

Draft, Draught (of a vessel). The depth of a vessel below the waterline measured vertically to the lowest part of the hull, propellers or other reference points.

Page 160.

Draft Marks. The numbers which are placed at the bow and stern of a vessel to indicate how much water she draws. These numbers should be as near the stem and stern as possible and should be six inches high and spaced twelve inches apart vertically.

Draft, Mean. The mean of the drafts measured at the bow and the stern, or in the case of vessels with straight keels the draft measured at the middle of the waterline length.

Draftsmen. Men engaged in the preparation of the general and detail plans from which are built the ship's hull, machinery, fitting, etc.

Drag. See ANCHOR, SEA.

Drag. The designed excess in draft aft over that forward.

Drain Hole Plug. See BLEEDER.

Drainage System. Piping located in the hold of a vessel and connected to drainage pumps for pumping overboard accumulations of water in the various compartments, hold, inner bottoms, etc.

Pages 600 to 605.
Plate XLIII.

Drawing Room Equipment. The equipment necessary to a drafting room to permit the engineers and draftsmen to carry on work such as making calculations, pencil drawings, tracings, blueprints, etc., for designs undertaken. It consists of drawing tables and benches, slide rules, calculating machines, plan filing cabinets, drawing instruments, scales, triangles, curves, splines, blueprinting and photostat machines and miscellaneous supplies such as drawing paper, tracing cloth, blueprint paper, pencil ink, erasers, etc.

Pages 694 to 696.

Dredge or Dredger. A vessel usually having a scow-shaped hull and equipped with especial machinery for use in deepening the channels of rivers, harbors, etc.

Pages 1045, 1104, 1105.

Dredging Pump. See PUMP DREDGING.

Dresser, Galley. See GALLEY DRESSER.

Driers. See PAINT.

Drift. In erecting the structure of a ship it is often found that the rivet holes in the pieces to be connected are not concentric and the distance that they are out of line is called the drift. Where the drift is slight it can be corrected by reaming, but in many cases it is necessary to drive tapered pins far enough through the holes to bring them in line.

Drift Angle. The angle formed by the tangent to the vessel's path in turning and the fore-and-aft centerline of the vessel. Inasmuch as a ship's bow in turning tends to swing in toward the center of her turning circle, the propelling force delivered is along a line oblique to that of the vessel's motion. This is one of the reasons for a ship's loss of speed during the act of turning.

Drift Pin. A conical shaped pin gradually tapered from blunt point to a diameter a little larger than the rivet holes in which it is to be used. The point is inserted in rivet holes that are not fair, and the other end is hammered until the holes are forced into line.

Drill. A cylindrical shaped tool with cutting facets on one end.

Drill Drift. A wrench for releasing a drill from its socket.

Drill Frame Hoist. A machine designed for operating the drill frames used in submarine drilling.

Drill Press. See DRILLING MACHINE.

Drill, Sensitive. A machine for drilling small holes. When small drills are used in a machine any undue pressure in feeding the drill will cause it to break. For this reason the pressure necessary for feeding must be plainly perceptible at the hand lever or other feeding device and sensitiveness in this respect is attained by making the parts light and easy to move or operate.

Drilling Machine. A machine designed for the purpose of drilling holes in metal, wood, fiber, etc.

Pages 723, 724, 726, 728, 730, 733, 738, 782, 785, 789, 1064.

Drilling Machine, Electric. A portable drilling machine driven by an electric motor and used for the same purpose as a pneumatic drilling machine.

Pages 728, 782, 1064.

Drilling Machine, Heavy Duty. A drilling machine especially adapted to rapid drilling. This type of machine was developed to drive high speed drills to the limit of their capacity.

Pages 723, 726.

Drilling Machine, Multiple Spindle. A drilling machine which is built in both vertical and horizontal designs, with which a number of holes may be drilled simultaneously. Some drilling machines equipped with multiple spindles are known as gang drills.

Page 723.

Drilling Machine, Pneumatic. Pneumatic drilling machines, or air drills, or pneumatic drills, as commonly called, are usually portable drilling machines driven by an air motor of the reciprocating piston type, which is contained within the casing of the machine. They are not only used for drilling, but for reaming, tapping, grinding, wood boring and countersinking.

Pages 782, 785, 789.

Drilling Machine, Radial. A drilling machine with a vertical spindle which is carried by an arm that may be swiveled about a vertical column. The distinguishing feature of this machine is the radial adjustment of the arm about the column, which adjustment, in conjunction with the traversing motion of the drill spindle head along the arm, makes it possible readily to locate the drill in any position within the range of the machine.

Pages 724, 733.

Drilling Machine, Upright. The most common form of drilling machine. The general design of the machine is vertical and the drill spindle is in a vertical position.

Drive, Electric. See ELECTRIC DRIVE.

Drop Forgers. Workmen who operate drop forging machines.

Drop Forging Machine. See FORGING MACHINE, DROP.

Drop Strake. See STRAKE, DROP.

Drum, Wildcat. See WILDCAT.

Dry Dock, Floating. A hollow floating structure of L or U shaped cross section, so designed that it may be submerged, that a vessel may be floated into it, and that it may then raise the vessel and itself so that the deck of the dock and consequently the bottom of the vessel is above the level of the water.

The bottom of a floating dry dock consists of one or more pontoons or rectangular shaped vessels with high wing structures erected on one or both sides according to whether the section is to be L or U shaped. The deck of the pontoon is fitted with stationary keel blocks and movable bilge blocks which can be pulled under a vessel from the top of the wing structure. Pumps are fitted in the wings by which the dock can be quickly submerged or raised.

Floating dry docks are used for repairing and painting the under water portions of vessels and for docking a damaged vessel. They are usually made up of several pontoons connected by more or less flexible joints and by the continuous wing structure. A pontoon may be detached at any time and docked on the remaining pontoons, thus making the dock self-repairing. On account of the unequal distribution of weight, fore and aft, in a ship, the pontoons in way of the middle portion of the ship should be given more buoyancy or lifting power than the end pontoons by regulating the amount of water pumped out of each pontoon. If this is not done the stresses set up in the longitudinal members of the ship's structure are much larger than in an excavated dock. Floating dry docks recently designed, having truss girders in the wing structures should also reduce the stress in the docked ship to an amount well within the stresses allowed for in the vessel's design. Floating dry docks are much cheaper to construct than excavated docks, and they possess a further advantage in that they may be moved or towed to a desirable location.

Pages 1104, 1105, 1106.

Dry Dock, Graving. A basin excavated at a waterway and connected thereto by gates or a caisson which may be opened to let a vessel in or out and then closed and the water pumped out. The dock is fitted with stationary keel blocks and movable bilge blocks, which usually are fitted on rack tracks, allowing them to be pulled under a vessel before the water is pumped out.

Graving docks are more common in Nevy Yards, as they are more expensive to construct than floating docks. On the other hand, when once made, they are practically permanent and they supply a more rigid foundation for supporting a ship than the floating dock.

The gate of a graving dock is usually a caisson or a complete vessel in itself, the cross section of which is generally elliptical in shape and having a strong rectangular shaped keel and end posts which bear against the bottom sill and side ledges at the entrance of the dry dock. The caisson is designed so that it may be submerged at the entrance of the dock until it rests against the sill, and it is also equipped with power and pumps so that it may raise itself.

When a ship is to be docked, sluice valves in the caisson are opened until the water in the dock reaches the same level as the water outside. The valves are then closed and the caisson pumped out and swung to one side, allowing a vessel to enter the dock. The caisson is then swung back to close the entrance and submerged, completely separating the basin from the waterway. After the vessel is lined up over the keel blocks the water is pumped out of the dry dock.

Graving docks are constructed by making a large excavation, driving pile or building concrete foundations in the bottom and by constructing wood, concrete or stone retaining walls around the sides. The sides are usually built in the form of steps.

Pages 1104, 1105, 1106.

Dry Dock, Railway. A railway dock consists of tracks built on an incline on a strong foundation and extending from a sufficient distance in shore, to allow a vessel of the maximum size that it is built for to be docked, to a sufficiet distance under water to allow the same vessel to enter the cradle. The cradle running on the tracks may be of wood or steel fitted with keel and bilge blocks and sufficiently weighted to keep it on the track when in the water. A hoisting engine with a winding drum or wild cat is fitted at the in shore end of the railway which operates the cradle by a cable or chain.

These docks are less expensive than either the floating or graving docks, and are extensively used for docking ships of moderate size. The older types of marine railways had their cradles designed so that a vessel, in entering the dock, grounded on the forefoot and pivoted as the cradle came out of the water to a position in which the vessel's keel was approximately parallel to the tracks. A later and better design has been developed in which the cradle is designed so that the whole vessel grounds at the same time, and which allows a ship to be pulled up on the shore on an even or approximately horizontal keel. Railway docks are usually designed for hauling a vessel up the tracks bow first, but side-haul docks have also been built.

Pages 1104, 1105, 1106.

Drying Oven. See OVEN, DRYING.

Dub. To smooth down; as to dub a spar or timber with an adze.

Ductility. That property of a material which permits of its being drawn out into a thread or wire.

Dug-out. A term applied to a boat fashioned out of a log.

Dump Scow. A flat bottom craft used for transporting rubbish, etc. No machinery is installed for its propulsion.

Dumping Boards. A term applied to the planks fitted on the top of the inner bottom underneath the hatch openings. These planks take the wear of the cargo when loading and protect the inner bottom plating.

Dunnage. Loose wood or waste material placed in the hold of a vessel for the protection of the cargo from dampness. Also used as descriptive of a sailor's kit or personal belongings.

Duplex Pump. See PUMP, DUPLEX.

Dutch Door. See DOOR, DUTCH.

Dutchman. A piece of wood or steel fitted into an opening to cover up poor joints or the crevices caused by poor workmanship.

Dynamo. See GENERATOR, ELECTRIC.

E

Eccentric. A form of crank in which a circular disc set eccentrically upon a shaft forms at once the crank web and crank pin.

Eccentrics are usually made of cast steel or iron and if large are lightened to save weight. They are made in two parts connected by tap bolts and keyed to the crank shaft.

Eccentrics are utilized to convert circular to rectilinear motion. The rectilinear travel is usually short relative to the diameter of the crank shaft so the ordinary form of crank is impracticable.

Eccentric Rod. A rod attached to the eccentric strap and designed to drive valves where the travel is less than half that of the piston.

Eccentric Strap. A metal ring fitted round the eccentric disc. It is made in halves and bolted together, provision being made to attach the eccentric rod unless same is cast as part of the strap. The eccentric strap is generally made of cast steel or brass.

Economizers, Boiler. See Boiler Feed Water Heater.

Eddy-making Resistance. See Resistance, Eddy-making.

Edge, Sight. That edge of a strake of shell plating which laps outside another strake and is, therefore, in plain sight.

Effective Horsepower. See Horsepower, Effective.

Effective Length. This term ordinarily indicates the mean length of that portion of the hull below the waterline. The length of a vessel has an important influence upon her resistance. In general, frictional resistance increases with increase in length and residuary or wave-making resistance decreases with increase in length. Certain formulæ involving the vessel's length are used for determination of the frictional resistance. These formulæ generally produce more accurate results if the mean length of vessel below the waterline is used, and for that reason the foregoing definition in general holds true.

In dealing, however, with residuary resistance, a vessel may be so formed as to produce a system of waves similar to the wave system of a vessel of greater length but of ordinary shape, and running at the same speed as the vessel under consideration.

In such a case the vessel might be considered to have an augmented length effective for wave making. This augmented length is termed the effective length in speaking of the residuary resistance, but owing to the practical difficulties in the way of estimating any exact or even reasonably approximate value of such an equivalent length, no effort is made toward the formulation of any rule.

Efficiency, Propeller. See Propeller Efficiency.

Efficiency, Turbine. See Turbine Efficiency.

Ejector, Ash. See Ash Ejector.

Ejector, Bilge. See Bilge Ejector.

Electric Arc. See Arc, Electric.

Electric Battery. See Battery, Electric Primary, and Battery, Electric Storage.

Electric Condenser. See Condenser, Static Electric, and Condenser, Rotary.

Electric Drive. A term applied where a ship is propelled by an electric motor or motors, which receive their power from generators that are operated by turbines, steam engines, or interval combustion engines. The electric drive with turbo generators has been installed on four ships classified by Lloyd's during the year 1918-19, and on a few ships built by the United States Navy.

In the Navy, tests have been made on three similar ships, the *Jupiter,* fitted with an electric drive; the *Neptune,* fitted with geared turbines, and the *Cyclops,* fitted with triple expansion reciprocating engines, and the results of these tests showed that the *Jupiter,* with the electric drive, gave an economy in steam per shaft horse-power 20 per cent better than the *Neptune* and 26 per cent better than the *Cyclops.*

Among the advantages claimed for the electric drive are, a saving in first cost, economy in steam consumption, a more reliable source of power in which it is claimed that if the main generating set is out of commission the auxiliary power may be used, a flexible and synchronous speed control which prevents propeller racing and the privilege of placing the motor aft, while the generating set is amidships, thus saving considerable length of propeller shafting and increasing the available cargo space.

Pages 934, 935, 936, 941, 942, 943.

Electric Fan. A small cast iron pedestal supporting an electric motor which operates a small fan. Electric fans are used in staterooms and quarters to circulate the air and keep them from becoming stuffy.

Page 952.

Electric Furnace. See Furnace, Electric.

Electric Gag Control. A mechanism attached to a punching machine for locating the plates as desired and for placing the punch over a center punch mark of the plate.

Electric Generator. See Generator, Electric.

Electric Hoist. See Hoist, Electric.

Electric Light Fixtures, Watertight. Electric light fixtures so arranged that the electrical connections of the circuit are protected by watertight casings.

Pages 947, 1070, 1072, 1073.

Electric Locomotives. A self-propelled vehicle running on rails for the purpose of hauling cars, power for which is developed by motors on its locomotive which are mechanically connected to the driving axles. The electric power for driving the motor is usually developed in a power house remote from the locomotive and is connected by a trolley, pantagraph or shoe from an overhead wire or third rail. In the case of "gas electric" and "oil-electric" locomotives the electric power for driving the motor is derived from a gas or oil engine driving a generator mounted on the locomotive.

Page 954.

Electric Meter. See Meter, Electric.

Electric Motor. See Motor, Electric.

Electric Propulsion. See Electric Drive.

Electric Range. A galley cook stove in which the heat is generated by electricity.

Electric Rivet Heater. A machine in which rivets are heated by an electric current. These macchines consist of a specially designed transformer with one or more openings in the secondary winding. The rivet or rivets to be heated are inserted in these openings. Placing the rivets in the openings complete the secondary circuit and the rivets are heated by the current passing through them.

Pages 760, 761, 958.

Electric Steel. See Steel and Iron.

Electric Telemotor. See Telemotor, Electric.

Electric Welding. See Welding, Electric.

Electric Watertight Plug. See PLUG, WATERTIGHT ELECTRIC.

Electric, Whistle Control. See WHISTLE CONTROL, ELECTRIC.

Electric Wire and Cable. Wire used for conducting electric currents is made from copper, copper alloys, aluminum, iron and steel. Annealed or soft-drawn copper wire has a conductivity higher than any other wire used commercially and is used almost exclusively for all low voltage power requirements. Its conductivity is assumed to be 100 per cent. Hard-drawn copper and aluminum are used for power lines on poles or towers, and iron wire is used commonly on telephone pole lines. Phosphor-bronze wire is generally adopted for wireless aerials. Hard-drawn copper wire has a conductivity of about 97 per cent; hard-drawn aluminum wire 61 per cent; and iron and steel wire from 8 to 16 per cent. Copper alloy and copper-clad steel wire is used in cases in which it is desirable to sacrifice some conductance for mechanical strength.

Cable

A number of strands of wire twisted or woven together constitute what is known as a cable. The term cable also applies to a number of conductors insulated from each other and contained in the same covering.

Insulated electric wire and cable are classified in two general ways, (1) depending upon the kind of insulators or covering used, and (2) depending upon the use for which the wire or cable is designed.

Insulation and Protection

The following materials are used as insulation for electric wires and cables: cotton, rubber, silk, paper, asbestos, enamel, varnished cloth and asphaltic and resinous impregnating compounds. Most of these materials are used singly or in combination. Cotton braid or tape and braid form the protective covering for weatherproof and rubber covered wire and a lead sheathing is often used to make a cable water and moisture proof. Steel tape, twisted wire and woven wire coverings are often used to protect cables from mechanical injury. These coverings are used both with and without lead sheathing.

Uses

With respect to the use for which wires and cables are designed they may be classified as annunciator wire, magnet wire, office wire, portable lamp cord, reinforced portable lamp cord, brewery cord, light and power cable, underground cable, submarine cable, deck cable, ignition wires and cables, etc. Pages 951, 1066, 1067, 1068, 1069.

Electrical Installations. The following Rules for the Installation of Electrical Equipment on board Vessels have been suggested by the Marine Committee of the American Institute of Electrical Engineers, and have been adopted by the Committee of the American Bureau of Shipping.

Pages 679, 680, 1064, 1065, 1070, 1071, 1072, 1073, 1074.

Plates LII to LX.

(1) General—All apparatus and appliances such as generators, motors, wires, switches, circuit breakers, cut-outs, etc., shall strictly conform in every respect to the Standardization Rules of the American Institute of Electrical Engineers and the National Electric Code and such special rules under Marine Construction Requirements contained herein.

No wood must be used for any purpose in any part of the installation.

The two-wire or three-wire complete metallic system of distribution is approved. The single wire system of distribution is disapproved.

In vessels carrying petroleum or any substance giving off an explosive gas no permanent conductors must be installed in any compartment liable to contain such fumes. Portable lamps of approved gas-tight construction may be temporarily used in pump room but the portable wire must be armored and the attachment made outside the pump room. All the metallic rigging of such vessels must be carefully and effectively grounded to the metal hull.

Generators, or storage batteries, required for emergency lighting and power must be located as far above the load water line as possible. Storage batteries must be properly ventilated and regularly inspected.

(2) Distribution.—All main and distribution switchboards must be made of approved non-combustible, non-absorptive, insulating material. Distribution panels must be totally enclosed in metal cabinets. Every circuit leading from a switchboard or distribution panel must be protected by an approved automatic circuit opening device and switch.

Distribution panels must not be located in inaccessible places or such compartments as bunkers, storerooms, cargo holds, or compartments allotted alternately to passengers, live stock and cargo. They must be so located that the load on one cut-out shall not exceed 660 watts except in the case of motors, searchlights, diving lamps, and electric heating devices.

The method of distribution for cargo spaces must be such that each freight compartment is separately controlled outside the compartment so that the electrical current shall be cut off when the vessel is under way.

(3) Installation of Wires.—All electrical conductors must be protected by one of the following methods:

(a) Armored with metal bands, with or without lead.
(b) Armored with metallic basket-weave braid, with or without lead.
(c) Plain braided wires enclosed by iron casing.
(d) Drawn into metal conduits—either rigid or flexible.
(e) Placed in metal molding.

No splices or joints in wires are permitted. Connections must be made by means of approved connection blocks mounted in metal boxes. These appliances must not be located in coal bunkers or other inaccessible places.

Wherever the conductors, protected by flexible metal conduits, metal molding, or armored metallic bands or braid, are exposed to severe mechanical injury, they must have an additional metallic protection.

(4) Generators and Motors.—Generators and motors must be located so as to avoid proximity to steam, water, or other piping, or to be properly protected from damage coincident thereto.

Name plates must be provided on this apparatus giving the maker's name, rating in revolutions per minute, volts, amperes and kilowatts or kilovolt amperes. The type whether shunt, series, or compound-wound must also be stated.

If the motor starting box does not completely break the motor circuit a switch breaking all poles must be installed between the feeder and the starting box.

Hand rails must be provided around generators, and similar protection given open type motors if employed.

(5) Switchboards.—Main switchboards and distribution switchboards where exposed to mechanical injury and moisture, must be properly protected. Such switchboards must be accessible from all sides.

For the control of the generator or generators a main switch, circuit breaker and ammeter must be provided for each machine. One voltmeter arranged with switch so that it may read the voltage of all generators and one set of ground detector lamps must be provided. (Separate voltmeters for each generator will be allowed.)

Hand rails with hickory or other approved insulated top must be provided in front of switchboards.

The signal lights must be controlled by an approved telltale board located in pilot house which will indicate a burned-out lamp. Each side of all signal circuits must be brought to this board and fused at this point. The feeder for this board must be continuous from the main switchboard and must not supply any other circuits in the vessel.

Distribution panels located in places not exposed to the weather may be enclosed in non-watertight metal cases. Distribution panels located on the weather deck or places exposed to the weather must be enclosed in watertight metal cases.

(6) Installation of Wires.—All conductors larger than No. 14 B. & S. gauge must be stranded. Except for fixture wiring and signaling systems no single conductor smaller than No. 14 B. & S. gauge shall be employed. No. 16 B. & S. gauge wire may be used for fixture and signaling wire, but in signaling systems energized by over 25 volts the insulation must comply with the requirements for the voltage employed. Bell wires must not be run in conjunction with light or power wire.

All conductors must be led through metallic stuffing tubes when passing through watertight bulkheads, and through all decks. Stuffing tubes through decks must extend to a height of 18 inches above the surface of the deck.

In conduit construction the conductors must not be "pulled in" until all the mechanical work on a given section has been completed. Pull boxes must be installed at sufficient intervals to permit pulling in the conductor without injurious strain. Pull boxes to be of watertight construction and allow an opening in the box at least ten times the diameter of the conductor contained therein.

In armored cable installations, all cable liable to be exposed to weather or moisture must be lead-covered, or otherwise specially protected. They must be carefully "laid" with no short or sharp bends and secured with screwed clips spaced not more than 14 inches apart. Where cables pass through beams, decks, bulkheads, or any part of the metal structure not requiring a stuffing tube the hole through which they pass must be bushed with lead or other material that will not permit chafing or corrosion to take place. No lead-covered, steel-armored cable over one and one-half inch outside diameter to be employed.

Twin conductors up to 60,000 circular mills may be used for all types of installation.

Portable conductors must be made of two or more stranded conductors not less than No. 14 B. & S. gauge laid together and provided with an approved insulation and covering.

On vessels carrying radio telegraph apparatus, all permanent wiring in the radio room and above the top metal deck must be magnetically shielded. Any protection placed around the antennæ leads to prevent ready access to same must be of metal, permanently and effectively grounded.

The insulation resistance of the completed wiring installation must conform to the requirements of the National Electric Code.

The size of all wiring and cable conductors must be in accordance with the following Table of safe capacities:

No. of Wires or Strands	Size of Wire or Strands B. & S. Gauge	Capacity in Amperes	No. of Wires or Strands	Size of Wire or Strands B. & S. Gauge	Capacity in Amperes
1	18	..	19	17	60
1	18	3	19	16	70
1	17	..	37	18	85
1	16	6	37	17	100
1	15	..	61	18	120
1	14	12	61	17	145
1	12	17	61	16	170
7	19	21	61	15	200
7	18	25	61	14	235
7	17	30	91	15	270
7	16	35	91	14	320
7	15	40	127	15	340
19	18	50			

(7) Suggestions.—Great care should be exercised in running electric leads in the vicinity of the magnetic compasses. If the leads carry large currents, in excess of 100 amperes, they should be crossed.

It is strongly recommended that all metal work above the top metal deck, including metal rigging for all masts and funnels, be permanently and effectively grounded. All short exposed flexible leads, such as those to searchlights and running lights, should be provided with a metallic shield well grounded to the hull of the vessel.

It is recommended that a switch be placed in the ground detector circuit on the main switchboard so that this ground connection may be broken when it is desired to test out the various circuits in the vessel.

It is strongly urged that a complete test of the insulation of the entire electrical equipment be made at least every six months and copy of report forwarded to the American Bureau of Shipping.

Electricians. Workmen who set up the electric plant and its auxiliaries with their fittings, such as wiring, switchboards, control panels, etc.

Electrolysis, Boiler. See Boiler, Galvanic Action.

Electrolyte. A solution or composition of fused salt in which electrical energy is generated by means of chemical action or in which chemical reaction occurs due to the passing of an electric current through it. The solutions in wet primary batteries and storage batteries, and the fused salts in dry batteries are called electrolytes.

Electromagnet. A magnet in which the magnetic field is produced by an electric current passing through a coil of wire wound upon a soft iron core.

Electromotive Force. That force which tends to cause an electric current to flow in a circuit. See Volt.

Ell. A sleeve fitting, internally threaded, having two openings, the centerlines of which are usually at right angles. It is used to make an angle connection between two pipes.

The angle of the ell is usually stated if other than 90°.

Ell, Branch. An elbow with a branch back outlet fixed in line with one of the main openings.

Embossing Press. See PRESS, EMBOSSING.

End-For-End. To have the wrong end foremost.

To place the opposite end where the other end was originally.

End Plate, Stern Tube. See STERN TUBE END PLATE.

Engine. The American Bureau of Shipping's rules for Engines are as follows:

Forgings.—Shafts, piston rods, connecting rods, and other important working parts of the machinery, are to be forged from selected scrap iron, rolled iron bars or a sound steel ingot in accordance with the requirements of the following paragraphs. Other material, such as nickel, steel, etc., will be accepted after compliance with such special tests as may be imposed.

Steel Forgings for machinery are to be forged from the lower two-thirds of ordinary ingots made by the Open Hearth process; the material is to be tested, and the sectional area of the body of the forging, when it leaves the hammer, should not exceed one-fifth, and no part of the forging should be more than two-thirds the area of the original ingot. Forgings are to be properly annealed in an annealing furnace, and must be free from defect. The tensile strength of the forgings is not to exceed 78,400 lbs. per square inch, without special sanction; the elongations are to vary from 30 per cent., at 60,000 lbs. to 22 per cent. with 78,400 lbs. tensile strength, measured on test specimens of which the gauge length is not less than 3½ times their diameter; specimens 1″ by ¾″, with edges rounded to 1/16″ radius, must stand being bent cold to 180 degrees without fracture over a radius of ¼″ for material under 72,000 lbs. tensile strength, and ⅜″ between 72,000 and 78,400 lbs. tensile strength. The test specimens are to be cut lengthwise from a part of the forging which is not of less sectional area than the body of the forging, and they are not to be detached until they have been stamped by the Surveyors, and until the forging has been annealed. One tension and one bend test are to be taken from each forging, except in the case of forgings over 7,000 lbs. weight and of all propeller shafts, where tests will be required from each end of the forging. Where a number of small forgings are made from one ingot, tests representing each end of the ingot will be sufficient. All ingot steel forgings are to be legibly marked in such a way that they can be traced to the heat from which the material has been made, and those which have satisfactorily passed the requirements are to be clearly stamped A. B. and with the identification marks furnished by the Surveyor.

All important forgings are to be subjected to examination during the process of manufacture, when machined or in the case of shafts when rough turned, and when finished.

Iron Forgings.—The test specimens are to be taken from the body of the forging; the material is to be in tensile strength between the limits of 44,000 and 54,000 lbs. per square inch, and to show an elongation of 20 per cent. and a gauge length corresponding to 3½ diameters of the test specimen. Specimens, 1 inch square, are to stand being bent cold to 90 degrees over a radius of 1½″ without fracture. All important forgings are to be subjected to examination during the process of manufacture, when machined or in the case of shafts when rough turned, and when finished.

Shafting.—The least diameters of shafts for reciprocating engines may be found from the following formula, except where the distance between main bearings is unusual, when they will receive special consideration:

$$D = \sqrt[3]{\frac{P.L.^2S.}{B}} \times C$$

Where D=Diameter of shaft, in inches.
P=Absolute pressure, *i. e.*, boiler pressure + 15 lbs.
S=Stroke of engine, in inches.
L=Diameter of low pressure cylinder, in inches.
B=Values as given in Table B.
C=1.0 for crank and thrust shafts.
C=.95 for intermediate shafts.
C=Values given in Table C for propeller shafts.

(3) The least diameter of shafts for direct coupled and geared turbine engines may be obtained from the following formula:

$$D = \sqrt[3]{\frac{PX65}{R}} XC$$

Where D=Diameter of intermediate shafts, in inches.
P=Shaft Horse Power.
R=Revolutions per minute.
C=1 for intermediate shafts.
C=1.05 D for thrust shafts between collars.
C=1.1 D for propeller shafts.

With geared turbines where the revolutions per minute of the propeller are comparatively low, the value of C for the propeller shaft is not to be less than 1.1 nor than the values of C given in Table C, substituting diameter of intermediate shafting for diameter of crank shaft in obtaining the ratio of propeller to shaft.

Thrust and propeller shafts may be gradually tapered off to the diameter of the intermediate shafting.

Hollow shafting may have the central hole equal in diameter to one-third of the diameter required by the formulæ for intermediate shafts, without any increase in external diameter over that required for solid shafts.

The webs of built crank shafts are to be keyed as well as shrunk on to the shaft, and the diameter of the shaft is to be increased in way of the web to make up the loss of sectional area at the key way; efficient dowel pins should be fitted in the crank pin.

It is recommended that liners on propeller shafts be fitted in one length, that the inboard ends of the liners be tapered, and that the space between the after end and the propeller boss be made watertight.

Shafts and other important forgings are to be subjected to examination during the progress of manufacture, when rough turned and when finished.

General Construction.—When the engine bed plate or thrust block is fastened direct to the tank, the top plating in way of same is not to be less than .75″ thick and is to be increased according to the size and power of the engines; the double bottom is to be

TABLE B

$\frac{L^2}{H^2}$	Compound and Quadruple Expansion, Two Cranks at 90°	Triple Expansion, Three Cranks at 120°	$\frac{L^2}{H^2}$	Compound and Quadruple Expansion, Two Cranks at 90°	Triple Expansion, Three Cranks at 120°	Quadruple Expansion, Four Cranks at 90°
Ratio 3	9910		Ratio 5¼	14305	15180	
" 3⅛	10160		" 5½	14770	15690	
" 3¼	10410		" 5¾	15235	16200	
" 3⅜	10660		" 6	15700	16710	
" 3½	10910		" 6½	16630	17730	
" 3⅝	11160		" 7	17560	18630	
" 3¾	11410		" 7½	18410	19530	
" 3⅞	11660		" 8	19260	20430	22660
" 4	11910		" 8½	20110	21330	23660
" 4⅛	12160		" 9	20960	22200	24660
" 4¼	12410		" 9½	21750	23070	25660
" 4⅜	12660		" 10	22540	23940	26580
" 4½	12910	13650	" 10½	23330	24810	27500
" 4¾	13375	14160	" 11	24120	25660	28420
" 5	13840	14670	" 11½	24900	26500	29340
			" 12	25680	27340	30260

Intermediate ratios are to have intermediate values of **B.**

TABLE C

Co-efft. of Displacement of Vessel at ⅔ Molded Depth	Ratio of Diameter of Propeller to Diameter of Crank Shaft.					
	13	14	15	16	17	18
·60	F00	1·01	1·02	1·03	1·04	1·05
·62	1·01	1·02	1·03	1·04	1·05	1·06
·64	1·02	1·03	1·04	1·05	1·06	1·07
·66	1·03	1·04	1·05	1·06	1·07	1·08
·68	1·04	1·05	1·06	1·07	1·08	1·09
·70	1·05	1·06	1·07	1·08	1·09	1·10
·72	1·06	1·07	1·08	1·09	1·10	1·11
·74	1·07	1·08	1·09	1·10	1·11	1·12
·76	1·08	1·09	1·10	1·11	1·12	1·13
·78	1·09	1·10	1·11	1·12	1·13	1·14
·80	1·10	1·11	1·12	1·13	1·14	1·15

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efficiently stiffened under the thrust block, to the approval of the Bureau's Committee. The holes for the holding down bolts are to be tapped through the plate and the bolts properly screwed in, and fitted with locks nuts underneath. The holding down bolts are to pass through the angle flanges or are to be kept as close to angle bars as possible; if they pass through bars, the flanges of the bars are to be of sufficient breadth to take the nuts.

Two bilge and two boiler feed pumps are to be fitted on the main engines in Vessels of 180 feet length and upwards, and are to be so arranged that one of either set may be examined while the other is at work, or equivalent independent pumping arrangements are to be provided; in Vessels of less than 180 feet length one bilge and one feed pump, or equivalent independent pumps, are to be provided each bilge pump must be adapted to draw from any compartment of the Vessel. All feed pumps worked by the main engines are to be fitted with spring-loaded relief valves.

The design and arrangement of pumps, valve chests, cocks, suction and delivery pipes, and sea connections are to be such as to prevent water being run into the Vessel accidentally. The bilge and ballast pipe lines must be entirely separate and valves so arranged that no pumps can be connected to both lines at the same time.

All sea connections, cocks and valves are to be placed, if practicable, above the level of the stokehold and engine room platforms, and so as to be easily worked from those platforms. Main and auxiliary inlet valve chests which would have long necks if fastened directly to the shell plating, should be at-

tached to wrought steel boxes built on to the shell plating so as to obviate the long neck. Sea cocks and valves which are fitted direct onto the hull plating are to be secured with tap bolts, or with bolts having countersink heads tapped through the plating and fitted with nuts inside.

It is recommended that discharge outlets be placed above the deep load line; the valves are to be fitted in an accessible position on the Vessel's side.

Boiler blow-off pipes are to have cocks or valves on the hull plating fitted with spigots extending through the plating, and plate flanges round same on the inside.

A general service pump, adapted to draw from the sea and hot well, to supply the boilers with water through separate auxiliary feed pipes and check valves, to deliver water on deck and to draw from each compartment, is to be fitted in all cases.

The ballast pump should have a branch discharge connected to the main injection pipe at or near the condenser, with a suitable valve. For circulating the water in the boilers, it is recommended that a connection be made to the auilxiary feed or donkey feed pump, each pump being fitted for boiler purposes only.

All pipes extended through bunkers, or other compartments beyond the machinery space, must be well protected with strong casings.

Testing.—Castings for high pressure cylinders of reciprocating engines are to be tested to 1.5W.

Castings for cylinders of Turbine Engines are to be tested under hydraulic pressure after having been rough bored to the following requirements:

H. P. cylinders, admission end, are to be tested to 1.33W.

H. P. cylinders, exhaust end, are to be tested to W.

I. P. cylinders are to be tested to 1.5V.

L. P. cylinders, admission end, are to be tested to 1.5V.

L. P. cylinders, exhaust end, are to be tested to 30 lbs. per square inch.

Where W = Working pressure of Bailers.

V = Pressure to which cylinder safety valves are to be adjusted.

Main and auxiliary steam stop valves are to be tested to twice the working pressure.

Evaporators and high pressure feed heaters are to be satisfactorily tested by hydraulic pressure before leaving the works of the manufacturer. Feed water filters between the pumps and the boilers are to be tested to 2.4 times the working pressure.

Spare Gear.—The following articles of spare gear are to be supplied to all Vessels built to the requirements of the American Bureau:

2 Connecting rod top-end bolts.

2 Connecting rod bottom-end bolts.

2 Main-bearing bolts.

1 Set of coupling bolts.

1 Set of feed, and bilge pump valves.

1 Set of piston springs, if common springs are used.

1 Safety valve spring of each size fitted, but not fewer than 1 spare spring for each 6 safety valves fitted.

¼ Set of fire bars for each boiler.

A number of bolts, nuts, and studs, of assorted sizes, including at least 6 cylinder cover bolts or studs, and 6 valve chest cover bolts or studs.

Bar and plate iron in various sizes.

Engine, Beam. A reciprocating engine in which one end of a heavy beam centrally pivoted is actuated by a link led from the cross head. The other end of the beam transmits motion to the crank shaft by means of a connecting rod.

This type of engine was at one time standard for lake and river side wheel steamers.

Engine Columns. The vertical or nearly vertical members designed to carry the weight of the cylinders and to support the guide bars or surfaces for the cross heads.

They may be of cast iron, cast steel or forged steel. Modern practice favors cast inverted Y columns at the back and cylindrical forged columns at the front of the engine.

Both cast and forged columns are made with flanges at upper and lower extremities for attachment to cylinders and bed plate respectively.

In order to resist transverse and longitudinal racking strains diagonal bracing rods are fitted.

Engine, Diesel. Diesel engines are internal combustion engines working on the Diesel principle, i. e., the fuel is injected by means of compressed air and is entered gradually into the cylinder and combusted during a part of the stroke without explosion, the ignition being obtained by the heat created by the high compression of the air in the cylinder.

The compression pressure runs between 400 and 600 pounds per square inch. In the injection nozzle the fuel is mixed with air, this air having a pressure as high as 650 to 850 pounds, which is necessary for introducing the fuel into the cylinder against the high compression pressure. The fuel is brought to the injection nozzle by means of a pump.

Compressed air is employed for starting, and no pre-heating of the engine is necessary.

The air for the fuel injection is obtained from a compressor driven by the engine, whereas the starting air is generally taken from an auxiliary air compressor.

Most Diesel engines are four cycle, but two-cycle engines have also been designed, these obtaining the scavenging air from a separate scavenging air compressor driven from the engine.

The gradual injection and burning of the fuel makes the combustion gases act with an even pressure during a comparatively long period of the stroke in the same way as the steam in an expansion steam engine.

The fuel consumption for the larger sizes is .40 to .42 pounds per B.H.P. an hour.

Pages 442, 443, 444, 889, 900, 901, 902, 903, 906, 907, 908, 909, 910, 911, 936.

The American Bureau of Shipping rules for the installation of Internal Combustion Engines are as follows: The engine room is to be thoroughly ventilated and so arranged as to prevent the accumulation of inflammable gases. Satisfactory provision is to be made for the interception of any overflow of fuel from the engines. The fuel tank for the daily supply is to be kept well away from the donkey boiler, the funnel, and the exhaust pipes. Where fuel of a lower flash point than 150 deg. Fahr. is used, donkey boilers must be placed in an efficiently ventilated compartment separate from the engine room and fuel tanks.

Propeller engines are to be fitted with a governor, or other satisfactory arrangement, to prevent racing

of the engines. Engines above 300 B. H. P. should be reversible.

Cylinders must be water-cooled and the water-jackets provided with test and drain cocks. An escape valve should be fitted on or near each cylinder head, in order to give warning should the pressure in the cylinder become excessive.

Main engine cylinder heads, cylinders not fitted with liners, and cylinders for air compressors for starting and fuel injection purposes, are to be tested by hydraulic pressure to twice their working pressure. Cylinder water jackets are to be tested to 50 lbs. per square inch.

The engine bedplate is to be well ribbed and strongly constructed, and the columns are to be carefully designed to withstand the tension stresses. When the engines are of the enclosed type, portable doors are to be fitted for the inspection of the cranks, bearings, etc., the crank cases to be provided with efficient means of ventilation. The engine room platforms are to be supported on metal framework, not on wood.

Compressed air reservoirs are to have sufficient capacity to ensure ample maneuvering power for the main engines. The material for cylindrical Air Holders constructed of riveted steel plates is to be of the quality and subject to the tests specified in Section 40 of the Rules for Boiler Shell Plates, American Bureau of Shipping. The thickness of the plates is to be governed by the formulæ for cylindrical boiler shells.

Plans showing details of riveting, etc., are to be submitted for approval.

Seamless and Welded Holders are to be made from steel of the best Mild Open Hearth Quality having a tensile strength of not less than 51,520 lbs. per square inch and showing an elongation of at least 25 per cent. on a gage length of 8 inches.

Air compressors should not draw air from the crank cases of the engines. The air is to be efficiently cooled after each compression stage and should have a final temperature not exceeding 20 degrees Fahrenheit above that of the cooling water before being allowed to enter the compressed air reservoirs. The compressors are to be fitted with safety valves, pressure gages, and satisfactory arrangements for preventing the entrance of dirt and the delivery of oily air. The cooler coils are to be readily accessible for cleaning and removal.

Auxiliary compressors are to be fitted for use when the main engines are being maneuvered, and when the air compressor on the main engines is not available; they should not be of less power than half that of the compressors for one set of main engines. Arrangements should be made to provide water circulation from an independent pump in the event of a breakdown in the circulating pump.

When Vessels are intended to navigate shallow waters, two inlet valves for water circulation should be fitted, one on the ship's bottom and the other above the turn of the bilge. There should be in all cases an efficient strainer between the inlet valves and the circulating pumps, so designed and arranged that it may be cleaned and overhauled while the engines are working. Where there is no sight discharge from the cylinder jackets, a test cock or other means must be provided to enable the Engineer to satisfy himself that there is a continuous flow of water through each jacket.

The fuel oil tanks are to be of sufficient strength to withstand the stresses due to the tanks being partly full when at sea; they are to be arranged so that leakage or drips will drain into wells having separate pumps; satisfactory ventilating arrangements are to be provided; and diaphragms of strong meshed wire gauze are to be fitted to all air pipes. The flash point of fuel oil carried in uninsulated tanks is not to be below 150 deg. Fahr., and such tanks are to be tested with a head of water at least 18 feet higher than that to which they are subject in practice. Where oil of a lower flash point is used, the tanks and connections are to be tested to at least 15 lbs. per square inch, and the tanks in sea-going Vessels are to be separated from the engine room and cargo spaces by coffer dams. Where the fuel oil is carried in the double bottom, an ample reserve is to be carried in a tank fitted separate from the double bottom, easily accessible for cleaning, etc., and fitted with internal coils for warming the oil when necessary. Fuel tanks which are worked under pressure are to be fitted with safety valves loaded to 5 per cent. above the working pressure, which discharge overboard or to the atmosphere above deck through wire gauze diaphragms.

Filters for the fuel oil are to have bolted covers. Escape valves are to discharge into pipes leading back to the tank or to the atmosphere above deck; in the latter case the upper ends of the pipes are to be turned down and fitted with wire gauze diaphragms.

All fuel and compressed air pipes are to be made of steel or annealed seamless copper; metal to metal joints are recommended where the pressure exceeds 400 lbs. per square inch. Exhaust pipes which pass through wood decks or close to combustible material must be effectively insulated. If the exhaust pipe is led overboard near the water line, it must be so arranged that water will not syphon back to the engine.

All silencers are to be constructed so that they can be readily opened up for cleaning and inspection.

Oil cooling tanks for forced lubrication are to be fitted with cooling coils connected to the water circulating system. The oil pumps are to be fitted with pressure gauges, and should be so designed that they cannot become air locked. The oil well is to be so arranged as to minimize the risk of drawing air when the vessel is in a sea way.

All electric ignition leads must be well insulated and protected from mechanical injury. The leads should be kept remote from petrol pipes, and should not be placed where they may come in contact with oil. Commutators must be enclosed, and sparking coils must not be placed where they are exposed to explosive vapors. Exposed spark gaps are not to be fitted. Where lamps are used for igniton or for vaporizing the fuel for paraffin and heavy oil engines, they should be fixed on a suitable bracket and the flame enclosed when in use.

Spare gear in accordance with the following list is to be supplied, and stowed where readily accessible:

2 Main bearing bolts and nuts.

2 Connecting rod bottom end bolts and nuts.

2 Connecting rod top end bolts and nuts.

1 Set bolts or studs for cylinder covers.

Packing rings for pistons and trunks of main engines and of each auxiliary internal combustion engine.

Piston rings for each stage of main and auxiliary air compressors, and for scavenging air pumps.

Fuel and air admission valves and exhaust valves,

with seats and springs, for main engines and for each auxiliary internal combustion engine.

Suction and delivery valves and seats for main and auxiliary air compressors, scavenging air pumps, oil fuel, water circulating, and lubricating oil pumps.

Springs of each size.

Assorted bolts, nuts, studs, bar and plate iron.

Engine Foundation. A term applied to the girders and brackets supporting an engine. They should be built rigid enough to assimilate the vibration of the engine and to efficiently distribute its weight to the structure of the ship. Practical points to be given consideration in designing an engine foundation are as follows:

(a) The height of the foundation should be such that efficient head room is available above the engine for removal of the cylinder covers.

(b) Particular care should be taken to keep the rivets in the top plates and flanges clear of the holding down bolts and also that sufficient space is allowed for installing these bolts when the bed plate is in place.

(c) Care should also be taken that sufficient access is provided for riveting all connections.

Where the engine sets directly on the tank top, the plating in the vicinity must be increased in thickness and heavier, and extra floors and longitudinals fitted in the double bottom.

Pages 534, 535.

The American Bureau of Shipping requires that in vessels with single bottoms the engines are to be seated directly upon thick plating laid upon deep floors, of ample strength for the size and power of the engines; intercostal plates of the full depth of the floors are to be fitted under the main lines of bolting, and efficient connections are to be made to the ordinary floors, keelsons, and sides of vessels. In vessels with double bottoms the engines should be bolted direct to the top of the double bottom structure and in accordance with the Bureau's requirements. The weight of engines and boilers is to be effectively distributed by means of longitudinal and transverse girders, which are to be shown on the plan of engine seating submitted for approval.

In twin screw steamers and others of high power it will be necessary to make additions to the strength of structure and rivet attachments which are proportional to the weight and power of the machinery.

Engine Hatch. See HATCH, ENGINE.

Engine, Hot Bulb. Hot bulb engines, or more correctly, surface ignition engines, are two-cycle internal combustion engines where the vaporizing of the fuel and the ignition of the charge is obtained by bringing the charge in contact with a hot surface.

The heat of this surface is maintained by the explosions. In some hot bulb engines the temperature of the hot surface is kept constant by the injection of fresh water and in others by injecting compressed air in the top of the cylinders, which prevents the surface from being overheated. The amount of water or air can be regulated in accordance with the load on the engine. Before the engine can be started the necessary heat for vaporizing and ignition is mostly obtained by means of a torch or other heating device, which is cut out when the engine has been started.

The compression is generally below 150 pounds, and the pressure from the explosions below 320 pounds per square inch. On account of the comparatively low compression and accordingly low temperature of the explosions, the cylinders, pistons and cylinder heads are not exposed to excessive strains, and consequently there is little risk that these parts will crack.

The fuel is injected into the combustion chamber by means of a pump through a nozzle, and when passing through the nozzle it is in some engines mixed with compressed air which breaks up the fuel and contributes to a complete combustion. The fuel consumption for the larger sizes is about .55 pounds per B.H.P. an hour, and low grades of fuel oil can be used.

The weight per B.H.P. varies considerably, but the average could be put at 160 pounds for the larger sizes.

Pages 904, 905, 906, 907, 908, 909, 910.

Engine, Inclined. A reciprocating engine in which the cylinders are located at an angle and below the crank shaft.

This type is successfully used on lake and river steamers.

Engine, Internal Combustion. See GAS ENGINE, ENGINE, DIESEL ENGINE, HOT BULB.

Engine Lathe. See LATHE, ENGINE.

Engine, Main. The engine or engines forming the propelling installation as distinguished from auxiliary engines.

Engine, Marine. An engine designed for the propulsion of ships.

The principal types of marine engine to-day are:

The steam turbine.

The steam reciprocating engine.

The electric motor.

The internal combustion engine.

Engine, Non-Condensing. An engine from the cylinder of which the exhaust steam passes directly into the atmosphere.

Engine, Oscillating. A reciprocating engine in which the cylinders are located directly below the crank shaft and are swung on trunnions.

In this type the piston rod is connected directly to the crank pin so that the connecting rod and cross head are eliminated.

This type is successfully used for side wheel paddle steamers.

Engine, Reciprocating. An engine designed to convert the pressure of live steam into work. This is accomplished by means of the backward and forward motion of a piston from end to end of a cylinder as the result of steam being alternately admitted to each end of the cylinder and the expanded steam exhausted from the other end. The straight line motion of the piston is communicated to the piston rod to which it is directly attached and is then transformed into rotary or circular motion by means of suitable mechanism.

Until recently this type of engine was in nearly universal use as the prime mover, driving either the screw propeller or paddle wheels, in all marine propelling installations.

At the present time it has one distinct advantage over its most important rival, the steam turbine, in that it may be operated through the greater part of its designed power range without a serious loss in economy.

The reciprocating engine is well adapted to low and moderate powers and speeds and to either small

or large variations in the power and speeds ordinarily used.

Although there have been in the past several variations, such as the inclined or diagonal, the general present day practice for the marine engines is "vertical inverted." This term is descriptive of the cylinder position and indicates the facts that the cylinders are placed with their axis in the vertical plane and at a height such that connecting rods, cranks, shafts, etc., are located below them.

When the connecting rod and crankshaft lie on the opposite side of the crosshead from the cylinder the engine is termed direct acting.

In modern practice the steam is passed through a succession of cylinders of increasing size. Such engines are termed multiple expansion engines.

From the standpoint of the expansion of steam, engines are termed, compound, triple, or quadruple expansion according as the expansion occurs successively in two cylinders or two steps, three cylinders or three steps, or four cylinders or four steps.

Engines are condensing or non-condensing depending on whether the steam from the cylinder is exhausted into a condenser or into the open air.

The variety of mechanical movements employed gives additional designations to reciprocating engines. It is not intended to deal with this feature here.

Pages 388, 393, 400, 401, 653, 655, 657, 883, 912, 913, 914, 915, 916, 917, 918, 919, 970, 1045.

Plate XII.

Engine Room Bulkhead. See BULKHEAD, ENGINE ROOM.

Engine Room Casing. See CASING, ENGINE ROOM.

Engine Room Control Valve. See VALVE, ENGINE-ROOM CONTROL.

Engine, Turning. A small steam engine or an electric motor arranged to turn the main engines over very slowly for purposes of repair, adjustment, etc.

Engineers, Designing. Those engineers, civil, mechanical or naval, who are responsible for the basic features of a design and the general methods by which its details are developed.

Page 1107.

Engineers, Operating. Engineers in charge of plant or machinery and responsible for its condition and operation.

Engraving Machine. A machine designed to cut or carve, in sunken patterns, the letters and figures on name plates, label plates, etc. The incision is often filled with black sealing wax to make the engraving clear and distinct.

Ensign. A flag indicative of a vessel's nationality. It is hoisted at the stern.

Page 1102.

Ensign Staff. A term applied to a flag pole erected at the stern of a vessel.

Entrance. The forward under water portion of a vessel at and near the bow.

Entrance, Angle of. The angle formed by the center line of a ship and the tangent to the designed waterline at the forward perpendicular.

Equilibrium, Neutral. The state of equilibrium in which a vessel inclined from its original position of rest by an external force tends to maintain the inclined position assumed after that force has ceased to act.

Equilibrium, Stable. The state of equilibrium in which a vessel inclined from its original position of rest by an external force tends to return to its original position after that force has ceased to act.

Equilibrium, Unstable. The state of equilibrium in which a vessel inclined from its original position of rest by an external force tends to depart farther from the inclined position assumed.

Equipment. The American Bureau of Shipping requires that all vessels shall have a complete equipment of anchors, chains and hawsers in accordance with the following tables:

The numbers, weights and sizes of the anchors, chains and hawsers are to be regulated by the tonnage for equipment, as obtained from the following formulæ:

$$\text{Tonnage under upper deck} = \frac{L \times B \times D \times C}{100}$$

Where L = Length of Vessel.
B = Breadth of Vessel.
D = Depth of Vessel.
C = Co-efficient of displacement taken at .8 of the molded depth, with .75 as a maximum.

For Vessels without sheer, the molded depth to be used for the under deck tonnage may be reduced by an amount corresponding to half the standard sheer, the latter being at the rate of 1 inch per 10 feet of the Vessel's length, plus 10 inches.

$$\text{Addition for superstructures} = \frac{l \times b \times d \times .75}{150}$$

Where l = length of superstructure.
b = breadth at upper deck amidships.
d = mean height of 'tween decks, beam to beam.

For houses and superstructures on top of superstructures the divisor is to be 200 instead of 150, and *b* is to equal the mean breadth of the house or superstructure.

Anchor stocks are to be in weight equal to one-fourth that of the anchor. Stockless anchors may be adopted, subject to the Committee's approval and the addition of one-fourth to the weights given in the Table 3; the weight of the head is not to be less than three-fifths of the total weight of the anchor.

In Vessels classed for Coastwise and West Indies, or other limited service subject to the Committee's approval, the spare bower anchor may be omitted.

Cables which are intended to form part of the equipment are not to be used as check chains when the Vessel is launched.

Equipment Number or Numeral. A key number used by the Classification Societies in their rules for determining the number and sizes of anchors, cables, hawsers, etc. These numbers, together with the corresponding equipment necessary are tabulated in the rules, and are really identification numbers, indicating the general size of the vessel as well as the proper equipment.

Equivalent Girder. A diagrammatic representation of the disposition of that material in a cross section which contributes to the longitudinal strength of a vessel. Such a diagram visualizes, at once, the manner in which the material is disposed relative to the neutral axis. When any of the members have not the same strength in tension and compression or when

TABLE 20
See Continuation

ANCHORS, CABLES AND HAWSERS FOR STEAM VESSELS

	EQUIPMENT / TONNAGE	Tons 90	Tons 130	Tons 170	Tons 210	Tons 260	Tons 320	Tons 380	Tons 450	Tons 520	Tons 600	Tons 690	Tons 800	Tons 920
ANCHORS	2 BOWERS Weight Exclusive of Stock	392	448	532	616	700	812	952	1092	1260	1428	1624	1820	2016
	Test in Lbs.	13300	14280	15960	17500	19040	21210	23800	26390	29400	32550	35980	39410	42560
	1 SPARE BOWER Weight Exclusive of Stock	. .	. .			.	.	784	924	1064	1204	1400	1540	1708
	Test in Lbs.	. . . .	. . . .	.	. . . .	. . .	. .	20720	23240	25900	28350	32060	34510	37450
	1 STREAM Weight Exclusive of Stock	112	140	196	252	308	364	420	476	560	644	728	784	868
	Test in Lbs.	7800	8190	9450	10640	11760	12810	13790	14840	16520	17990	19600	20720	22190
	1 KEDGE Weight Exclusive of Stock	56	56	84	112	140	168	196	224	252	280	308	336	364
	Test in Lbs.	6400	6400	7100	7800	8190	8820	9450	10080	10640	11200	11760	12320	12810
C	Numeral in Record Book as a Means of Equipment Identification.	11	12	13	14	15	16	17	18	19	20	21	22	23
CABLE	STUD CHAIN Length in Fathoms.	120	120	135	150	165	165	180	195	195	210	210	210	210
	Diameter	11/16″	12/16″	13/16″	14/16″	15/16″	1″	1 1/16″	1 2/16″	1 3/16″	1 4/16″	1 5/16″	1 6/16″	1 7/16″
	Proof Test	19040	22680	26600	30800	35392	40320	45472	50960	56840	63000	69440	76120	83160
	Break Test	28560	33880	39872	46200	53088	60480	68096	76440	85120	94360	104160	114240	124600
	Weight per 15 Fathoms	405	480	570	655	755	800	970	1085	1215	1345	1485	1625	1775
STREAM CHAIN (STUD CHAIN OR SHORT LINK CHAIN OR STEEL WIRE)	LENGTH IN FATHOMS	45	45	45	45	45	45	60	60	60	60	60	60	75
	STUD CHAIN Diameter	8/16″	9/16″	9/16″	10/16″	10/16″	11/16″	11/16″	12/16″	13/16″	13/16″	14/16″	14/16″	15/16″
	Proof Test	10080	12600	12600	15680	15680	19040	19040	22680	26600	26600	30800	30800	35392
	Break Test	15120	18816	18816	23560	23560	28560	28560	33880	39872	39872	46200	46200	53088
	Weight per 15 Fathoms	240	300	300	365	365	405	405	480	570	570	655	655	755
	SHORT LINK CHAIN Diameter	9/16″	10/16″	10/16″	11/16″	11/16″	12/16″	12/16″	13/16″	14/16″	14/16″	15/16″	15/16″	1″
	Proof Test	8400	10360	10360	12600	12600	15210	15210	17696	20440	20440	23520	23520	26880
	Break Test	16800	20720	20720	25200	25200	30240	30240	35392	40880	40880	47040	47040	53760
	Weight per 15 Fathoms	325	390	390	445	445	525	525	620	710	710	815	815	925
	STEEL WIRE Circumference	1 7/8″	2″	2″	2 1/4″	2 1/4″	2 1/2″	2 1/2″	2 3/4″	3″	3″	3 1/4″	3 1/4″	3 3/8″
TOWLINES (Hemp or Steel Wire)	LENGTH IN FATHOMS	60	60	60	60	75	75	75	75	75	75	90	90	90
	Hemp—Circumference	5 1/2	6	6 1/2	6 1/2	7	7 1/2	7 1/2	8	8	8 1/2	8 1/2	9	9
	Equivalent Steel Wire—Circumference	2	2 1/8	2 1/4	2 1/4	2 3/8	2 1/2	2 1/2	2 5/8	2 5/8	2 7/8	2 7/8	3	3
	Break Test	18800	21200	24000	24000	26700	29500	29500	32700	32700	39200	39200	42700	42700
Hawsers—90 Fathoms Each		1@3½	1@4	1@4	1@4½	1@5	1@5½	1@5½	1@6	1@6½	1@6½	1@6½	1@6½	1@7
Warps—90 Fathoms Each		. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	1@4½	1@5	1@5	1@5½

Add 25% to Table weights for STOCKLESS ANCHORS.

TABLE 20
See Continuation

ANCHORS, CABLES AND HAWSERS FOR STEAM VESSELS

	EQUIPMENT / TONNAGE	Tons 1070	Tons 1210	Tons 1400	Tons 1640	Tons 1920	Tons 2220	Tons 2550	Tons 2920	Tons 3310	Tons 3740	Tons 4210
ANCHORS	2 BOWERS Weight Exclusive of Stock	2240	2520	2772	3052	3304	3556	3780	4088	4480	4872	5264
	Test in Lbs	46480	50960	54950	59500	63280	67060	70420	74900	80080	85680	90720
	1 SPARE BOWER Weight Exclusive of Stock	1904	2156	2352	2604	2800	3024	3220	3472	3808	4144	4480
	Test in Lbs.	40880	45010	48440	52220	55440	59080	62020	65800	70840	75600	80080
	1 STREAM Weight Exclusive of Stock	980	1064	1148	1260	1344	1428	1484	1568	1680	1792	1932
	Test in Lbs.	24360	25900	27370	29400	31080	32550	33530	35000	36960	38920	41300
	1 KEDGE Weight Exclusive of Stock	392	448	476	504	532	560	588	616	672	728	784
	Test in Lbs.	13300	14280	14840	15400	15960	16520	17010	17500	18480	19600	20720
C	Numeral in Record Book as a Means of Equipment Identification.	24	25	26	27	28	29	30	31	32	33	34
CABLE	STUD CHAIN Length in Fathoms.	210	240	240	240	240	240	240	270	270	270	270
	Diameter	1 8/16″	1 9/16″	1 10/16″	1 11/16″	1 12/16″	1 13/16″	1 14/16″	1 15/16″	2″	2 1/16″	2 2/16″
	Proof Test	90720	98336	106400	114800	123480	132440	141680	151200	161280	171360	182000
	Break Test	131488	137536	148960	160720	172760	185360	198240	211680	225792	239904	254800
	Weight per 15 Fathoms	1935	2090	2235	2410	2590	2785	2975	3175	3355	3570	3785
STREAM CHAIN (STUD CHAIN OR SHORT LINK CHAIN OR STEEL WIRE)	LENGTH IN FATHOMS	75	75	75	75	75	75	75	90	90	90	90
	STUD CHAIN Diameter	1 5/16″	1 5/16″	1″	1″	1 1/16″	1 1/16″	1 2/16″	1 2/16″	1 3/16″	1 3/16″	1 3/16″
	Proof Test	35392	35392	40320	40320	45472	45472	50960	50960	56840	56840	56840
	Break Test	53088	53088	60480	60480	68096	68096	76440	76440	85120	85120	85120
	Weight per 15 Fathoms	755	755	800	800	970	970	1085	1085	1215	1215	1215
	SHORT LINK CHAIN Diameter	1″	1″	1 1/16″	1 1/16″	1 2/16″	1 2/16″	1 3/16″	1 3/16″	1 4/16″	1 4/16″	1 4/16″
	Proof Test	26880	26880	30240	30240	33880	33880	37856	37856	42000	42000	42000
	Break Test	53760	53760	60480	60480	67760	67760	75712	75712	84000	84000	84000
	Weight per 15 Fathoms	925	925	1035	1035	1165	1165	1300	1300	1435	1435	1435
	STEEL WIRE Circumference	3 3/8″	3 3/8″	3 1/2″	3 1/2″	3 3/4″	3 3/4″	4″	4″	4 1/4″	4 1/4″	4 1/4″
TOWLINES (Hemp or Steel Wire)	LENGTH IN FATHOMS	90	90	105	105	105	105	105	120	120	120	120
	Hemp—Circumference	10	10	10 1/2	10 1/2	11	11	12	12	13	13	13 1/2
	Equivalent Steel Wire—Circumference	3 1/4	3 1/4	3 1/2	3 1/2	3 3/4	3 3/4	4	4	4 1/2	4 1/2	4 1/2
	Break Test	50100	50100	58200	58200	66700	66700	76100	76100	96100	96100	96100
Hawsers—90 Fathoms Each		1@7½	2@6½	2@6½	2@6½	2@6½	2@6½	2@7	2@7	2@7	2@7	2@7½
Warps—90 Fathoms Each		1@6	2@5	2@5	2@5	2@5½	2@5½	2@6	2@6	2@6	2@6	2@6½

Add 25% to Table weights for STOCKLESS ANCHORS

TABLE 20

See Continuation

ANCHORS, CABLES AND HAWSERS FOR STEAM VESSELS

	EQUIPMENT / TONNAGE	Tons 4720	Tons 5260	Tons 5850	Tons 6480	Tons 7140	Tons 7850	Tons 8600	Tons 9440	Tons 10300	Tons 11200	Tons 12100
ANCHORS	2 BOWERS Weight Exclusive of Stock	5656	6132	6580	7084	7532	8036	8512	9072	9604	10192	10696
	Test in Lbs.	95620	101290	106680	112280	117040	122360	127120	132160	137480	142520	146860
	1 SPARE BOWER Weight Exclusive of Stock	4816	5208	5600	6020	6384	6832	7224	7728	8176	8652	9072
	Test in Lbs.	84840	90020	94920	99960	104440	109480	113680	119280	123760	128450	132160
	1 STREAM Weight Exclusive of Stock	2072	2212	2380	2548	2716	2884	3080	3248	3444	3640	3836
	Test in Lbs.	43540	45990	48860	51380	53970	56910	59920	62440	65380	68320	71260
	1 KEDGE Weight Exclusive of Stock	840	924	980	1064	1148	1232	1288	1372	1456	1540	1624
	Test in Lbs.	21700	23240	24360	25900	27370	28840	29960	31570	33040	34510	35980
C	Numeral in Record Book as a Means of Equipment Identification.	35	36	37	38	39	40	41	42	43	44	45
CABLE	STUD CHAIN Length in Fathoms	270	270	270	300	300	300	300	300	300	300	330
	Diameter	2 3/16"	2 4/16"	2 5/16"	2 6/16"	2 7/16"	2 8/16"	2 9/16"	2 10/16"	2 11/16"	2 12/16"	2 13/16"
	Proof Test	192920	204120	215600	227360	239456	252000	261408	270816	280224	289632	298816
	Break Test	269920	285600	301840	318304	335160	352800	365960	379120	392280	405440	418320
	Weight per 15 Fathoms	4015	4245	4485	4725	4760	5265	5535	5815	6105	6405	6705
STREAM CHAIN STUD CHAIN OR SHORT LINK CHAIN OR STEEL WIRE	LENGTH IN FATHOMS	90	90	90	90	90	105	105	105	105	105	105
	STUD CHAIN Diameter	1 4/16"	1 4/16"	1 5/16"	1 5/16"	1 6/16"	1 6/16"	1 7/16"	1 7/16"	1 8/16"	1 8/16"	1 9/16"
	Proof Test	63000	63000	69440	69440	76120	76120	83160	83160	90720	90720	98336
	Break Test	94360	94360	104160	104160	114240	114240	124600	124600	131488	131488	137536
	Weight per 15 Fathoms	1345	1345	1485	1485	1625	1625	1775	1775	1935	1935	2090
	SHORT LINK CHAIN Diameter	1 5/16"	1 5/16"	1 6/16"	1 6/16"	1 7/16"	1 7/16"	1 8/16"	1 8/16"	.....	.....	.....
	Proof Test	46200	46200	50680	50680	55440	55440	60480	60480	.....	.....	.....
	Break Test	92400	92400	101360	101360	110880	110880	120960	120960	.....	.....	.....
	Weight per 15 Fathoms	1585	1585	1735	1735	1895	1895	2050	2050	.....	.....	.....
	STEEL WIRE Circumference	4 1/2"	4 1/2"	4 3/4"	4 3/4"	5"	5"	5 1/4"	5 1/4"	5 1/2"	5 1/2"	5 1/2"
TOWLINES Hemp or Steel Wire	LENGTH IN FATHOMS	120	120	130	130	130	130	130	130	140	140	140
	Hemp—Circumference	13 1/2	14	14	15	15	16	16	17	17	.....	.....
	Equivalent Steel Wire—Circumference	4 3/4	5	5 1/4	5 1/2	5 3/4	6	6	6 1/4	6 1/2	6 1/2	6 3/4
	Break Test	107000	118720	131000	143600	157000	170900	170900	185500	200700	200700	216400
Hawsers—90 Fathoms Each		2@7 1/2	2@8	2@8	2@8 1/2	2@8 1/2	2@8 1/2	2@8 1/2	2@8 1/2	2@9	2@9 1/2	3@8 1/2
Warps—90 Fathoms Each		2@6 1/2	2@7	2@7	2@7 1/2	2@7 1/2	2@7 1/2	2@7 1/2	2@7 1/2	2@8	2@8 1/2	3@7 1/2

Add 25% to Table weights for STOCKLESS ANCHORS

TABLE 20

Concluded

ANCHORS, CABLES AND HAWSERS FOR STEAM VESSELS

	EQUIPMENT / TONNAGE	Tons 13100	Tons 14200	Tons 15300	Tons 16500	Tons 17700	Tons 19000	Tons 20400	Tons 21800	Tons 23300	Tons 24800	Tons 26500
ANCHORS	2 BOWERS Weight Exclusive of Stock	11284	11844	12460	13076	13720	14392	15120	15848	16548	17248	17976
	Test in Lbs.	151270	155470	160090	164710	169190	173390	177940	182490	186865	190960	194600
	1 SPARE BOWER Weight Exclusive of Stock	9604	10080	10584	11116	11676	12236	12852	13440	14084	14672	15288
	Test in Lbs.	137480	141680	146020	150010	154210	158410	163030	167440	171465	175140	178990
	1 STREAM Weight Exclusive of Stock	4032	4256	4480	4732	4956	5208	5460	5684	5964	6244	6496
	Test in Lbs.	74200	77280	80080	83580	86870	90020	93170	95970	99400	102690	105840
	1 KEDGE Weight Exclusive of Stock	1708	1792	1904	1988	2072	2184	2296	2380	2492	2604	2716
	Test in Lbs.	37450	38920	40880	42240	43540	45500	47460	48860	50540	52220	53970
C	Numeral in Record Book as a Means of Equipment Identification.	46	47	48	49	50	51	52	53	54	55	56
CABLE	STUD CHAIN Length in Fathoms	330	330	330	330	330	330	330	330	330	330	330
	Diameter	2 1/16"	2 5/16"	3"	3 1/16"	3 2/16"	3 3/16"	3 4/16"	3 5/16"	3 6/16"	3 7/16"	3 8/16"
	Proof Test	308224	317408	326592	335552	344400	353248	361984	370496	378840	386960	395136
	Break Test	431480	444360	457184	469728	482160	494480	506688	518560	530320	541632	553056
	Weight per 15 Fathoms	7015	7330	7650	7980	8320	8660	9010	9360	9725	10095	10475
STREAM CHAIN STUD CHAIN OR SHORT LINK CHAIN OR STEEL WIRE	LENGTH IN FATHOMS	105	120	120	120	120	120	120	120	120	120	120
	STUD CHAIN Diameter	1 9/16"	1 10/16"	1 10/16"	1 11/16"	1 11/16"	1 12/16"	1 12/16"	1 13/16"	1 13/16"	1 14/16"	1 14/16"
	Proof Test	98336	106400	106400	114800	114800	123480	123480	132440	132440	141680	141680
	Break Test	137536	148960	148960	160720	160720	172760	172760	185360	185360	198240	198240
	Weight per 15 Fathoms	2090	2235	2235	2410	2410	2590	2590	2785	2785	2975	2975
	SHORT LINK CHAIN Diameter	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	Proof Test	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	Break Test	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	Weight per 15 Fathoms	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	STEEL WIRE Circumference	5 1/2"	5 3/4"	5 3/4"	6"	6"	6 1/4"	6 1/4"	6 1/2"	6 1/2"	6 3/4"	6 3/4"
TOWLINES Hemp or Steel Wire	LENGTH IN FATHOMS	140	140	140	140	150	150	150	150	150	150	150
	Hemp—Circumference	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	Equivalent Steel Wire—Circumference	7	7 1/4	7 1/4	7 1/2	7 1/2	7 3/4	8	8 1/4	8 1/2	8 1/2	8 3/4
	Break Test	232700	249800	249800	267200	267200	285300	303900	327000	347200	347200	367300
Hawsers—90 Fathoms Each		3@8 1/2	3@8 1/2	3@8 1/2	3@9	3@9	3@9 1/2	3@9 1/2	3@9 1/2	3@10	3@10	3@10
Warps—90 Fathoms Each		3@7 1/2	3@7 1/2	3@7 1/2	3@8	3@8	3@8 1/2	3@8 1/2	3@8 1/2	3@9	3@9	3@9

Add 25% to Table weights for STOCKLESS ANCHORS

TABLE 21
See Continuation

ANCHORS, CABLES AND HAWSERS FOR SAILING VESSELS

	EQUIPMENT / TONNAGE	Tons 60	Tons 80	Tons 110	Tons 140	Tons 170	Tons 200	Tons 240	Tons 280	Tons 330	Tons 380	Tons 430	Tons 500	Tons 580	Tons 670	Tons 760	Tons 830
ANCHORS	2 BOWERS Weight Exclusive of Stock	392	448	532	616	700	812	952	1092	1260	1428	1624	1820	2016	2240	2520	2772
	Test in Lbs.	13300	14280	15960	17500	19040	21210	23800	26390	29400	32550	35980	39410	42560	46480	50960	54950
	1 SPARE BOWER Weight Exclusive of Stock							784	924	1064	1204	1400	1540	1708	1904	2156	2352
	Test in Lbs.							20720	23240	25900	28350	32060	34510	37450	40880	45010	48440
	1 STREAM Weight Exclusive of Stock	112	139	196	252	308	364	420	466	560	644	728	784	868	980	1064	1148
	Test in Lbs.	7800	8100	9450	10640	11760	12810	13790	14840	16520	17990	19600	20720	22190	24360	25900	27370
	1 KEDGE Weight Exclusive of Stock	56	56	84	112	140	168	196	224	252	280	308	336	364	392	448	476
	Test in Lbs.	6400	6400	7100	7800	8190	8820	9450	10080	10640	11200	11760	12320	12810	13300	14280	14840
C	Numeral in Record Book as a Means of Equipment Identification.	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
CABLE	STUD CHAIN Length in Fathoms	120	120	120	120	135	135	150	165	165	180	180	195	195	210	210	210
	Diameter	11/16"	12/16"	13/16"	14/16"	15/16"	1"	11/16"	12/16"	13/16"	14/16"	15/16"	16/16"	17/16"	18/16"	19/16"	110/16"
	Proof Test	19040	22680	26600	30800	35392	40320	45472	50960	56840	63000	69440	76120	83160	97020	98336	106400
	Break Test	28560	33880	39872	46200	53088	64080	68096	76440	85120	94360	104160	114240	124600	131488	137536	148960
	Weight per 15 Fathoms	405	480	570	655	755	800	970	1085	1215	1345	1485	1625	1775	1935	2090	2235
STREAM CHAIN STUD CHAIN OR SHORT LINK CHAIN OR STEEL WIRE	LENGTH IN FATHOMS	45	45	45	45	45	45	45	45	45	60	60	60	60	60	60	60
	STUD CHAIN Diameter	8/16"	9/16"	9/16"	10/16"	10/16"	11/16"	11/16"	12/16"	12/16"	13/16"	14/16"	14/16"	15/16"	15/16"	15/16"	1"
	Proof Test	10080	12600	12600	15680	15680	19040	19040	22680	26600	26600	30800	30800	35392	35392	35392	40320
	Break Test	15120	18816	18816	23560	23560	28560	28560	33880	39872	39872	46200	46200	53088	53088	53088	60480
	Weight per 15 Fathoms	240	300	300	365	365	405	405	480	570	570	655	655	755	755	755	800
	SHORT LINK CHAIN Diameter	9/16"	10/16"	10/16"	11/16"	11/16"	12/16"	12/16"	13/16"	14/16"	14/16"	15/16"	15/16"	1"	1"	1"	11/16"
	Proof Test	8400	10360	10360	12600	12600	15120	15120	17696	20440	20440	23520	23520	26880	26880	26880	30240
	Break Test	16800	20720	20720	25200	25200	30240	30240	35392	40880	40880	47040	47040	53760	53760	53760	60480
	Weight per 15 Fathoms	325	390	390	445	445	525	525	620	710	710	815	815	925	925	925	1035
	STEEL WIRE Circumference	1⅞"	2"	2"	2¼"	2¼"	2½"	2½"	2¾"	3"	3"	3¼"	3¼"	3⅜"	3⅜"	3⅜"	3½"
TOWLINES Hemp or Steel Wire	LENGTH IN FATHOMS	60	60	60	60	60	60	60	75	75	75	75	75	75	75	90	90
	Hemp—Circumference	5½	5½	5½	6	6½	6½	6½	7	7½	7½	7½	8	8	8½	8½	9
	Equivalent Steel Wire—Circumference	2	2	2	2⅛	2¼	2¼	2¼	2⅜	2½	2½	2½	2⅝	2⅝	2⅞	2⅞	3
	Break Test	18800	18800	18800	21200	24000	24000	24000	26700	29500	29500	29500	32700	32700	39200	39200	42700
Hawsers—90 Fathoms Each		1@3½	1@3½	1@3½	1@4	1@4	1@4	1@4½	1@5	1@5½	1@5½	1@5½	1@6	1@6½	1@6½	1@6½	1@6½
Warps—90 Fathoms Each															1@4½	1@5	1@5

Add 25% to Table weights for STOCKLESS ANCHORS

TABLE 21
Concluded

ANCHORS, CABLES AND HAWSERS FOR SAILING VESSELS

	EQUIPMENT / TONNAGE	Tons 1020	Tons 1190	Tons 1360	Tons 1560	Tons 1780	Tons 2020	Tons 2280	Tons 2600	Tons 2940	Tons 3300	Tons 3700	Tons 4100	Tons 4500	Tons 4900
ANCHORS	2 BOWERS Weight Exclusive of Stock	3052	3304	3556	3780	4088	4480	4872	5284	5656	6132	6580	7084	7532	8036
	Test in Lbs.	59500	63280	67060	70420	74900	80080	85680	90720	95620	101290	106680	112280	117040	122360
	1 SPARE BOWER Weight Exclusive of Stock	2604	2800	3024	3220	3472	3808	4144	4480	4816	5208	5600	6020	6384	6832
	Test in Lbs.	52220	55440	59080	62020	65800	70840	75600	80080	84840	90020	94920	99960	104440	109480
	1 STREAM Weight Exclusive of Stock	1260	1344	1428	1484	1568	1680	1792	1932	2072	2212	2380	2548	2716	2884
	Test in Lbs.	29400	31080	32550	33530	35000	36900	38920	41300	43540	45990	48860	51380	53970	56910
	1 KEDGE Weight Exclusive of Stock	504	532	560	588	616	672	728	784	840	924	980	1064	1148	1232
	Test in Lbs.	15400	15960	16520	17010	17500	18480	19600	20720	21700	23240	24360	25900	27370	28840
C	Numeral in Record Book as a Means of Equipment Identification.	27	28	29	30	31	32	33	34	35	36	37	38	39	40
CABLE	STUD CHAIN Length in Fathoms	210	210	240	240	240	240	240	240	270	270	270	270	270	270
	Diameter	111/16"	112/16"	113/16"	114/16"	115/16"	2"	21/16"	22/16"	23/16"	24/16"	25/16"	26/16"	27/16"	28/16"
	Proof Test	114800	123480	132440	141680	151200	161280	171360	182000	192920	204120	215600	227360	239456	252000
	Break Test	167020	172760	185360	198240	211680	225792	239904	254800	269920	285600	301840	318304	335160	352800
	Weight per 15 Fathoms	2410	2590	2785	2975	3175	3355	3570	3785	4015	4245	4485	4725	4760	5265
STREAM CHAIN STUD CHAIN OR SHORT LINK CHAIN OR STEEL WIRE	LENGTH IN FATHOMS	75	75	75	75	75	75	75	75	90	90	90	90	90	90
	STUD CHAIN Diameter	1"	11/16"	11/16"	12/16"	12/16"	13/16"	13/16"	13/16"	14/16"	14/16	15/16"	15/16"	15/16"	16/16"
	Proof Test	40320	45472	45472	50960	50960	56840	56840	56840	66000	63000	69440	69440	76120	76120
	Break Test	60480	68096	68096	76440	76440	85120	85120	85120	94360	94360	104160	104160	114240	114240
	Weight per 15 Fathoms	800	970	970	1085	1085	1215	1215	1215	1345	1345	1485	1485	1625	1625
	SHORT LINK CHAIN Diameter	11/16"	12/16"	12/16"	13/16"	13/16"	14/16"	14/16"	14/16"	15/16"	15/16"	15/16"	16/16"	17/16"	17/16"
	Proof Test	30240	33880	33880	37856	37856	42000	42000	42000	46200	46200	50680	50680	55440	55440
	Break Test	60480	67760	67760	75712	75712	84000	84000	84000	92400	92400	101360	101360	110880	110880
	Weight per 15 Fathoms	1035	1165	1165	1300	1300	1435	1435	1435	1585	1585	1735	1735	1895	1895
	STEEL WIRE Circumference	3½"	3¾"	3¾"	4"	4"	4¼"	4¼"	4¼"	4½"	4½"	4¾"	4¾"	5"	5"
TOWLINES Hemp or Steel Wire	LENGTH IN FATHOMS	90	90	90	105	105	105	105	105	120	120	120	120	120	120
	Hemp—Circumference	9	10	10	10½	10½	11	11	12	12	12	13	13	13½	13½
	Equivalent Steel Wire—Circumference	3	3¼	3¼	3½	3½	3¾	3¾	4	4	4	4¼	4½	4½	4¾
	Break Test	42700	50100	50100	58200	58200	66700	66700	76100	76100	76100	85700	96100	96100	107000
Hawsers—90 Fathoms Each		1@7	1@7½	2@6½	2@6½	2@6½	2@6½	2@6½	2@7	2@7	2@7	2@7	2@7	2@7½	2@7½
Warps—90 Fathoms Each		1@5½	1@6	2@5	2@5	2@5	2@5½	2@5½	2@6	2@6	2@6	2@6	2@6	2@6½	2@6½

Add 25% to Table weights for STOCKLESS ANCHORS

TABLE 22

See Continuation

ANCHORS, CABLES AND HAWSERS FOR STEAM TRAWLERS AND COASTERS

	EQUIPMENT TONNAGE	Tons 70	Tons 90	Tons 110	Tons 130	Tons 150	Tons 170	Tons 190	Tons 210	Tons 235	Tons 250	Tons 290	Tons 320	Tons 350	Tons 380	Tons 415
ANCHORS	2 BOWERS Weight Exclusive of Stock	364	392	420	448	476	504	532	560	588	616	644	672	700	728	756
	Test in Lbs.	12810	13300	13790	14280	14840	15400	15960	16520	17010	17500	17990	18480	19040	19600	20160
	1 STREAM Weight Exclusive of Stock	196	196	224	224	252	252	280	280	308	308	336	336	364	364	392
	Test in Lbs.	9450	9450	10080	10080	10640	10640	11200	11200	11760	11760	12320	12320	12810	12810	13300
CABLES STUD CHAIN OR SHORT LINK	STUD CHAIN CABLE Length in Fathoms	60	60	60	60	75	75	90	90	90	105	105	105	120	120	120
	Diameter	12/16″	13/16″	13/16″	14/16″	14/16″	15/16″	15/16″	1″	1″	1 1/16″	1 1/16″	1 2/16″	1 2/16″	1 3/16″	1 3/16″
	Proof Test	22680	26600	26600	30800	30800	35392	35392	40320	40320	45472	45472	50960	50960	56840	56840
	Break Test	33880	39872	39872	46200	46200	53088	53088	60480	60480	68096	68096	76440	76440	85120	85120
	Weight per 15 Fathoms	480	570	570	655	655	755	755	800	800	970	970	1085	1085	1215	1215
	SHORT LINK CHAIN Length in Fathoms	60	60	60	60	75	75	90	90	90	105	105	105	120	120	120
	Diameter	13/16″	14/16″	14/16″	15/16″	15/16″	1″	1″	1 1/16″	1 1/16″	1 2/16″	1 2/16″	1 3/16″	1 3/16″	1 4/16″	1 4/16″
	Proof Test	17696	20440	20440	23520	23520	26880	26880	30240	30240	33880	33880	37856	37856	42000	42000
	Break Test	35392	40880	40880	47040	47040	53760	53760	60480	60480	67760	67760	75712	75712	84000	84000
	Weight per 15 Fathoms	620	710	710	815	815	925	925	1035	1035	1165	1165	1300	1300	1435	1435
	HAWSERS AND WARPS Length of Each in Fathoms	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
	Hawser Circumference—Hemp	5	5	5	5	5½	5½	5½	5½	6	6	6	6	6½	6½	6½
	Steel	1¾	1¾	1¾	1¾	2	2	2	2	2⅛	2⅛	2⅛	2⅛	2¼	2¼	2¼
	Warp Circumference—Hemp	3	3	3	3	3	3	3½	3½	3½	4	4	4	4½	4½	4½
	Steel	1	1	1	1	1	1	1¼	1¼	1¼	1½	1½	1½	1⅝	1⅝	1⅝

Add 25% to Table weights for STOCKLESS ANCHORS

TABLE 22

Concluded

ANCHORS, CABLES AND HAWSERS FOR SAILING TRAWLERS AND COASTERS

	EQUIPMENT TONNAGE	Tons 50	Tons 60	Tons 70	Tons 80	Tons 95	Tons 110	Tons 125	Tons 140	Tons 155	Tons 170	Tons 185	Tons 200	Tons 220	Tons 240	Tons 260
ANCHORS	2 BOWERS Weight Exclusive of Stock	364	392	420	448	476	504	532	560	588	616	644	672	700	728	756
	Test in Lbs.	12810	13300	13790	14280	14840	15400	15960	16520	17010	17500	17990	18480	19040	19600	20160
	1 STREAM Weight Exclusive of Stock	196	196	224	224	252	252	280	280	308	308	336	336	364	364	392
	Test in Lbs.	9450	9450	10080	10080	10640	10640	11200	11200	11760	11760	12320	12320	12810	12810	13300
CABLES STUD CHAIN OR SHORT LINK	STUD CHAIN CABLE Length in Fathoms	60	60	60	60	60	60	60	60	75	75	75	90	90	90	105
	Diameter	12/16″	13/16″	13/16″	14/16″	14/16″	15/16″	15/16″	1″	1″	1 1/16″	1 1/16″	1 2/16″	1 2/16″	1 3/16″	1 3/16″
	Proof Test	22680	26600	26600	30800	30800	35392	35392	40320	40320	45472	45472	50960	50960	56840	56840
	Break Test	33880	39872	39872	46200	46200	53088	53088	60480	60480	68096	68096	76440	76440	85120	85120
	Weight per 15 Fathoms	480	570	570	655	655	755	755	800	800	970	970	1085	1085	1215	1215
	SHORT LINK CHAIN Length in Fathoms	60	60	60	60	60	60	60	60	75	75	75	90	90	90	105
	Diameter	13/16″	14/16″	14/16″	15/16″	15/16″	1″	1″	1 1/16″	1 1/16″	1 2/16″	1 2/16″	1 3/16″	1 3/16″	1 4/16″	1 4/16″
	Proof Test	17696	20440	20440	23520	23520	26880	26880	30240	30240	33880	33880	37856	37856	42000	42000
	Break Test	35392	40880	40880	47040	47040	53760	53760	60480	60480	67760	67760	75712	75712	84000	84000
	Weight per 15 Fathoms	620	710	710	815	815	925	925	1035	1035	1165	1165	1300	1300	1435	1435
	HAWSERS AND WARPS Length of Each in Fathoms	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
	Hawser Circumference—Hemp	5	5	5	5	5	5	5	5	5½	5½	5½	5½	6	6	
	Steel	1¾	1¾	1¾	1⅞	1¾	1¾	1¾	1¾	2	2	2	2	2	2⅛	2⅛
	Warp Circumference—Hemp	3	3	3	3	3	3	3	3	3	3	3	3½	3½	3½	4
	Steel	1	1	1	1	1	1	1	1	1	1	1	1¼	1¼	1¼	1½

Add 25% to Table weights for STOCKLESS ANCHORS

regarded as contributing to one and not the other, or when allowance is made for rivet holes in tension but not in compression; then two separate girders must be considered, one for hogging and one for sagging.

Erectors. Workmen who put together and secure fabricated parts to form the structure or machine.

Escape Valve. See VALVE, ESCAPE.

Euphroe. A wood block or slat or metal fitting perforated to allow the awning crowfoot halyards to pass.

Evaporator. An auxiliary for supplying fresh water to make up the loss in boiler feed water. Steam leaks in pipe joints and stuffing boxes may occur. The whistle may be used or the exhaust opened or in some other manner losses of boiler feed water take place. These losses are appreciable and the evaporator must supply the "make up" feed in order to avoid the use of salt water.

A typical evaporator consists of a chamber into which boiler steam is passed in coils or nests of tubing. Salt water is admitted into the chamber and is converted into steam which passes over to the condenser or low pressure receiver. The water found in the coils by the loss of heat is returned to the feed.

Pages 425, 885, 970, 996, 1024.

Plates XIV, XLVII, XLVIII.

Evaporator Feed Pump. See PUMP, EVAPORATOR FEED.

Evaporator Foundation. A term applied to a foundation supporting an evaporator.

Page 538.

Even Keel. That condition in which a ship floats at her designed draft both forward and aft, or in which her keel line is parallel to its designed position.

Exhaust Fan. A type of fan outfit used to remove dust and smoke from shop buildings ashore. The usual method of construction for fans of this type consists of a metal ring with arms supporting an electric motor, the shaft of which is centered on the ring. The fan is mounted on the motor shaft and is made the full diameter of the ring less a small clearance at the tips of the blades.

Page 952.

Exhauster, Planing Mill. A system of piping leading from a chamber outside the building and terminating in funnels or hoppers directly over the knives of the machines in the mill. A suction is induced in the system by a large fan and by this means the shavings from work passing through the machines are drawn off and deposited in the collection chamber. The chamber usually has a trap at the bottom for emptying and is elevated sufficiently to allow a cart used for carrying the shavings away to pass beneath.

Expander, Boiler Tube. See BOILER TUBE EXPANDER.

Expander, Tube. See TUBE EXPANDER.

Expansion Hatch. See HATCH, EXPANSION.

Expansion Joint. A term applied to a joint which permits linear movement to take up the expansion and contraction due to changes in temperature.

Pages 623, 624, 625.

Plate XLVI.

Expansion Tanks. A term applied to the trunkways below the cargo hatches in an oil tanker that are provided for the purpose of allowing the cargo oil to expand.

Expansion Trunk. A trunk extending above a hold for the stowage of liquid cargo. The surface of the cargo liquid is kept well up in the trunk, thus allowing for expansion of the liquid without danger of excessive strain coming on the hull, and allowing for contraction without undue increase in free surface with its accompanying effect upon stability.

Extenders. See PAINT.

Extreme Breadth. See BREADTH (Extreme).

Eye. A hole through the head of a needle, pin, bolt, etc., or a loop forming a hole or opening through which something is intended to pass, such as a hook, pin, shaft or rope. Familiar examples are an eye at the end of a tie bar in a bridge truss, an eye at the end of a rope as the parts of shrouds and stays that pass over a masthead.

A "worked eye" is one having its edge rounded off like a ring, while a "shackle eye" is drilled straight through, permitting an inserted bolt or pin to bear along its entire length.

Eye Bolt. A bolt having either a head looped to form a worked eye or a solid head with a hole drilled through it forming a shackle eye. Its use is similar to that of a pad eye.

Eyes. The forward end of the space below the upper decks of a ship which lies next abaft the stem, where the sides approach very near to each other.

The hawse pipes are usually run down through the eyes of a ship.

F

Fabricate. To shape, assemble and secure in place the component parts in order to form a complete whole.

To manufacture.

Fabricated Ship. A ship that is constructed by assembling plates and shapes that have been laid out and formed, without the aid of templates taken from the work during the process of construction. One advantage of this method of construction is that the material may be laid out at the steel mills and shipped to the yards ready for erection.

In cargo vessels having a constant section or parallel middle body of considerable extent, a good practice is to fabricate the middle portion and then to build the bow and stern in the regular way. In vessels having a warped surface throughout, it would appear that a large number of vessels would have to be built to the same lines in order to gain any advantage.

A ship of simplified form, the body plan of which is made up of straight lines and arcs of circles, is the most favorable type for the fabricated system.

Face Mask. A mask worn by men in a foundry while pouring molten metal and by welders while making welds with acetylene gas or electric welding apparatus to protect their eyes from the glare and their faces from sparks or flying particles of molten metal.

Page 763.

Face Plate. A plate fitted perpendicular to the web and fastened to the flanges at one edge of a frame, stiffener or girder to compensate for the continuous plating attached to the flanges at the other edge.

Factor of Safety. A design factor such that where multiplied by the allowed working stress for a given material it will give a product equivalent to the ultimate strength of that material. The foregoing defines "factor of safety" as ordinarily used. Strictly speaking and especially for elastic materials this definition applies only to the "nominal factor of safety." The real factor of safety for design work involving elastic materials is that factor which if multiplied by the allowed working stress will be equal to the stress required to strain the material to its elastic limit.

If the nominal factor of safety is used in any case, the real factor of safety for the case in hand is

smaller in proportion as the elastic limit of the material is lower than the ultimate strength.

For design in such materials as wood, cast iron in compression, and the like, the distinction between nominal and real factor of safety is non-existent.

Faggoting. Described under STEEL AND IRON.

Fair Curves. Curves which do not in any portions of their entire lengths show changes of direction such as to mark those portions as out of harmony in any respect with the curves as a whole or with the other portions of the curves.

Fairleads. A term applied to fittings that are used to change or preserve the direction of a rope or chain so that it is delivered fairly to a sheave or drum.

Large fairleads in the shape of a drum on a vertical shaft are used to deliver a hawser coming through a chock or mooring pipe to a gypsy on a winch or windlass.

Fairleads are also used with the steering leads in which case they may be fittings with small sheaves or annular rings. With steering leads the fairleaders are generally more for preserving than changing the line of the ropes.

Fair Line. A term applied to a curved line when it is smooth and without bumps or abrupt breaks in direction. A sweet line.

Fair or Fair Up. To so draw the lines of a vessel that the defined surfaces will show no irregularities throughout their entire extent.

To line up the frames to their proper position.

Fair Ship. To keep the ship properly placed on the berth during the building period.

Fairwater. A term applied to plating fitted in the shape of a frustrum of a cone, around the ends of shaft tubes and struts to prevent an abrupt change in the stream lines.

Also applied to any casting or plating fitted to the hull for the purpose of preserving a smooth flow of water.

Fake. To lay a rope or chain down in long bights side by side or in coils in regular order so that it will run out clear or can be easily and rapidly paid out. Also one complete circle of a coil of rope.

Fall. By common usage the entire length of rope used in a tackle, though a strict adherence to the term would limit its application to the end to which the power is applied. The end secured to the block is called the standing part, the opposite end, the hauling part.

False Keel. See KEEL, FALSE.

False Sternpost. See STERNPOST, FALSE OR INNER.

Fan Electric. See ELECTRIC FAN.

Fan Exhaust. See EXHAUST FAN.

Fan, Induction. See BLOWER.

Fantail. The stern overhang in vessels which have round or elliptical after endings to uppermost decks and which extend well abaft the after perpendicular.

Pages 496, 497.

Farad. The unit of electrostatic capacity. It represents the capacity of a conductor that requires 1 coulomb of electricity to charge it to the potential of 1 volt.

Fascia. A strip of wood used in covering over openings in joiner work.

Fast. A rope or chain used to moor a boat to the wharf. It is designated in accordance with the end of the boat with which it is used as bow-fast or stern-fast.

Fasteners. Men who drive the iron bolts that fasten the parts of a wooden vessel together.

Fastenings. A term applied to bolts, nails, rivets, treenails, etc.

Fastenings, Through. A term applied to a fastening that is driven completely through the pieces to be connected.

Fathom. A unit of length used in measuring cordage, depths, etc. The length varies in different countries, being six feet in Great Britain and the United States. This is roughly obtained by extending both arms.

Faucet. A term applied to a valve or cock used to control the flow of a liquid.

Fay. To unite closely two planks or plates so as to bring the surfaces into intimate contact.

Feed Pipe, Boiler, Internal. See BOILER FEED PIPE, INTERNAL.

Feed Pump, Auxiliary. See PUMP, AUXILIARY FEED.

Feed Pump, Evaporator. See PUMP, EVAPORATOR FEED.

Feed Pump, Main. See PUMP, MAIN FEED.

Feed Water, Boiler. See BOILER FEED WATER.

Feed Water Heater, Boiler. See BOILER FEED WATER HEATER.

Feed Water Heater Foundation. A term applied to the seating supporting the feed water heater.

Page 537.

Felloes. The pieces of wood composing the rim of a steering wheel.

Fend Off. To prevent a ship or boat from coming violently in contact with a pier, another ship, or structure.

Fender. This term is applied to various devices fastened to or hung over the sides of a vessel for the purpose of preventing rubbing or chafing. A common type consists of a timber running fore and aft along the side of a vessel above the waterline. On the outer or wearing side of the timber a strip of iron bark or a piece of flat bar iron may be attached.

The fender may be held in position by angle bars attached to the outside plating or planking and having a space between them equal to the width of the fender. The fender itself may be bolted to the ship.

A wood spar, a bundle of rope, or cork form covered with a half-hitching of sennit used to fend a vessel off from a pier or to prevent damage by a too forcible contact when coming alongside another vessel.

Ferrule, Condenser Tube. See CONDENSER TUBE FERRULE.

Ferry. A craft used regularly for the transport of cargo or passengers back and forth across a narrow body of water or river.

Such a craft may vary in type from a small high speed yacht to a large, heavy scow used in the carriage of fully loaded freight cars.

Fid. A wood or metal bar used to support the weight of a topmast or top-gallant mast when in position, being passed through a hole or mortise at its heel and resting on the trestle trees or other support; a hardwood tapering pin or tool, used by riggers and sailmakers to open the strands of a rope, eye, grommet, etc. A "hand fid" is rounded at the ends. A "standing or cringle fid" is larger than a hand fid and has a flat base.

Page 345.

Fidded Topmast. See TOPMAST, FIDDED.

Fiddle Block. See BLOCK, FIDDLE.

Fidley. A term applied to the top of a boiler casing. Through it pass the smoke stack and boiler room ventilators. The top around the stack and cowls is fitted with gratings made of bar steel with metal covers that can be closed when the weather is very bad.

Fidley Gratings. A term applied to gratings made of bar steel and fitted over the top of the boiler hatch.

Page 574.

Fife Rail; Pin Rail. A term applied to a rail worked around a mast and fitted with holes for belaying pins for securing the running gear.

Figure Head. An ornament, usually the figure of a woman, placed on the foremost edge of the stem just below the bowsprit.

Filler Piece. See LINER.

Fillets. A term applied to the metal filling in the bosom or corners where abrupt changes in direction occur in the parts of a casting or forging.

Filling Transoms. See TRANSOMS, FILLING.

Filter, Feed Water. An apparatus designed for the removal of oil from boiler feed water.

It consists of a suitable connection and a container in which is placed the filtering material. This material may be gravel, sand, or broken stone, etc., or it may be cloth, sponge or similar material.

Water may be led through the apparatus by gravity or forced through under pressure. In the latter case provision must be made for relief from excessive pressure should a stoppage in the filter occur.

Pages 425, 664, 1007.

Plates XIV, XLVII, XLVIII.

Fire and Bilge Pump. See PUMP, FIRE AND BILGE.

Fire Boat. A vessel of about the type and size of a large tug, but fitted with all available fire fighting apparatus.

Firemen. Members of a ship's boiler room force who are responsible for the care of the fires under the boilers.

Fire Tube Boiler. See BOILER, FIRE TUBE.

Fireproof Bulkhead. See BULKHEAD, FIREPROOF.

Fireproof Flooring. See FLOORING, FIREPROOF, and also GRATINGS.

Fish Boom. See DAVIT, FISH.

Fish Hook. A large hook attached to a stout cable and used on some vessels to take the anchor on board.

Also applied to a hook attached to a line and used for the purpose of catching fish.

Fish Pendant. A stout piece of rope or cable having a thimble on one end and a fish hook on the other.

Fish Tackle. A tackle used in pulling an anchor on board from under the cat head.

Fish Tackle Pendant. A rope one end of which is attached to the foremast and the other end to the fish tackle.

Fittings, Pipe. A term applied to the connections and outlets, with the exception of valves and couplings, that are attached to pipes.

Fixed Light. A thick glass, usually circular in shape, fitted in a frame fixed in an opening in a ship's side, deck house or bulkhead. The fixed light is not provided with hinges and serves only to provide access for light.

Plate 576.

Fixtures, Watertight Electric Light. See ELECTRIC LIGHT FIXTURES, WATERTIGHT.

Flags. Emblems or symbols made of cloth, bunting or silk. They are used to denote the country or company to which a vessel belongs, and also for various signals.

Page 1103.

Flags, Signal. Flags used in signaling. These flags symbolize the letters of the alphabet according to code. It is thus possible for one vessel to communicate with another or with a shore station.

Page 1103.

Flam. A term often used to express the same meaning as flare, but more properly used to denote the maximum curl or roll given to the flare at the upper part, just below the weather deck.

Flange. The turned edge of shape or girder which acts to resist a bending movement. A casting or forging which may be attached to a pipe forming a flange or projecting rim suitable for bolting the pipe secure. Some pipe flanges are worked as an integral part of the pipe.

Flange, Blank. Applied to a flange fitting that is complete with the exception of the bolt holes. Also applied to a flat plate or flange that is used to close the end of a pipe.

Flanged Plate. See PLATE, FLANGED.

Flanging Machine. A machine designed for flanging plate work. See Rolls, Bending, and Flanging Machine, Hydraulic.

Flanging Machine, Hydraulic. A machine designed to bend or flange long or short plates.

It often consists of a heavy cast iron or steel beam actuated in a vertical direction by a number of hydraulic rams. The hydraulic cylinders are supported over the work table by four heavy columns which also serve as guides for the beam.

Flanging Press. See PRESS, FLANGING.

Flare. The spreading out from the central vertical plane of the forebody of a ship with increasing rapidity as the section rises from the waterline to the rail.

Flare-up Light. See LIGHT, FLARE-UP.

Flashlight Signal, Electric. The electric flashlight signal is used in conjunction with the electric whistle control. It consists of a cluster of electric lights made into any design and mounted on the masthead above the pilot house and electrically connected to the circuit that operates the whistle control. When the whistle switch is closed in the pilot house to blow the whistle, current is also supplied to the flashlight lamps on the masthead, lighting them in time with the signal given by the whistle. This gives to the eye the same signal that the whistle gives to the ear.

Often in heavy winds the whistle signal can not be heard but the escaping steam carries the message to the eye. The employment of the flashlight sends this same message at night when the steam can not be seen.

This combination has been approved as a safety device by the Supervising Inspectors at Washington.

Flat. A term applied to a partial deck built without any camber.

Page 494.

Flat of Bottom. That portion of a ship's bottom without rise or having a rise without curvature or nearly so.

Flat Plate Keel. See KEEL, FLAT PLATE.

Flat Rope. See ROPE, FLAT.

Flexible Joint. A pipe joint so constructed that the pipes it connects can turn or bend without leaking. They are usually constructed on the ball and socket principle.

Flexible joints in shafting are usually called universal joints. Page 1050.

Floating Dry Dock. See DRY DOCK, FLOATING.

Floating Power. The sum of the utilized buoyancy and the reserve buoyancy of a vessel. Utilized buoyancy is the buoyancy required to counteract the vessel's weight. It is exerted by that portion of the vessel's hull which is below her water-line.

Flood Light. This term is given to a light so arranged as to give a diffused light over a large area. It is directly opposite in purpose to the spot light which is designed to give an intense light over a small area. By an arrangement of reflectors a non-glare light has been perfected, making it possible to work facing the light without eye strain or confusion. For work on deck, in holds, and for loading and unloading this type of lamp has been found very useful.
Page 947.

Floodable Length. The length of vessel which may be flooded without sinking her below her safety or margin line. The value of the floodable length for a given vessel varies from point to point throughout her length due to change in form. Similarly at a given point it varies from time to time, depending upon the permeability of the cargo or condition of loading.

Floor. A plate placed vertically in the bottom of a ship usually on every frame and running athwartship from bilge to bilge. The inside flanges or webs of the frame bars are riveted to the lower edges of the floors and the reverse frames are riveted to the top. The floors are generally cut in the way of the vertical center keelson, to which they are attached by angle clips on each side. In the way of the longitudinals they are sometimes continuous and sometimes intercostal, but, in any event, the longitudinals and floors are securely clipped together, forming a strong, box girder-like structure. In wood ships, the lowest frame timber or the one crossing the keel is called the floor.
Pages 480 to 483.

Floor Clips. Angle clips used to connect the longitudinals and brackets to the floor.

Floor, Continuous. A floor extending in one length from bilge to bilge and also applied to those extending in one length from center line to bilge.

Floor, Deep. A term applied to any of the floors in the fore and after ends of vessels. Due to the converging sides of ships in the bow and stern, the floors become much deeper than in the main body.

Floor Head. A wooden ship term for the end of a floor timber.

Floor Head Chock. A piece shaped to form a scarph joint between the floor and futtock in a wooden ship.

Floor, Intercostal. A floor composed of a range of plates fitted between longitudinals and securely clipped to them.

Floor, Long and Short Arm. A wooden ship term applied where the floor arms are alternately long and short on both sides of the keel.

Floor, Main. The floor placed at the extreme beam.

Floor, Midship. The floor fitted at the midship section or at a point half-way between perpendiculars.

Floor Plates. See FLOORS. Also used to designate the plates used in the construction of floors.

Floor, Transom. The floor or vertical plate extending athwartship across the top of the stern post and attached thereto. On account of the overhanging nature of the stern this plate is made of extra thickness. Plates attached to the arch and propeller post of the stern frame are also called transoms.
Page 497.

Flooring, Fireproof. A flooring consisting of a fireproof compound laid on a deck. See also GRATINGS.

Flooring, Metallic. This type of flooring consists of light metal plates either smooth, checkered, or having a ridged upper surface. They are principally used for working floors in the boiler and machinery spaces. See also GRATINGS.

Flooring, Stokehold. A flooring of checkered plating or grating is usually fitted in the fire room a small distance above the inner bottom plating.

Flooring, Ventilating. See GRATINGS.

Flow Meter. An instrument for measuring the total flow of steam, water, oil, air or gas through pipes or closed conduits.
Page 950.

Flush Deck. See DECK, FLUSH.

Flush-deck Vessel. A vessel constructed with an upper deck extending throughout her entire length without a break or an erection, such as forecastle, poop, or similar structure.

Flush System. See PLATING, FLUSH SYSTEM.

Flushing Pump. See PUMP, SANITARY.

Fly. The length of a flag; that portion of a flag farthest away from the supporting spar or halyard.

Flying Bridge. See BRIDGE, NAVIGATING.

Flying Jib Boom. See JIB BOOM, FLYING.

Flying Jib Boom Stay. A stay running from the forward end of the flying jib boom to the martingale.

Foaming, Boiler. See BOILER FOAMING.

Forced Draft, Boiler. See BOILER FORCED DRAFT.

Force Pump. See PUMP, FORCE.

Forcing Press. See PRESS, FORCING.

Fore. A term used in indicating portions or that part of a ship at or adjacent to the bow.
Applied to that portion of the ship lying between the midship section and stem as fore body. Also to portions or parts of the ship lying between the midship section and stem as fore hold and foremast.

Fore Deadwood. See DEADWOOD, FORE.

Fore Deck. See DECK, FORE.

Fore Peak. The extreme forward end of the vessel below decks. The forward trimming tank.

Fore Peak Bulkhead. See BULKHEAD, FORE PEAK.

Fore and Aft. Parallel to the ship's centerline.

Fore-and-aft Ribbands. See RIBBANDS, FORE-AND-AFT.

Fore and Afters. A term applied to the portable beams running fore and aft in a hatchway which support the covers and in turn are supported by athwartship cross beams. This term is also applied to sailing vessels having a schooner rig.

Forebody. That portion of the ship's body forward of the midship section.

Forecastle. A short structure at the forward end of a vessel formed by carrying up the ship's shell plating a deck height above the level of her uppermost complete deck and fitting a deck over the length of this structure. The after end of the forecastle may or may not be closed by a transverse bulkhead.
The name given to the crew's quarters on a merchant ship when they are in the fore part of the vessel.

Forecastle Deck. See DECK, FORECASTLE.

Forecastle Deck Stringer. See STRINGER, FORECASTLE DECK.

Forecastle Deck Stringer Bar. See STRINGER, BAR.

Forecastle Frame. See FRAME, FORECASTLE.

Forecastle Gunwale. See GUNWALE, FORECASTLE.

Forecastle Sheerstrake. The strake of outside plating adjacent to the forecastle deck.

Forefoot. A term designating the approximate intersection of the curved portion of the stem with the keel. That point in the forward end of the keel about which the boat pivots in an endwise launching.

Forelock. A wood or metal pin securing a shackle pin or bolt in place. Wood forelocks are usually coated with white lead before being driven home, while steel ones are tinned or galvanized. Forelocks are principally used in connecting shackles for chain cables.

Foreman, General, on Ship. A boss or overseer who has charge of all the workmen working either on the hull or installing the propelling and auxiliary machinery.

Forestay. A stay extending from the head of the fore mast, fore top mast, fore top-gallantmast, etc., to the deck, bowsprit, jib-boom, or flying jib-boom. It prevents the foremast from falling backward under the tension of the shrouds, backstays, etc.

Forge. A basin or receptacle, holding burning fuel for heating small iron or steel bars and other metal parts.

Forges are usually provided with a means of forced draft to intensify the heat. The term forge is used to designate the process of forging.

Forge, Rivet. See FURNACE, RIVET.

Forging. A piece of metal, hammered, bent or pressed to shape while hot.

Pages 892, 893, 894, 895, 896, 897, 898.

Forging Ahead. Moving forward at a rapid rate of speed.

Forging Machine. A machine for shaping metal by hammering or pressing it into dies while hot.

Page 752.

Forging Machine, Drop. A type of power hammer in which dies are fitted and the hot metal shaped by being forced into the dies with a succession of sharp, heavy blows from the hammer.

Forging Press. A type of power machine in which dies are fitted and the hot metal shaped by being forced into the dies by a steady pressure. Forging presses are generally of the hydraulic type.

Page 751.

Forging Press, Steam Hydraulic. See FORGING MACHINE.

Forming. Roughing out, shaping timbers or structural shapes for fabrication.

Forward. In the direction of the stem.

Forward Part. The portion of the vessel in the vicinity of the stem, the bows.

Forward Perpendicular. A line perpendicular to the base line and intersecting the forward side of the stem at the designed waterline.

Forward Perpendicular, Area at. The area of the cross section at the forward perpendicular when the vessel has a projection below the designed waterline, such as a ram or bulbous section; the bulbous section being introduced to secure the advantage of increased length without increasing the waterline length.

When a vessel is not fitted with an actual ram she may be given a vertical area at the forward perpendicular by snubbing the lines of the forefoot sharply into the stem from slightly abaft thereof.

Forward Quarter. Those portions of the vessel's sides immediately abaft the stem.

Foul. A term applied to the underwater portion of the outside of a vessel's shell when it is more or less covered with barnacles, grass or foreign matter. It has been found that even an oily film over the vessel's bottom will retard the speed and that barnacles or grass will reduce a vessel's propulsive efficiency to a large extent.

Found. "All found"—complete as to fittings, outfit and equipment. "Well found"—all fittings, outfit and equipment of good quality and in good condition.

Foundation, Boiler. See BOILER FOUNDATION.

Foundation, Distiller. See DISTILLER FOUNDATION.

Foundation, Engine. See ENGINE FOUNDATION.

Foundation, Evaporator. See EVAPORATOR FOUNDATION.

Foundation, Refrigerating Machine. See REFRIGERATING MACHINE FOUNDATION.

Foundation, Steering Engine. See STEERING ENGINE FOUNDATION.

Foundation, Winch. See WINCH FOUNDATION.

Foundation, Windlass. See WINDLASS FOUNDATION.

Foundations, Auxiliary. A term applied to seatings constructed of wood, steel or a combination of both for the purpose of providing foundations for Condensers, Distillers, Evaporators, Pumps or any of the auxiliary machinery in the engine or boiler room.

These foundations may be built up from the tank top, bracketed to the bulkheads or hung from beams.

Pages 536 to 544.

Founder. To sink as the result of the entrance of water.

Foundrymen. Workmen engaged in the manufacture of metal fittings or parts by casting.

They are responsible for the preparation of molds, usually in sand, from the patterns furnished; for the proper mixing and melting of the metals required and for the pouring and cleaning of the castings.

Frame. A term generally used to designate one of the transverse ribs that make up the skeleton of a ship. Where the structure is built up of a relatively small number of strong transverse webs or belt frames and a relatively large number of smaller fore and aft bars, the fore and aft bars are called the frames.

The frames act as stiffeners, holding the outside plating in shape and maintaining the transverse form of the ship.

The frames in wood ships are spaced very closely together and sometimes they are adjacent to each other. The usual spacing in steel ships is between 20 and 32 inches, although wider spacing is used, particularly on war ships.

Three types of frames are in general use; the built up frame consisting of two bars riveted together; the solid frame consisting of a bulb angle, channel or Z bar; and the web frame composed of a web plate with bars riveted to each edge. Web frames are widely spaced with either built up or solid frames between them.

On account of the converging sides of a ship at the bow and stern, the flanges of frames are toed toward the midship section. This allows an open bevel or obtuse angle between the flanges of the frames in the bow and stern.

Theoretically, the ship would be stronger with the flanges of the frames at right angles to the shell but, practically, this would be difficult to accomplish due to the winding nature of the shell. Another disad-

vantage would be the difficulty in connecting athwartship members to the shell.

Pages 370 to 468, 485, 487 to 491, 493 to 498.

Frame, Angle Bar. A frame composed of an angle bar.

Frame Angle Bars. The angle bars which compose or are a part of a frame.

Frame Bender. See BULLDOZER.

Frame Bender, Portable. A machine designed for bending steel shapes to required curvatures. It often consists of a hydraulic ram mounted on wheels for moving over the bending slabs and a pin arrangement for preventing motion while in use.

Frame Bracket. See BRACKET, FRAME.

Frame, Boss. A frame that is bent to fit around the boss in the way of a stern tube or shaft.

Frame, Bridge House. A frame supporting the outside planking or plating of a bridge house.

Frame, Built-up. Described under Frame.

Frame, Bulb Angle. A solid frame composed of a bulb angle.

Frame, Bulkhead. See BULKHEAD BOUNDING BAR.

Frame, Bulwark. A frame projecting above the upper deck for the purpose of supporting the bulwark. See also STANCHIONS, BULWARK.

Frame, Butted. A term applied where the ends of the frames butt together as over the keel. In this case, which occurs with a bar or wood keel, a heel piece about 3 feet long with its flange reversed is required. The heel piece serves to make a continuous member out of a starboard and port frame and furnishes additional attachment to the shell plating.

Frame, Cant. A term applied to any of the frames in the overhanging portion of the stern of a ship. They abut on the transom frame to which they are connected by brackets and radiate out to form the skeleton of the overhanging stern. The spacing of these frames at the knuckle line should be about the same as the frame spacing amidships.

Also a term applied to the frames in the bow and stern that are not set up at right angles to the keel.

Pages 474, 475, 496, 497.

Frame, Channel Bar. A solid frame composed of a channel bar.

Frame, Deep. A web frame or a frame whose athwartship dimension is over the general amount.

Frame, Forecastle. A frame supporting the shell plating in the way of the forecastle.

Frame, Intermediate. A term applied to a frame in the double bottom, to which floor plates are not attached and where the floors are fitted to alternate frames.

Frame, Lapped. Where a joint in a frame is made by lapping the ends. This is done by reversing the flange of one member.

Frame Liner, Straight. A strip of plate or bar steel, the width of the faying flange of the frame inserted between the frame and the outside strake of an in-an-out system of shell plating.

Frame Liner, Tapered. A strip of plate or bar steel the width of the faying flange of the frame and tapering from the thickness of the outside plating down to a line. This liner is inserted between the frame and the outside plating at every seam of a clinker system.

Frame Liners. See LINERS, FRAME.

Frame, Longitudinal. A term applied to any of the frames that run fore and aft.

Frame, Main. The frame installed at the point of extreme breadth.

Frame, Midship. The frame installed half way between perpendiculars or at the midship section.

Frame, Poop or Poop House. A frame supporting the shell plating in the way of the poop. A frame supporting the outside planking or plating of a poop house.

Frame, Reverse. A bar riveted to the upper edge of a floor plate or the web or inner flange of a frame. The fore and aft flanges of reverse bars when riveted to frames are toed in the opposite direction to the flange of the frame. One advantage of using frames and reverse frames over solid frames is that the reversed frame may be stopped at or a little above the bilge where the design will permit. A common design is to run all reverse frames in the bow and stern to the upper, forecastle or poop deck as the case may be and to run the alternate reverse frames to the upper deck in the main body.

Frame, Rudder. See RUDDER FRAME.

Frame, Side. A term applied to a frame extending from the bilge to the upper deck.

Frame, Solid. Described under frame.

Frame Spacing. The distance between heel and heel of consecutive frames. The classification societies require that the distance between frames shall not exceed a certain amount usually between 20 and 32 inches.

Frame Squad. A crew of workmen who assemble and erect the frames of a ship.

Frame, Stern. See STERN FRAME.

Frame, Transom. A term applied to the frame or the frame and floor plate extending athwartship across the stern post and fastened thereto. This frame acts as a foundation or support for the structure of the overhanging stern in a vessel.

Frames attached to the arch and propeller post of a stern frame are also called transoms.

Page 497.

Frame, Transverse. A term applied to a frame that runs athwartship.

Frame, Tunnel. A term applied to one of the frames supporting the plating of shaft and access tunnels. When the tunnel has a rounded top the frame may be made in one piece bent round at the top. The spacing of the frames should coincide with the main transverse frames of the ship.

Page 507.

Frame, Web. A built up member consisting of a web plate to the edges of which single or double bars are riveted. They are placed several frame spaces apart with smaller frames in between. They extend from the tank top to the deck and between decks where extra strength is required. Where a web frame system is installed the intermediate frames may be smaller than for the ordinary framed ship. The web frame on account of its great depth is very stiff and it backs up the intermediate frames through intercostal girders running fore-and-aft between web frames.

Pages 488, 489, 491.

Frame, Web, Angle Bars. Angle bars riveted to the inner edge of the web plate of a web frame.

Frame, Web, Angle Clips. Clips used for attaching the web frames to tank top, decks, stringers, etc.

Frame, Wing. A term applied to one of the side frames in a ship.

Frame, Z Bar. A solid frame composed of a Z bar.

Framing, Paddle Box. The framing upon which the semi-circular compartments for housing the paddle wheels is constructed.

Framing Plan. A diagrammatic plan showing the distribution and type of construction of the members making up the vessels framing. Plate XXXVII.

Freeboard. The distance from the waterline to the top of the weather deck at side.

Sometimes used with reference to the entire out of water portion of a vessel's side.

Pages 231, 232.

Freeboard Deck. See DECK, FREEBOARD.

Freeing Port. See PORT, BULWARK, CLEARING OR FREEING.

Freighter. A vessel designed for the safe and economical transportation of merchandise from port to port

Large cargo capacity, economy of operation, good sea-going qualities, reliability of machinery, strength of hull, and efficient cargo handling facilities are essential characteristics.

Pages 370 to 419, 1104, 1105.

Plates V to XVI.

Frequency of an Electric Circuit. The number of cycles the electromotive force, or current, passes through in one second. When an alternating electromotive force, or current, has passed through a complete set of positive and negative values, starting from any value and again returning to that value, in the same direction, it has completed what is called a cycle.

Fresh Water Pump. See PUMP, FRESH WATER.

Friction Drum. A drum used to control the speed of the windlass shaft when paying out. Friction drums are used on winches to throw the power on or off the hoisting drum shaft.

Friction Saw. A rapidly revolving soft steel disc, the edge of which is slightly nicked by a special chisel.

Frictional Resistance. See RESISTANCE, FRICTIONAL.

Fuel, Boiler. See BOILER FUEL.

Fuel Oil Burning System. The fuel oil burning system includes everything necessary to an oil burning installation including the fuel oil tanks, oil pump, air compressor heater, piping, burners, etc.

Pages 988 to 995, 1014, 1015.

Fuel Oil Heater. An auxiliary used in connection with an oil burning installation to heat the fuel oil and make it volatile. It usually consists of a chamber in which a steam coil is fitted. The oil is admitted to the chamber and heated by live steam passing through the coil after which it is carried by a pipe line to the burners.

Pages 990, 996.

Fuel Oil Heater Foundation. A term applied to the seating supporting the fuel oil heater. Page 541.

Fuel Oil Service Pump. See PUMP, FUEL OIL SERVICE.

Full Ended. When the extremities of the waterlines in the vicinity of the load line are strongly convex to the surrounding water and the ends of the sectional area curve are full indicating that the displacement is carried well forward and aft towards the ends of the vessel.

Fuller. A tool used in hand forging to smooth rough surfaces or to make offsets.

Funnel, Boiler. See SMOKE STACK.

Furnace. A built up chamber in which fuel is burned to produce intense heat. Furnaces are used to heat plates, shapes, etc., to permit their being hammered or bent to a ship's form.

A space or receptacle built in a boiler in which the combustion of the fuel takes place.

Furnace, Angle. See FURNACE, BAR.

Furnace, Bar. A furnace used for heating shapes forming the frames, etc., in order to shape and bevel them to the required form. These furnaces are generally of small width and great length.

Furnace, Corrugated. A cylindrical type of furnace used in fire tube boilers, the shell of which is corrugated to resist external pressure.

Furnace Door, Boiler. See BOILER DOOR, FURNACE.

Furnace, Electric. A furnace in which the heat is furnished by an electric arc, or by the current going through the furnace charge or a special resistor, as in the resistance furnace, or by the current flowing through the secondary of a special transformer as in the induction furnace.

Page 958.

Furnace Front. See BOILER FURNACE FRONT.

Furnace, Hardening or Tempering. A furnace using solid fuel such as coal, coke, etc., and containing a cast iron or clay plate or receptacle in which the pieces to be hardened or tempered may be heated. The heat is reflected from the grate to the plate by an arch.

Steel is also hardened by use of a liquid bath, consisting of lead, mercury, common salt and other compositions in a furnace similar to a Tempering Pot Furnace.

Furnace Men. Workmen who heat and bend plates and shapes to the required forms. They also bend and bevel frame bars and fashion boss plates.

Furnace, Oil. A furnace in which oil fuel is used for producing the required heat.

Furnace, Plate. A furnace used for heating plates which require working into special forms, such as boss plates. These furnaces generally are wide and only about half as long as an angle furnace.

Furnace, Rivet. A small basin or receptacle, holding burning fuel for heating rivets.

Rivet furnaces are usually provided with a means of forced draft and the basins are generally supported in light metal stands fitted with handles for moving from place to place.

Coke and oil are the fuels most commonly used.

Furnace, Tempering Pot. A furnace containing a receptacle which holds a bath for drawing temper in steel. A commonly used bath consists of lead and tin in varying proportions, boiling linseed oil or lead heated to the melting point by coal, oil, gas or other fuel. The composition of the bath depends upon the temper required.

Furnaced Plate. See PLATE, FURNACED.

Furniture. The furniture aboard a ship may be divided into two groups, built-in and portable.

Built-in furniture consists of berths, seats, lockers, side boards, etc., that are an integral part of the joiner work of the ship.

Portable furniture consists of arm chests, bedsteads, benches, boxes, bureaus, chairs, chests, chiffoniers, desks, file boxes, lockers, sofas, swinging berths, tables, toilet racks, wash basin stands, wardrobes, etc. Benches include seats for the crew and steerage passengers, work benches for carpenter, engineer or mechanics. Boxes include ice boxes, and lockers include provision lockers, chronometer lockers, etc.

Pages 583, 584, 588, 589, 590, 592, 593, 594, 595, 596.

Furrings. Strips of wood secured to the frames or studding for the purpose of securing an even surface to attach sheathing or ceiling.

Fuse. A short piece of metal, in the form of a wire, rod or strip, forming part of an electric circuit to protect electrical apparatus or electric wiring from excessive current. For a given circuit, a fuse is used of such metal and conductivity that it will melt and thus open the circuit as soon as the limit of current carrying capacity of the circuit is reached. Fuses are generally placed in boxes, tubes or other receptacles, to prevent the vaporized metal flying out on surrounding objects.

Fuse Box. A fireproof receptacle, enclosing a fuse or fuses, with suitable contacts or clips for readily attaching them.

Fusible Plug. A plug of soft metal fitted near the dangerous low water level in fire tube boilers, its purpose being to melt out when the water level drops too low and allow the escaping steam to extinguish the fires.

Fusible plugs generally consist of a bronze casing with a hole filled with pure tin.

In externally heated cylindrical boilers with flues, fusible plugs are located in the top of the upper flue and in the shell of the boiler immediately below the fire line.

Scotch boilers and boilers having a combustion chamber are provided with plugs located in the crown sheet of the combustion chamber.

Page 1101.

Futtock Double. A piece of timber forming two futtocks in one length.

Futtocks. The pieces of timber of which a frame in a wood ship is composed. Starting at the keel they are called the first futtocks, 2nd futtocks, 3rd futtocks, and so on.

Pages 440, 445, 447.

G

Gadget. A slang term applied to various fittings. It is generally used where a proper name for the fitting is hard to decide upon or not remembered.

Gaff. A spar to which the top of a main, mizzen or similar sail is attached. It usually has a jaw fitted at one end to clasp the mast.

Page 813.

Gage. An instrument used in determining the pressure in a boiler, that is, the pressure above the atmosphere.

A glass or pipe column, the latter fitted with gage cocks, used to determine the amount of liquid in a boiler or tank. See Boiler Gage, Water.

An instrument for measuring dimensions, number of threads, etc. A standard length, thickness or number of threads.

Page 1005, 1006, 1035, 1088.

Gage. An instrument or standard of measure used on fine machine work, etc. Some of the most common gages are the micrometer, plug and ring gage, snap gage, thickness gage, limit gage, drill gage, thread gage, wire gage, etc.

Page 734.

Gage Cock. A small cock fitted to a boiler or tank for the purpose of determining whether the liquid within is up to the level that it is fitted at.

Pages 965, 1035.

Gage, Draft. An installation comprising a glass tube, graduated to scale and a small pipe, in communication with the sea. It indicates, in approximate units, the draft of the vessel.

Page 1088.

Gage Glass. A glass tube forming a part of a gage used to determine the amount of liquid in a boiler or tank. See gage.

Page 1031.

Gage, Jacket. A gage mounted on the steam jacket of a cylinder for the purpose of determining the pressure therein.

Gage Pipe. A small pipe connecting the steam or water gage to a boiler.

Galley. The space on shipboard where the food is prepared; a ship's kitchen.

Page 582.

Galley Dresser. A cook's work table located in the galley. It is usually a built-in structure of metal or wood on which the cook prepares the food, having shelves and lockers fitted underneath for stowing miscellaneous cooking utensils.

Page 582.

Galley Equipment. Equipment necessary to a ship galley for cooking, baking, warming, etc. Included in this equipment are ranges, steam tables, coffee and hot water urns, vegetable cookers, kettles, etc.

Pages 1095, 1096, 1097, 1098, 1099.

Galley Force Pump. A hand pump used in the galley for drawing fresh water from the tanks below.

Page 1055.

Galley Smoke Pipe or Funnel. A smoke pipe fitted to the galley range. It is constructed of sheet iron and lead up through the deck above or through the galley skylight to the open air.

Page 582.

Galvanizing. The process of coating one metal with another, ordinarily applied to the coating of a metal (usually iron or steel) with zinc. The chief purpose of galvanizing is to prevent corrosion. The methods of galvanizing commonly used are:

(a) Dipping the object to be galvanized in molten zinc.

(b) Placing the object in an electrolytic bath.

(c) The sherardizing process.

The dipping process, often called hot galvanzing, consists of submerging the object in a bath of molten zinc, the thickness of the coating depending upon the temperature of the bath and the nature of the object.

Electro-galvanizing, or wet galvanizing, may be accomplished by using an aqueous solution of zinc sulphate, zinc acetate or zinc chloride, the anodes being of zinc. The thickness of the zinc coating depends upon the density of the current (which may be from 4.5 to 20 amperes per square foot of cathode surface), the strength of the bath, and the time.

Sherardizing may be described briefly as follows: The object or objects to be coated are placed in a container in contact with zinc dust, and the container is then heated for several hours at a temperature in the vicinity of 600 degrees F., the position being changed at intervals in order to allow the zinc dust to come in contact with all exposed parts of the work.

Page 958.

Gammoning Piece. A timber on top of the filling chocks between the bobstay-piece and stem. An iron band, or lashing used to assist in securing the bowsprit to the stem.

Gangboard, Gangplank. A term applied to boards or a

movable platform used in transferring passengers or cargo from vessel to wharf or dock or vice-versa.

Pages 569, 570.

Gangway. A term applied to a place of exit from a vessel. Gangways are fitted in the shape of ports, which may be closed, in the sides of a vessel and in the shape of movable portions of bulwarks or railing on the weather decks.

The American Bureau of Shipping requires that gangways and other openings in bulwarks are to be kept well away from the breaks of superstructures, and the thin plating is to be doubled in way of mooring pipes.

Gangway Port. See PORT, GANGWAY.

Gantline, Girtline. A rope reeving through a single block aloft and used for hoisting or lowering rigging, etc.

Gantry Crane. See CRANE, GANTRY.

Gap Lathe. See LATHE, GAP.

Garboard Plate. See PLATE, GARBOARD.

Garboard Strake. See STRAKE, GARBOARD.

Garland. A strap lashed to a mast by which it is hoisted on board and placed in position.

Gas Cutting. A method of cutting metal by a gas torch through which a stream of gas and oxygen is united, making a flame of high temperature. The method consists of heating the spot to be cut and then projecting a stream of oxygen which causes the metal to burn away.

Gas Engine. An engine in which the power is developed in the cylinders themselves by means of the combustion of gas, thus eliminating the boilers and piping of the steam engine with the added weight and heat losses involved.

At the present time this type of engine is fitted only in small craft up to about one hundred feet length on account of excessive fuel consumption in large installation..

These engines are divided into two great classes, viz: two and four cycle engines.

In the two cycle engine a power impulse is given once every revolution while in the four cycle engine it occurs once every two revolutions.

The two cycle engine is used for small and medium sized boats as tenders, launches, etc., for river, lake, and harbor work where small powers and short runs are the rule and where fuel economy is not of the greatest importance.

The four cycle engine possesses the advantages of reliability and economy as compared with the two cycle engine and monopolizes the marine gas engine field with the exception above noted.

The American Bureau of Shipping rules for the installation of Internal Combustion Engines are given under Engine, Diesel.

Page 909.

Gas Engine, Back-firing. An explosion which takes place in the passage outside of and either to or from the cylinder. It may be the result of any of a number of causes among which are: Improperly timed ignition, poor mixture, a faulty admission valve, a loose valve cam, etc.

Gas Engine, Blowing. The leakage of gas past the piston rings on the compression stroke due to the loss of the oil film between piston rings and cylinder wall.

Gas Engine, Carbureter. A device designed to saturate air or gas with volatilized hydro-carbon.

An efficient carbureter must be capable of adjustment as to the proportion of fuel and air obtained and it must be compact and simple in construction.

Gas Engine, Carburetion. The method or act of charging to saturation air or gas with volatilized hydrocarbon.

In order to obtain complete combustion each charge of fuel must be supplied with an amount of oxygen suited to its particular need. Excessive air supply lowers temperature, retards flame propagation, and hampers ignition. Inadequate air supply, causes carbon deposits and incomplete combustion.

Gas Engine, Carburetion, Spray. Carburetion in which gasoline is introduced into the mixing chamber of the carbureter through a needle valve. It enters into this chamber in the form of a fine spray and as the result of the suction created by the passing air, the air in turn being drawn through the mixing chamber because of the vacuum in the cylinder created by the suction stroke of the piston.

Gas Engine Charge. The amount of mixture required to fill the cylinder.

Gas Engine Clearance. The space in the cylinder which is occupied by the mixture when at its maximum compression, i. e. when the piston is at its extreme position in the compression stroke.

Gas Engine Compression. The forcing of the mixture in the engine cylinder into a small space before ignition. Compression results in a more intimate intermingling of the air and fuel and in an increase of the temperature of the mixture. Under these conditions the burning of the mixture takes place with more certainty than would be the case at a lower temperature and pressure.

Gas Engine Connecting Rod. In internal combustion engines (with the exception of large stationary installations) the rod which connects the wrist pin (in the piston) with the crank. Thus the piston motion is transmitted to the crank by the connecting rod without the assistance of a piston rod.

Connecting rods are of steel having rectangular cross sections in large and I cross sections in marine and light engines.

Gas Engine Cooler. A device designed to lower the temperature of the circulating fresh water. The apparatus consists of copper tubes through which the hot water from the engine jacket passes and around which the cool water from the sea circulates.

This apparatus is used in connection with large internal combustion engines where parts might be seriously injured by galvanic action were sea water used.

Gas Engine Cooling System. A method of artificially lowering the temperature of the cylinder or other engine parts. This is rendered necessary on account of the great heat developed within the cylinder by the combustion of the mixture.

There are two methods of cooling: 1st, water cooling; 2nd, air cooling.

In the first method, water is admitted to the lower part of the jacket and drawn off near the top, the action of the heat causing the circulation. Where a more positive and rapid circulation is required a pump is placed in the supply line.

In the second or air system, cooling is accomplished by radiation from ribs cast on the outside of the cylinder. To facilitate this action a fan is installed to increase the air circulation. The size of cylinder to which this system may be successfully applied is limited.

In addition to the cooling of the cylinder water is used in large installations to cool both piston and exhaust valves.

Gas Engine Counter Shaft or Cam Shaft. A shaft running the length of a multi-cylinder engine parallel to the main shaft and geared thereto. It actuates the valves and sometimes the pumps and other devices. It is of small diameter but made of high grade material. When the admission and exhaust valves are on the same side of the cylinders one countershaft is fitted; when on opposite sides two are used.

Gas Engine Crank Chamber. The chamber formed below the cylinders of a two cycle engine by the walls of the crank case.

Gas Engine Crank Chamber Explosion. An explosion taking place in the crank chamber of a two cycle engine. It is due to incomplete combustion resulting from too thin a mixture or a delayed spark.

Gas Engine Cylinder. A casting in which is formed a cylindrical chamber intended for the explosion of the mixture and the travel of the piston. It is made of close grained, gray cast iron of great hardness.

Two or more cylinders may be cast as one piece or each cylinder may be cast as a separate unit.

Cylinders may be either water or air cooled. In the former case a water jacket is cast with the cylinder or otherwise provided. In the latter thin ribs are cast on the outer surface of the cylinder in order to increase the heat radiating surface. Both, jacket and ribs are practically confined to the upper part of the cylinder, viz: the compression space where the heat is greatest.

Gas Engine, Double Acting. An engine in which successive explosions takes place on alternate sides of the piston.

In general, only the large slow speed heavy duty engines are of this type.

Gas Engine Dual Ignition. An ignition system in which the current may be supplied either from battery or magneto or from both as desired.

Gas Engine Efficiency. The ratio of the heat transformed into useful or mechanical work to the total heat supplied the engine.

Gas Engine Fly Wheel. A heavy wheel keyed to the crank shaft at the forward end of the engine. It is constructed with a thin web and a relatively heavy rim in order to secure as large an inertia effect as possible. By this means the effect of the periodic impulses of the internal combustion engine upon the speed of rotation is modified. The smaller the number of cylinders the greater will have to be the relative size of fly wheel.

Gas Engine Fuel System. The train or succession of numbers by means of which the fuel is conducted from the source of supply to the cylinder and carried away therefrom in the form of exhaust gas.

In general, this system consists of fuel tank, supply line, strainer, carbureter, exhaust line and muffler.

Gas Engine Ignition. The firing of the explosive mixture in the cylinder of the engine.

Gas Engine Ignition, Hammer Break. A method of make and break ignition in which the contacts are brought together suddenly and separated.

Gas Engine Ignition, Make and Break. An ignition system in which contact in the electrical circuit is mechanically made and broken within the cylinder. The break causes a spark to pass between the contacts.

Gas Engine, Knocking. The sound accompanying or resulting from improper adjustment of engine parts, too rich a mixture, too open a throttle or carbon deposits in the cylinder.

Gas Engine Long Stroke Motor. A motor in which the length of stroke is materially in excess of the diameter of cylinder bore. The line of demarcation between long and short stroke motors is usually drawn at a value of stroke to cylinder diameter ratio of 1½.

Gas Engine Lubrication System. The system by means of which lubricating oil is supplied to the various working parts of the engine.

The intense heat in the cylinder and the high piston speed of internal combustion engines require the constant presence of an oil film between piston and cylinder wall. Oil for this purpose is provided either by the splash or mechanical feed system. In the former, a closed crank case with an oil bath in its lower portion is provided. The crank dips into this bath at each revolution causing the oil to be thrown onto cylinder walls, bearing, etc. Mechanical feed may be of various types, in principle consisting usually of a lubricator or small oil reservoir connecting with the engine by means of a duct. This duct supplies the piston or cylinder wall. Only special grades of oil should be used for the above purpose.

The lubrication of the working parts aside from the foregoing presents no problems essentially different from those of all other high speed mechanisms.

Gas Engine Misfiring. The failure to fire or explode the charge. This may be either continuous or intermittent.

Continuous misfiring is generally due to faulty ignition. Broken wires, foul spark plugs, bad contacts, etc., are among its causes.

Intermittent misfiring may be due to leaky valves, poor compression, weak battery, poor mixture, etc.

Gas Engine Mixture. The intermingled fuel and air when ready for introduction into the cylinder.

Gas Engine Mixture, Lean. A mixture in which too small an amount of fuel is present.

Gas Engine Mixture, Rich. A mixture in which too large an amount of fuel is present.

Gas Engine Muffler. A part of the exhaust system of an internal combustion engine designed to modify or control the noise of the exhaust into the atmosphere. It is essentially an increase in the area of the exhaust line near its end so that the exhaust gases reach the atmosphere at reduced speed and pressure.

Gas Engine Overheating. The rise in temperature of the engine or its parts due to the improper functioning of auxiliary systems such as cooling or lubrication or to improper adjustment of bearings, etc.

Gas Engine Piston. The cylindrical part upon which the explosion of the mixture acts directly and to which it imparts linear motion. On account of the sudden impulses experienced in this type of engine and in order to simplify guiding, packing, etc., in single acting engines, the piston is made cylindrical, rather than disc shaped, having an axial length from 1¼ to 1⅝ times its diameter. This great relative length obviates the necessity of a piston rod. The piston is fitted with packing rings working in grooves and usually three or four in number. Frequently the wrist pin is permanently secured in and to the piston.

In slow heavy duty engines of the double acting type a piston more nearly approaching that of the steam engine type and having a piston rod, guides, etc., may be used.

Gas Engine Push Rod. A rod carried in guides fastened to the engine casting and used for the transmission of motion to the valve stem. It is actuated by the cam carried on the countershaft.

Gas Engine Scavenging. The act or process of ejecting the burned gases from a cylinder prior to or simultaneously with the entrance of a new charge.

Gas Engine, Single Acting. An engine in which the explosion takes place on but one and the same side of the piston.

All the small, high speed engines are of this type.

Gas Engine Spark, Jump. A system of ignition in which a current of high potential is caused to jump from one to another of the spark plug terminals. The closing of the circuit causes the jump of the spark. The spark plug is located in the cylinder head so that by proper timing, ignition may take place when the mixture is highly compressed.

Gas Engine Spark, Wiping. A method of make and break ignition in which the contacts are made to brush together.

Gas Engine Three-Point Suspension. The system of carrying the crank shaft in which three main bearings are used.

Gas Engine Timing. The fixing or regulation of the point in the stroke at which ignition takes place.

Gas Welding. See WELDING, GAS.

Gaskets. Packing materials, by which air, water, oil or steam tightness is secured in such places as on doors, hatches, steam cylinders, manhole covers, or in valves, between the flanges of pipes, etc. Such materials as rubber, canvas, asbestos, paper, sheet lead and copper, etc., are extensively used.

Ropes or plaited stuff used to confine furled sails to their yards or booms. Harbor Gaskets are usually of plaited stuff named according to their position as yard-arm, quarter and bunt gaskets. A Sea Gasket, also termed a Furling Line, is a long rope passed around both the yard and sail when a neat appearance is not so much desired as security. Page 103.

Gasoline Engine. See GAS ENGINE.

Gate Shear. See SHEAR, GATE.

Gate Valve. See VALVE, GATE.

Gear. A comprehensive term in general use on shipboard signifying the total of all implements, apparatus, mechanism, machinery, etc., appertaining to and employed in the performance of any given operation. For instance the brooms, brushes, buckets, dust pans, mops, etc., constitute the "cleaning gear"; the rudder, steering engine or motors, shafting, gears, drums, etc., the "steering gear"; etc.

Gear Cutter, Automatic. A machine designed to cut spur and bevel gears and worm-wheels. These machines are generally automatic, all the operations required in gear cutting being performed by the machine itself except the placing of the wheels in position and setting the machine for the proper depth and length of cut.

Geared Door. See DOOR, HORIZONTAL OR VERTICAL, SLIDING.

Geared Shaper. See SHAPER, GEARED.

Gearing. A term applied to wheels provided with teeth that mesh, engage, or gear with similar teeth on other wheels in such a manner that motion given one wheel will be imparted to the other.

Pages 890, 937.

General Arrangement Plans. The plans showing the various quarters, spaces and compartments into which a ship is usually divided. For general arrangement plans of various types of vessels see pages 370 to 468.

General Service, Pump. See PUMP, GENERAL SERVICE.

Generator, Asynchronous. A commutator type of alternating current generator which does not operate at synchronous speed.

Generator, Compound. A direct current generator in which the field consists of both series and shunt field coils.

Generator, Electric. A machine which transforms mechanical energy into electrical energy.

Lloyd's Rules suggest that great care should be taken that generators, motors and electric leads on board ship are not located in such a place that they will influence the compasses.

Pages 391, 393, 399, 400, 401, 425, 442, 443, 444, 656 to 659, 934, 936, 937, 938, 944, 945, 953, 1010, 1041, 1056, 1057, 1058, 1059, 1060, 1061, 1062.

Plates XII, XIV, XLVII, XLVIII.

Generator, Engine Driven. An electric generator driven by a gas or steam engine of the reciprocating type.

Pages 938, 944, 945, 1010, 1056 to 1061.

Generator, Series. A direct current generator in which the field winding is connected in series with the armature winding, thus allowing the full armature current to go through the field coil. This is an almost obsolete type of generator.

Generator, Shunt. A direct current generator in which the field coil is shunted across the armature, thus allowing only a small portion of the armature current to pass through the field coil. The voltage of a shunt generator is very nearly constant, with a slight decrease in voltage as the load increases.

Generator, Synchronous. An alternating current generator the speed of which bears a certain fixed relation to the frequency of the circuit.

Generator, Turbine Driven. See TURBO-GENERATOR.

German Silver. Described under Metals.

Gib. A metal fitting that holds a member in place or presses two members together.

Gig. A pulling or row boat of fine model and good length used principally for the convenience of the shipmaster in the performance of his duties between the ship and the shore.

Gilders. Decorators in gilt or gold leaf.

Gilguy. A designation for a makeshift contrivance on board ship; also a term applied by sailors to anything whose name is unknown to them.

Gimbals. A device by which a ship's compass, chronometer, etc., are suspended in a constant horizontal position irrespective of the rolling and pitching of the vessel. It consists of two concentric brass hoops or rings whose diameters are pivoted at right angles to each other on knife-edge bearings.

Gin Blocks. See BLOCKS, GIN.

Girder. On ships this term is generally applied to continuous beams running in a fore and aft direction under the decks. They are used in connection with stanchions for the purpose of supporting the decks and binding the deck beams together.

This term is sometimes used to designate the longitudinal in the double bottom. Page 494.

Girder, Boiler. See Boiler Girder.

Girder, Deck. A term applied to a continuous beam running in a fore and aft direction under, and attached to, the deck beams. Also applied to a continuous range of intercostal plates and bars running fore and aft between deck beams. In deciding the height between decks the depth of the girders should be considered so that sufficient head room will be provided for.

Page 520.
Plate XXXVIII.

Girder Equivalent. See Equivalent, Girder.

Girder, Intercostal. A term applied to a range of short plates fitted between and attached to continuous structural members.

Girder, Longitudinal. See Longitudinal Girder.

Girder, Ship's (Strength). That portion of a ship's hull structure which is composed of continuous, longitudinal members, whose material, location and connection to other portions of the structure are such that they efficiently resist the forces which tend to produce hogging or sagging. The principal members falling within the above definition are longitudinal framing, shell plating, inner bottom plating, longitudinal bulkheads and decks.

Girders, Side. See Stringer, Side.

Girder, Wing. See Margin Plate.

Girdle. Extra planking fitted over the wales in a wooden ship.

Girtband. Sometimes termed bellyband. A strip of canvas worked across the middle portion of a sail to provide additional strength.

Girth. The distance measured on any frame line from the intersection of the upper deck with the side around the body of the vessel to the corresponding point on the opposite side.

Gland, Stern Tube. See Stern Tube Gland.

Globe Valve. See Valve, Globe.

Glue, Marine. A preparation of pine, coal tar or asphaltum pitch used to fill the crevices between the planks of a wood deck to prevent water and dirt from leaking through.

Pages 804, 807.

Goggles, Safety. See Safety Goggles.

Gold. Described under Metals.

Gooseneck. A fitting used to attach and support a cargo boom. See Pacific Iron.

A short piece of pipe, used as a ventilator, one end of which is given a 180° bend and the other end attached to a deck over an opening equal to the diameter of the pipe. Also applied to pipes and fittings in which a large bend or curve is worked.

Pages 336, 337.

Gouge. A tool with a half round cutting edge used to cut grooves.

Governing. The process of controlling automatically the speed of the engine under varying loads.

In internal combustion engines this is a more difficult matter than in steam engines because of the difference in character between the two power mediums involved.

Governing may be done by any of several systems through the medium of mechanical governors such as the fly ball, inertia, etc.

Among the systems employed may be mentioned, the hit and miss; the throttling of the exhaust; the throttling of the mixture; the varying of the quality of the mixture, etc.

Governor. An apparatus or mechanism designed to eliminate great increases in engine speed due to propeller emergency.

There are various types of governors for marine engines. None is entirely satisfactory because of tardy operation.

Modern practice favors a form of governor which depends upon change of engine speed for its impulse.

Governor, Pump. A pressure controlling valve for governing pumps for fresh or salt water, oil, ammonia, air, etc.

Page 1043.

Grab Stand. A piece of apparatus designed to hold a drilling machine when in operation.

Grade Line. An established reference line from which measurements are taken to any point.

Grain. A term applied to the texture or fibres of wood.

Grain Measure. A term used where the capacity of a cargo hold is measured to the shell of the vessel instead of to the inside of the frames or cargo battens.

Grain, Straight. A term applied where the grain runs parallel or nearly so to the face of the board.

Grain, Vertical or Edge. A term applied where the grain of the wood is near or at right angles to the face of the board.

Granny Knot. See Knot, Granny.

Grapnel. An implement having four prongs or hooks radiating from a common shank, fitted with a ring in the end of the latter and used as an anchor for small boats, for the purpose of recovering objects dropped overboard, for securing one vessel to another in boarding, or to make fast a towline to a burning vessel, hooking on to lines, etc. Also known as Grappling Iron.

Grapnel Line. A line bent to a grapnel, sometimes tailed with a length of chain next to the grapnel in order that it may not be burned away in towing a burning vessel or severed by the crew in boarding a hostile vessel.

Grappling Irons. See Grapnel.

Grate, Fire Grate. A type of cast iron grating made up of heavy portable cast iron bars and bearers installed in the furnace. It is used to support the burning fuel.

Grate Bars. These bars support the fire in a boiler furnace and are usually made of cast iron. The bars are generally rectangular in cross section with the long side vertical and somewhat deeper in the center than at the ends. Lugs are cast on the sides to provide an air space between bars about equal to their thickness and they are commonly cast in pairs. A shallow groove running along the top of each bar will aid in keeping down the adhesion of clinkers.

The grate bars are usually fitted in two lengths set to slope slightly toward the rear of the furnace and are supported in the front and rear by the furnace structure and in the center by a bearing bar.

Grate Bearer. A support for boiler grate bars, usually made of cast iron.

Grate Surface, Boiler. See Boiler Grate Surface.

Grated Hatch. See Hatch, Grated.

Grating, Fantail. A lattice work, made of wood, fitted at the after end of tug-boats. It is built about eighteen inches above the deck and extends forward for a distance of about twelve feet. This grating forms a good drainage platform for stowing hawsers and towing gear when they are not in use.

Grating, Wood. A lattice work consisting of two sys-

tems of wood bars running at right angles to each other. One system is usually mortised into the other to form a flush surface.

Gratings are used as drainage platforms on the bridges, bath rooms, cold storage spaces, etc. They are generally made up in sections in sizes convenient for handling.

Simple gratings are also often made by securing a number of small square strips of wood together with bolts or rivets, small blocks being inserted between the strips in way of the rivets to act as separators.

Page 812.

Gratings, Flooring, Hatchway, Walkway, Ladder Steps. A structure of metal bars so arranged as to give a support or footing over an opening, while still providing spaces between the members for the passage of light and the circulation of air. For large openings it is usually built up in panels of comparatively small size grouped on a supporting frame. For small openings it may be made in one section of the proper size. The most common applications for gratings in marine construction are for covering fair-weather and boiler hatches, floors for oil fired boiler rooms, walkways, and galleries in the engine and boiler rooms, ladder steps, etc.

One of the oldest forms of grating consists of metal bars set on edge, punched or drilled at intervals, and strung on rods with short spacers of pipe placed intercostally between bars to maintain the opening. Another form of grating consists of a frame of flat bars set on edge with holes punched or drilled at short intervals in two opposite sides to receive the ends of square or round rods or flat bars set on edge. The ends of any of these types of closely spaced cross bars are turned down to form a shoulder and to fit the holes in the frame bars. The holes in the frame bars are usually countersunk on the outer side, allowing the ends of the grating rods or bars to be riveted up to a flush surface.

A light and strong type of grating consists of alternate straight and corrugated or reticuline bars set on edge and solidly riveted together. To construct this grating the corrugated or reticuline bars are pressed to shape, after which they and the straight bars are carefully punched to templates, then assembled in alignment, and a heavy rivet formed in each hole. This grating possesses excellent non-slipping qualities and is also suitable for trucking.

Pages 574, 575, 977.

Gratings, Fidley. See FIDLEY GRATINGS.

Gratings, Hatch. Gratings usually constructed of wood, fitted over hatch openings. They are particularly desirable where hatch covers are removed or opened.

Gratings, Skylight. See SKYLIGHT GRATINGS.

Graving Dock. See DRY DOCK, GRAVING.

Graving Pieces. Small pieces of wood fitted into the deck where the surface has been injured or decayed, and where it is not deemed feasible or practicable to renew the entire piece.

Grease Cup. A receptacle designed to hold grease and used where a positive feed is required for lubricating machinery.

Grease, Launching. See LAUNCHING GREASE.

Greaser. A member of a ship's boiler room force who cleans out the bilges and boiler flues and performs other work of the lower grade.

Gridiron. Heavy sleepers or timbers fastened to the tops of piling at or near the bottom of a river or harbor where there is a tide. Boats or scows are placed on the gridiron at high tide so that work may be done on their sides or bottom at low tide. Scows are also placed on gridirons so that they will remain at the level while they are being loaded or unloaded.

Grill Work. An ornamental lattice work.

Grinder. See GRINDING MACHINE.

Grinder, Band Saw. A machine in which an abrasive wheel is used for sharpening the teeth of a band saw.

Grinding Machine. A machine employing an abrasive wheel for any kind of grinding, such as sharpening or forming tools, truing machine centers, finishing machine surfaces, etc. Grinding machines are generally electric motor or belt driven, but pneumatic machines are built in both the portable and bench types.

Pages 728, 734.

Grinders. Men who remove excess material by means of an emery wheel.

Grindstone. An abrasive wheel generally used for sharpening wood working tools.

Gripe. A curved piece of timber joining the forward end of the keel and the lower end of the cutwater.

Gripe, Release. Fittings and chain assembled together for holding purposes which can be easily parted at a moment's notice.

Page 688.

Gripes, Boat. An arrangement for holding small boats securely in their stowage chocks. They are made up of lashings or chains fitted on one end with a turnbuckle or pelican hook and a shackle for attachment to a pad eye on the deck and on the other end with a flat bar hook for attachment to the gunwale of the boat.

Page 688.

Grommet. A ring of fibre usually soaked in red lead or some other packing material and used under the heads of bolts and nuts to preserve tightness. Also applied to washers or eyelets of metal.

Gross Tonnage. See TONNAGE, GROSS.

Ground Tackle. A general term for all anchors, cables, buoys, ropes, purchases, etc., used in the operation of mooring and unmooring a ship.

Gudgeons, Rudder. Lugs cast or forged on the stern post for the purpose of hanging and hinging the rudder. They are bored to form a bearing for the rudden pintles and are usually bushed with a lignum vitae or white metal bearing surface.

Guess Warp. A hawser carried out in a small boat and bent to a distant fixed object in order to warp the vessel toward it.

The name originated from the necessity of having to judge the distance by the eye.

Gun, Life Saving. See LINE THROWING GUN.

Gun Tackle. A purchase consisting of two single blocks and a length of rope.

Gunboat. A war vessel designed principally for use on a foreign station. Its principal characteristics are moderate displacement, moderate speed, good cruising radius, moderate draft, light battery, comfort for the personnel, and robust construction.

Gunwale. A term applied to the line where an upper deck stringer intersects the shell.

Gunwale Bar. A term applied to the bar connecting a stringer plate on a weather deck to the sheer strake.

Gunwale, Bridge. The line where the bridge deck stringer intersects the shell.

Gunwale, Forecastle. The intersection of the forecastle deck stringer with the shell.

Gunwale, Poop. The line where the poop deck stringer intersects the shell.

Gunwale, Quarter Deck. The line where the quarter deck intersects the shell.

Gunwale, Rounded. A term applied where the shell and frames are rounded into a deck.

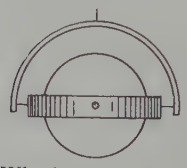
Gunwale Stringer. See STRINGER, GUNWALE.

Gusset; Gusset Plate. A term applied to a horizontal bracket. It is used as additional attachment for strong hold beams to stringers, the bottom of side frames, to the tank top, etc.

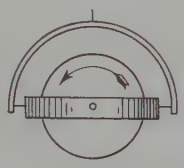
Guys. Wire or hemp ropes or chains to support booms, davits, etc., laterally. They may consist of single lines or purchases, leading from the davit head or boom end to the deck. In the case of single lines they are either lashed to eyes or rings or else fitted with turnbuckles and hooked or shackled to deck connections. Guys are employed in pairs. Where a span is fitted between two booms or davits one pair only is required for the two. Guys to booms that carry sails are sometimes known as backropes.

Gypsy. A small auxiliary drum usually fitted on one or both ends of a winch or windlass. The usual method of hauling in or slacking off on ropes with the aid of a gypsy is to take a couple of turns with the bight of the rope around the drum, and to take in or pay out the slack of the free end.

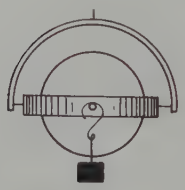
Gyroscope. Strictly, any rotating mass. Usually a wheel so constructed as to demonstrate or utilize gyroscopic action. By gyroscopic action of a spinning mass is meant its strong resistance to forces tending to change the plane of its rotation, and a second action known as precession. Precession is the motion of a spinning body under the action of forces tending to change its plane of rotation. Precessional motion occurs slowly about an axis perpendicular to the applied force. The illustration will make this clear.



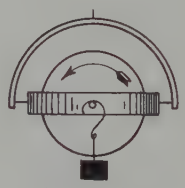
Wheel not running.



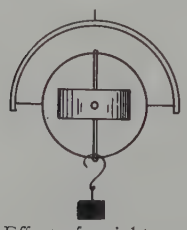
Wheel running.



Add weight to end of shaft.



Weight added.



Effect of weight: Wheel turns about horizontal axis.

Effect of weight: Continuous slow "Precession" about vertical axis.

Page 1094.

Gyroscopic Compass. See COMPASS, GYROSCOPIC.

Gyroscopic Stabilizer. See STABILIZER, GYROSCOPIC.

H

Hack Saw. See SAW, HACK.

Half Breadth Plan. See LINES, PLAN.

Half Hitch. A hitch formed in the end of a rope by passing the end around the standing part and then bringing it up through the bight.

Halyards. Light lines used in hoisting signals, flags, etc. Also applied to the ropes by which gaffs, sails or yards are hoisted.

Hambroline. A cord of three yarns, approximately the same size and yardage as Roundline. It is used for serving, worming, etc., but is of an opposite twist from Roundline.

Hammer, Calking. A hammer used in the hand calking of plates, shapes, etc.

Hammer, Plying. A type of hand riveting hammer.

Hammer, Pneumatic. The pneumatic hammer is a combination of a cylinder, a reciprocating piston or plunger, a valve for automatically controlling the movements of the plunger, and a throttle valve for regulating the flow of air to the hammer from the supply pipe. Pneumatic hammers are made in a variety of designs, some being intended especially for riveting, and others for such operations as chipping, calking, or scaling.

Hammer, Power Forging. A machine which, by means of a crank or eccentric, by steam or by compressed air against a piston in a cylinder, imparts a vertical motion to a hammer or ram die. Such hammers are made with single frame or double frame, and are known as Motor Driven, Belt Driven, Pneumatic, Steam, and Steam Hydraulic.

In the Helve Type the arm or helve moves through an arc, the hammer or die striking the work when near a horizontal position.

Pages 735, 747, 750.

Hammer, Set. A hammer used in bringing a shape or frame bar to its final shape on the bending slab.

Hammer, Riveting. See RIVETING HAMMER.

Hammer Runners. Men who operate power hammers that make large forgings.

Hammock. A rectangular canvas article suspended from hooks attached to the vessel's deck beams or other structure. It is used for berthing seamen aboard ship. Of late years it has been superseded to some extent by fixed berths of various types.

Hammock. A term applied to a swinging canvas bed principally used on war ships. The hammocks are hung from hooks attached to deck beams and are taken down and stowed away during the day time.

Hammock Berthing. A term applied to compartments used for storage of hammocks.

Hammock Cloths. The canvas covering fitted for the protection of the hammocks.

Hamper, Top Hamper. Articles of outfit, especially spars, rigging, etc., above the deck. While ordinarily indispensable, they are in certain emergencies both a source of danger and an inconvenience.

Hand Bending Machine, Portable. A light type of

bending press mounted on small wheels for moving about a yard or shop.

Hand Glue Press. A form in which a wood frame or object to be glued together is held or compressed until the glue is hard and set.

Hand Pump. See PUMP, HAND.

Hand Spike. A round bar or lever of hard wood which is placed horizontally in the head of a capstan to push against in order to revolve the capstan. A lever for moving heavy weights.

Hand Wheels. Wheels for operating machinery, valves, doors, etc., by hand.

Page 608.

Handy Man. A workman who performs a variety of work pertaining to several trades in which the amount of work belonging to any of the trades does not warrant the assigning of individual tradesmen to do it.

Hank. A ring of rope, wood, or iron that slides on a stay and to which the luff of a staysail is seized.

Harbor Deck. See DECK, HARBOR.

Hard Steel. See STEEL AND IRON.

Harness. A term, now practically obsolete, for the furniture of a vessel.

Harness Cask. A large tub used to contain the salted provisions intended for immediate consumption.

Harpoon. A long shanked, barb-pointed spear or javelin used to strike whales or other large fish.

Hatch. The American Bureau of Shipping requires that all openings in decks or complete tiers of beams are to be framed so as to provide efficient support and attachment to the ends of the half beams by means of tie plates and efficient fore and aft carlings or coamings.

Cargo and other Hatchways on the exposed or weather portions of the Freeboard Deck and of such exposed portions of the decks of superstructures as are situated forward of the midship half length, are to have coaming plates not less than 24 inches in height; they are to extend to the bottom of the beams and are to be riveted to them and to the hatchway end beams. Coamings on other parts of the weather decks of superstructures may be 18 inches high. The connection to the deck, tie or 'thwartship plates is to be made with an agle bar of not less thickness than the coaming plates and having solid welded corners; where a wood deck is laid, the vertical flange of this bar is to stand half an inch above the wood deck and is to be flush riveted. The thickness of coaming plates is not to be less than .34″ in Vessels not exceeding 100 feet in length, and not less than .44″ in Vessels of 200 feet length and above; the thickness for Vessels of intermediate lengths may be obtained by interpolation. Where hatchways exceed 10 feet in length and the coamings are required to be 24 inches high, the coamings are to be stiffened by bulb angles or their equivalent, placed about 10 inches below the top of the coaming; the depth of the bulb angle is not to be less than 4 inches in Vessels not exceeding 100 feet in length, and not less than 7 inches in Vessels 200 feet length and above; the depths for intermediate lengths may be obtained by interpolation; the hatch cleats are to be riveted to the bulb angle. Coamings which are more than 30 inches and not more than 36 inches in height are to have efficient brackets or stays from the horizontal bulb angle to the deck, not more than 10 feet apart; where the height exceeds 36 inches the framing and supports must provide equivalent strength and stiffness. Hatchway coamings are to be of sufficient strength to act as efficient deck girders between the points of support. Heavy convex or patent moldings are to be fitted on the upper edges of the coamings, and the lower edges are to be flanged or provided with other suitable protection.

Hatch beams and fore and afters are to be so spaced that the unsupported length of the hatch covers does not exceed 4 feet 6 inches in hatchways which require to have 24-inch coamings under par. 2, nor 5 feet 6 inches in those for which 18-inch coamings are permitted. The arrangement of the supports is not to be less effective than required in this and following paragraphs; the proposed arrangements for all hatchways are in all cases to be submitted for approval. Wood hatch covers are to be solid and not less than 2½″ thick; the hatch rests are to be at least 2½″ wide, and where necessary are to be beveled so as to provide solid bearing surface of not less than that amount. Cleats are to be efficient and spaced not more than 24 inches center to center from end cleats placed not more than 6 inches from the hatchway corners. Satisfactory battening arrangements are to be provided for all weather deck hatchways.

Beams without fore and afters are to be of the sizes given in Table A where 24-inch coamings are required and are to be so spaced that the unsupported length of hatch cover does not exceed 4 feet 6 inches. They may be of the sizes given in Table B where 18-inch coamings are permitted, and may be so spaced that the unsupported length of hatch cover does not exceed 5 feet 6 inches. Beams with fore and afters are not to be spaced more than 10 feet centers; the sizes of beams and fore and afters are to be as required by Table A where 24-inch coamings are required by par. 2, and as required by Table B where 18-inch coamings are permitted. The top angle mountings are not to be recessed to form bearers for the fore and afters but are to be fitted in a fair line across the beam.

Angle mountings on the upper edges of beams and steel fore and afters are to extend to the extreme ends in all cases and the ends of the web plates are to be flushed up on each side by doubling plates; having the same thickness as the angle bars and at least 7 inches wide. Steel fore and afters are to have bearing pieces of heavy angle bars on their lower edges, in way of each hatch beam which they cross. Wood fore and afters are to be made of well seasoned timber, free from rot, sap and shakes; they are to have steel shoes at least 7″ x .5″ at each end, and plate bearing pieces at least 9″ x 5″ in way of each hatch beam which they cross.

All carriers for beams and fore and afters are to be steel and are to be fitted as close to the sides and throat of the hatch beams and fore and afters as is practicable. The bearing surface is not to be less than 3 inches and carriers made of angle bars are not to be less than .50″ thick. The carriers for beams are in all cases to overlap the hatchway coaming angle. All carriers are to be solid or are to have not less than two ⅞-inch rivets under the bearing surface. Where fore and afters extend across hatch beams, efficient clips are to be fitted on top of the beams to keep them in position.

Cargo, coaling and other such openings in the Free-

TABLE A

Breadth of Hatchway	Angle Mountings	BEAMS WITHOUT FORE AND AFTERS — Spacing Center to Center		BEAMS WITH FORE AND AFTERS — Spacing Center to Center		
		4′ 0″	5′ 0″	6′ 0″	8′ 0″	10′ 0″
10′	3 ×3 ×·40	9×·46 B.P.	10×·50 B.P.	11×·30 P.	12×·32 P.	14×·34 P.
12′	3 ×3 ×·40	11×·50 "	12×·50 "	12×·32 "	14×·34 "	17×·36 "
14′	3 ×3 ×·42	12×·50 "	12×·32 P	14×·34 "	17×·36 "	20×·38 "
16′	3½×3 ×·42	12×·32 P.	14×·34 "	16×·36 "	19×·38 "	22×·38 "
18′	4 ×3 ×·44	14×·34 "	16×·36 "	18×·36 "	21×·38 "	25×·40 "
20′	4 ×3 ×·44	15×·34 "	18×·36 "	20×·38 "	24×·40 "	28×·42 "
22′	4½×3 ×·46	16×·36 "	19×·36 "	22×·38 "	26×·42 "	30×·44 "
24′	5 ×3½×·46	17×·36 "	20×·38 "	23×·40 "	28×·42 "	32×·44 "
26′	5½×3½×·48	18×·36 "	21×·38 "	24×·40 "	29×·42 "	34×·46 "
28′	6 ×3½×·50	19×·38 "	22×·38 "	25×·40 "	31×·44 "	36×·48 "
30′	6 ×3½×·52	20×·38 "	23×·40 "	26×·42 "	32×·44 "	38×·48 "

Length of Fore and After	Angle Mountings	BULB PLATE CENTER FORE AND AFTERS — Spacing Center to Center			BULB ANGLE SIDE FORE AND AFTERS — Spacing Center to Center		
		3′ 0″	4′ 0″	5′ 0″	3′ 0″	4′ 0″	5′ 0″
6′	2½×2½×·36	6×·36	6½×·38	7×·38	6×3 ×·36	6½×3½×·38	7×3½×·38
8′	2½×2½×·38	7×·42	8 ×·44	9×·44	7×3½×·42	8 ×3 ×·44	9×3½×·44
10′	2½×2½×·40	8×·50	9½×·50	11×·50	8×3½×·50	9½×3½×·50	11×3½×·50

Length of Fore and After	WOOD CENTER FORE AND AFTERS — Spacing Center to Center						WOOD SIDE FORE AND AFTERS — Spacing Center to Center					
	3′ 0″		4′ 0″		5′ 0″		3′ 0″		4′ 0″		5′ 0″	
	D.	B.	D.	B.	D.	B.	D.	B.	D.	B.	D.	B.
6′	5½	7	6	7	6½	7	5½	5½	6	6	6½	6
8′	6½	7	7½	7	8	7	6½	6½	7½	7	8	7
10′	8	7	8½	8	9	9	8	7	8½	8	9	9

Sizes are given in inches. Sizes for intermediate lengths and spacing may be obtained by interpolation.
B.P. = Bulb Plate. P = Plate. D = Depth. B = Breadth.
Depths for hatch beams are at middle of length and measured from top mounting to lower edge. Depths for fore and afters are measured from under side of hatch covers to lower edge.
Where plates are specified, two angles of the size given for mountings are to be fitted at the upper and lower part of the beam respectively.
Where bulb plates are specified, two angles of the size given for mountings are to be fitted at the upper part of the beam or fore and after.
Where bulb angles are specified, one angle of the size given for mountings is to be fitted at the upper part of the section.

TABLE B

Breadth of Hatchway	Angle Mountings	BEAMS WITHOUT FORE AND AFTERS — Spacing Center to Center		BEAMS WITH FORE AND AFTERS — Spacing Center to Center		
		4′ 0″	5′ 0″	6′ 0″	8′ 0″	10′ 0″
10′	3 ×3 ×·40	8 ×·40 B.P.	9 ×·44 B.P.	9½×·46 B.P.	10½×·50 B P.	11½×·52 B.P.
12′	3 ×3 ×·40	9 ×·44 "	10 ×·50 "	11 ×·50 "	11 ×·30 P	13 ×·34 P.
14′	3 ×3 ×·42	10 ×·50 "	11½×·50 "	11 ×·30 P.	13 ×·32 "	15 ×·34 "
16′	3½×3 ×·42	11 ×·30 P.	11 ×·30 P.	12 ×·32 "	15 ×·34 "	17 ×·36 "
18′	4 ×3 ×·44	11 ×·30 "	12 ×·32 "	14 ×·34 "	17 ×·36 "	19 ×·38 "
20′	4 ×3 ×·44	12 ×·32 "	13 ×·34 "	16 ×·36 "	19 ×·38 "	21 ×·38 "
22′	4½×3 ×·46	12½×·32 "	14 ×·34 "	17 ×·36 "	20 ×·38 "	23 ×·40 "
24′	5 ×3½×·46	13 ×·34 "	14½×·34 "	18 ×·36 "	21 ×·38 "	25 ×·40 "
26′	5½×3½×·48	13½×·34 "	15 ×·34 "	19 ×·38 "	22 ×·38 "	26 ×·42 "
28′	6 ×3½×·50	14 ×·34 "	16 ×·36 "	20 ×·38 "	23 ×·40 "	27 ×·42 "
30′	6 ×3½×·52	15 ×·34 "	17 ×·26 "	21 ×·38 "	24 ×·40 "	28 ×·42 "

Length of Fore and After	Angle Mountings	BULB PLATE CENTER FORE AND AFTERS — Spacing Center to Center			BULB ANGLE SIDE FORE AND AFTERS — Spacing Center to Center		
		3′ 0″	4′ 0″	5′ 0″	3′ 0″	4′ 0″	5′ 0″
6′	2½×2½×·36	5×·34	5½×·34	6 ×·36	5×3×·34	5½×3 ×·34	6 ×3 ×·36
8′	2½×2½×·38	6×·38	7 ×·40	7½×·42	6×3×·38	7 ×3 ×·40	7½×3½×·42
10′	2½×2½×·40	7×·44	8 ×·46	9 ×·50	7×3×·44	8 ×3½×·46	9 ×3½×·50

Length of Fore and After	WOOD CENTER FORE AND AFTERS — Spacing Center to Center						WOOD SIDE FORE AND AFTERS — Spacing Center to Center					
	3′ 0″		4′ 0″		5′ 0″		3′ 0″		4′ 0″		5′ 0″	
	D.	B.	D.	B.	D.	B.	D.	B.	D.	B.	D.	B.
6′	5	7	5½	7	6	7	5	5	5½	5	6	5
8′	6	7	6½	7	7	7	6	5	6½	6	7	6
10′	7	7	7½	7	8	7	7	6	7½	7	8	7

Sizes are given in inches. Sizes for intermediate lengths and spacing may be obtained by interpolation.
B.P. = Bulb Plate. P = Plate. D = Depth. B = Breadth.
Depths for hatch beams are at middle of length and measured from top mounting to lower edge. Depths for fore and afters are measured from under side of hatch covers to lower edge.
Where plates are specified, two angles of the size given for mountings are to be fitted at the upper and lower part of the beam respectively.
Where bulb plates are specified, two angles of the size given for mountings are to be fitted at the upper part of the beam or fore and after.
Where bulb angles are specified, one angle of the size given for mountings is to be fitted at the upper part of the section.

board Deck, where protected by erections which are not fully enclosed, are to have coamings at least 9 inches in height and are to have covers, beams, and arrangements for battening down as effective as those required for cargo hatchways which may have 18-inch coamings under par. 2. Flush bunker scuttles of the bayonet type may be fitted in spaces which are always accessible.

Cargo openings in decks below the Freeboard Deck or within fully enclosed superstructures are to be framed with carlings and beams of sufficient strength; hatch beams and fore and afters may be of the sizes given in Table A where the height of 'tween decks does not exceed 8 feet; where the 'tween deck height is greater, the sizes are to be suitably increased.

Mast Openings on weather and wedging decks are to have coamings formed of bulb plate and angle, or a bulb angle riveted to mast partners or plating; the height of the coamings is to be one-third the diameter of the mast or 9 inches whichever is the less. In all cases where beams are cut, efficient carlings are to be fitted.

Engine and Boiler Openings in the Freeboard Deck are to be protected by superstructures and enclosed by efficient steel or iron trunk casings, extending to at least 6 feet above the superstructure deck. The plating is to be from .20″ to .38″ thick, efficiently stiffened with angles or tee bars about 24 inches apart with .20″ plating, gradually increasing to about 48 inches pitch with .38″ plating; the stiffeners are to be fitted in line with the beams, and are to be of the sizes given in the Bureau's bulkhead tables.

Coamings at least .44″ thick and 15 inches high, are to be fitted round casings on the exposed or weather portions of superstructure decks and within superstructures which are not fully enclosed. Doors in such exposed casings are to be of iron or steel, capable of being closed and fastened from either side of the casing, and the door sills are to be at least 15 inches above the deck. The upper part of casings is to be efficiently tied by beams and plating, and the base of the casings is to be efficiently supported by stanchions, etc. In small Vessels and in special cases the above requirements may be modified on submission of detailed plans. Where it is impossible to protect machinery casings by superstructures or houses on the Freeboard Deck, the proposed arrangements are to be specially submitted, and are to provide ample strength and protection to the openings. Machinery openings in all decks are to be kept as small as practicable; as many plated through beams as possible are to be fitted at each deck. Strong steel casings are to be fitted round all deck openings in way of coal, cargo, and passenger spaces. Special care is to be taken to adapt the arrangements of casings, through beams, and pillars in the machinery space to the necessity for providing sufficient rigidity to the hull structure.

Engine room skylights are to be of substantial make of wood, iron or steel and properly secured; all fidley gratings and other openings on top of casings, are to have efficient covers, and hatchways are to have satisfactory battening arrangements.

Permanent Companion Ways in exposed positions on weather decks are to be covered by strong steel hoods, riveted to tie plates or deck plating.

Hatch or Hatchway. An opening in a deck through which cargo may be handled, machinery or boilers installed or removed, and access obtained to the decks and holds below.

Page 817.

Hatch, After. A term applied to the deck openings aft of the midship portion of a vessel.

Hatch Bar. A term applied to flat bars used for securing and locking hatch covers.

Hatch Battens. A term applied to the flat bars used to fasten and make tight the edges of the tarpaulins that are placed over hatches. The batten and edge of the tarpaulin are wedged tightly in closely spaced cleats.

Hatch Beams. A term applied to the portable beams fitted to the coamings for the purpose of supporting the hatch covers. The ends of these beams receive hard usage in shipping and unshipping and should be reinforced at these points by doubling strips.

Pages 379, 412, 418, 422, 559, 560, 561.

Hatch, Boiler. A hatch fitted over the boiler room through which the smoke stack passes. Iron grating is usually fitted around the stack for ventilation but steel covers that can be closed in heavy weather should also be fitted. This hatch should be made large enough to provide for the installation or removal of the boilers.

Hatch, Booby. An access hatch leading from a weather deck to the quarters. A small companion readily removable in one piece. A wooden hood-like covering, for a hatch, fitted with a sliding top.

Hatch, Cargo. A term applied to the deck openings leading to the cargo holds.

Pages 559, 560, 561, 562, 563.

Hatch Carlings. Fore and aft girders running under the coamings at the sides of hatches to which the partial or half deck beams are attached.

Hatch Carrier. A term applied to the supports attached to the hatch coamings which take the ends of fore and afters and cross beams.

Pages 379, 412, 418, 422, 559, 560, 561.

Hatch, Ceiling. An opening in the hold ceiling fitted with a cover that can be removed when the cargo is taken out. The object of these hatches is to provide access to the sides and bottom for cleaning and repairs.

Hatch Cleats. A term applied to the clips attached to the outside of the hatch coamings for the purpose of holding the hatch battens and edges of the tarpaulin covers.

Hatch, Coaling. An opening in the deck provided for the purpose of filling the coal bunkers. A trunk or casing is fitted from the upper opening to the top of the coal bunker.

Page 558.

Hatch Coaming. See Coaming, Hatch.

Hatch Covers. Covers for closing up the top of hatchways, usually made of wood planks and in sections that can be handled by the crew. When made of wood one or more tarpaulins are stretched over them to keep out the rain and sea.

Watertight covers made of steel plates are also in use, but they are more or less in the way when the cargo is being handled.

Hatch, Crank. A term applied to the hatch over the engines in a paddle wheel steamer.

Hatch End Beam. A term applied to the deck beam at the fore or after end of a hatchway. Where the hatchway does not stop at a deck beam an end beam may be fitted under the coaming or the coaming may be produced down to form an end beam.

Hatch, Engine. A hatch fitted over the engine room. It is usually provided with a skylight having hinged covers that can be operated from below. The hatch should be made large enough to provide for the installation or removal of the engine.

Hatch, Expansion. A term applied to hatches with high coamings fitted on oil tankers for the purpose of allowing space for expansion of the oil.

Hatch, Fore. A term applied to the deck openings forward of the midship portion of a vessel.

Hatch, Grated. A term applied where the top of the hatch is fitted with a wood or steel grating.

Hatch Gratings. See GRATINGS, HATCH.

Hatch, Main. A term applied to one of the principal cargo hatches.

Hatch Rests. A term applied to the shelf fitted at the top of coamings for the purpose of supporting the edges of the hatch covers.

Pages 418, 558, 559, 560, 561.

Hatch Strong Back. A portable beam fitted in a hatchway for the purpose of lifting heavy weights as a beam fitted over the engine in the engine hatch for lifting cylinder covers, etc. The portable hatch beams fitted to the coamings to provide supports for the hatch covers are sometimes called strongbacks.

Hatch, Upper, Main, Lower, etc., Deck. An opening for access or cargo handling in any deck is usually given the name of the deck on which it is situated as Upper Deck Hatch.

Hatch, Watertight. A term applied where the hatch is fitted with a steel watertight cover. The bearing edges of the cover are fitted with strips of rubber which are compressed down on to the coaming by dogs.

Pages 558, 559.

Hatch, Wood. A term applied where the side framing of the hatch is made of wood.

Hatchway Gratings. See GRATINGS.

Hatchway Trunk. A term applied where the space between a lower and the hatch or hatches above it are enclosed by a casing.

Hawse Bag. See JACKASS.

Hawse Pipes. Tubes leading the anchor chain from the deck on which the windlass is located down and forward through the vessel's bow plating.

Hawse pipes are generally of cast iron or cast steel. They are of heavy scantling and sometimes made in two or more parts to facilitate construction. At the upper and lower ends they terminate in bolsters of sufficient radius to prevent the nipping or undue abrasive action of the chain.

The American Bureau of Shipping specifies that Hawse Pipes are to be of ample size and strength; they are to have full round flanges and the easiest possible lead, in order to minimize the nip on the cables; they are to be secured to thick or double plating by rivets spaced not more than 7 diameters; when in position they are to be thoroughly tested for watertightness by means of a hose, in which the water pressure should not be less than 30 lbs. per square inch. Hawse pipes for stockless anchors are to provide ample clearances; the anchors are to be shipped and unshipped so that the Surveyor may be satisfied that there is no risk of the anchor jamming in the hawse pipe.

Page 529.

Hawse Timbers. A term applied to the vertical frame timbers in the bow of a wood ship in the way of a hawse hole or pipe.

Hawser. A large rope, either fibre or wire, used for warping, towing, mooring, etc.

Hawser, Port. See PORT HAWSER.

Hawser Reel. A heavy reel for the stowage of hawsers when not in use. In its simplest form it consists of a cylindrical body on which the hawser is wound. At each end a disc shaped guard is fitted to keep the hawser in place. Hawser reels are sometimes mounted on frames and fitted with friction brakes with which to control the paying out of the rope.

Hawser Rope. See ROPE, HAWSER.

Head of the Bowsprit. The forward end.

Head of Keel. See FOREFOOT.

Head of a Ship. The fore end formerly fitted up for the accommodation of the crew. A vessel is trimmed by the head when drawing more water forward and less aft than contemplated in her design.

Head-Board. A piece of timber connecting the end of the bob-stay with the top of the stem.

Head Sails. The sails forward of the foremast. These are triangular fore and aft sails termed in general jibs and stay sails.

Heads. The upper portions of wood frames. Also used to designate seamen's toilets.

Header. A box or pipe, usually of rectangular cross section and having either a straight or sinuous form, into which the ends of the tubes in water tube boilers are expanded. A pipe or casting into which several smaller pipes are lead.

Also the top piece of a door frame or window frame.

Header, Window Frame. The horizontal piece at the top.

Headledge. A term applied to the forward or after end coaming of a hatch. This term is more frequently used in connection with wood coamings.

Heat Insulation. See INSULATION, HEAT.

Heater, Boiler Feed Water. See BOILER FEED WATER HEATER.

Heater, Fuel Oil. See FUEL OIL HEATER.

Heater, Rivet. See RIVET HEATER.

Heating System. A system of piping and radiators or pipe coils designed for heating the enclosed spaces and quarters of a vessel during cold weather. Steam is usually used to supply the warmth but hot water installations have been made in special cases.

Pages 612, 613.

Heater or Heater Boy. A boy who operates forges to heat rivets for the riveters.

Heating Surface, Boiler. See BOILER HEATING SURFACE.

Heating Tongs. Long handled tongs used by rivet heaters to place rivets in the forge and withdraw them when heated for driving.

Heave. To haul; to cast or hurl; as, to heave the lead, to heave a line. The alternate rising and falling of a vessel in a seaway.

Heave-handsomely. A command to proceed slowly and carefully when pulling in the anchor chain.

Heave-round. A term used on shipboard as a command to start pulling in the anchor chain.

Heaver. A wood bar used as a lever; a sailmakers' tool consisting of a fluted tapering metal pin fitted with a handle at right angles to the pin similarly to an auger.

Heave-To. To bring a sailing ship into such a position that the wind produces no headway.

To stop the engines of a ship and lie without headway.

Heaving Line. A small line bent to a hawser, the loose end thrown ashore and caught for the purpose of hauling one end of the hawser to the wharf for making fast.

Heaving the Lead. Taking soundings with a lead and line.

Heavy Duty Drill. See Drilling Machine.

Heavy Oil Engines. See Engine, Diesel and Hot Bulb.

Heel. The inclination of a ship to one side, caused by wind or wave action.

Heel Knee. A bar bent to a right angle or V-shape for the purpose of securely connecting the bottom of the stern post to the keel.

Heel of a Keel. The extreme after end of the keel.

Heel Piece. A bar about three feet long serving as a connecting piece for the ends of frames, whose ends butt together. The flange of the heel bar is reversed from those of the frames it connects.

Heeling. Hauling a vessel over on her side for cleaning and painting; careening; causing a vessel to list to one side by shifting weights on board for the purpose of ascertaining her center of gravity.

Helm. A term applied to the tiller, wheel or steering gear, and also to the rudder. It indicates the control of the maneuvering or steering gear as in the term "Port the helm," and again the position of the rudder in the expression "Lee helm."

Helm Port. A term applied to the hole in the counter of a vessel through which the rudder stock passes.

Helpers. Men who assist skilled workmen in any trade. In most trades they are merely assistants performing the heavier work requiring no particular skill and continue as such, but in some trades they are expected to learn the trade.

Helve Hammer. See Hammer, Power Forging.

Hemp Rope. See Rope, Hemp.

High Speed Steel. See Steel and Iron.

Hinge. A fitting used to join doors, covers or parts to partitions or other parts and so constructed that the door or movable part is free to swing or turn on the fitting. Also called butts.

Hitch. A term applied to a variety of methods of bending a line to a post, spar, or ring so that it may be readily detached.

Hogged. Permanently deformed by the action of hogging forces.

Hogging. A distortion of a vessel's form in which the bow and stern drop below their normal position relative to the midship portion of the vessel. Structural weakness, grounding, or improper loading may result in this condition.

Hoist. To raise or elevate by man power or by the employment of mechanical appliances such as cranes, derricks, shear legs, tackles, differential blocks, etc.; any device employed for lifting weights.

Hoist, Electric. Any type of device in which the power for raising weights is furnished by an electric motor.

Hoist, Marine Railway. A winch or windlass located at the head of the tracks for taking in or letting go the rope or chain used for raising or submerging the cradle.

Hoist, Steam. Any type of device in which the power for raising weights is furnished by a steam engine.

Hoisting Crew. Men who have the care of getting on board ship and securing in their proper places any heavy weights requiring the use of shear legs, cranes or other hoisting or moving gear.

Hoisting Engine. A term applied to a winch or any power machine used in hoisting cargo, sails, ashes, etc.

Hold Beam. See Beam, Hold.

Hold Beam Stringer. See Stringer, Hold Beam.

Hold Bunker. A bunker or that part of a bunker below the lower deck. That part of the hold space which may be at times used for stowage of coal for ship's use.

Hold Pillar. See Pillar, Hold.

Hold Stringer. See Stringer, Hold.

Holder-On. See Air Holding On Hammer.

Holders-On, or Backers-Up. Workmen who place the rivets in the holes and press against the heads a heavy hammer or dolly-bar while the riveters are hammering up the points.

Holding Ground. An anchorage where an anchor will bite into the bottom so as to prevent it from dragging.

Holds. Spaces or compartments between the lowermost decks and the bottom of the ship, or top of the inner bottom if one is fitted. The spaces below decks allotted for the stowage of cargo.

Holes, Drain. Holes in bulkheads, floors or other obstructions to provide clear flow of liquid to the pump suctions.

Holidays. Portions of a ship's surface which through inadvertence have been missed in the application of paint or other protective coating.

Hollow Ended. When the extremities of the waterlines in the neighborhood of the designed load line are concave to the surrounding water, and when the sectional area curve at the ends is fine indicating relatively small displacement in these locations.

Hollow Keel. See Keel, Hollow.

Hollows of Resistance. See Resistance, Hollows of.

Holystone. A soft sandstone used in scrubbing wood decks. The origin of the name is probably due to the kneeling posture of the men while using the stone, or else to the fact that they were formerly most frequently used on Sunday; to clean a deck by the application of a holy-stone.

Home. Close up; snugly in place.

The port from which a vessel hails.

Hood. A shelter over a companionway, scuttle, etc. It is generally built of canvas spread over an iron frame. It may also be constructed of light metal plating.

Page 558.

Hood Stick. An arrangement designed for holding a drilling machine to be used in light drilling.

Hoods. A term applied to those plates placed at the extreme forward or after end of a ship.

Hook, Breast. A triangular shaped plate fitted between decks or deck stringers in the bow for the purpose of rigidly fastening the stem and fore-hoods of outside plating and the ends of side stringers firmly together. In wood ships a piece of iron bent in a V shape and fitted horizontally in the bow between decks to hold the bow planking in place.

Page 501.

The American Bureau of Shipping requires that Breast Hooks are to be fitted at the ends of all stringers and between stringers where required; they are to be fitted over hawse pipes and the structure

thoroughly stiffened and tied in this neighborhood to the satisfaction of the Surveyors.

Hook, Deck. A triangular plate fitted at the extreme ends of decks or deck stringers to hold the ends of the decks, the fore-hood plating and stem rigidly together. In wood ships a steamed timber or knee piece fitted at the extreme ends of the decks for the purpose of binding the bow timbers together.

Hook, Fore, See HOOK, DECK AND BREAST.

Hook, Pelican. See PELICAN HOOK.

Hookers On. Men who place the necessary slings on material to be transported by a crane and assist the crane operator as to the proper disposition of the material.

Hooks. Triangular pieces of plate fitted in the extreme ends of vessels for the purpose of tying the ends of stringers and keeping the outside plating in place.

Horizontal Acetylene Compressor. A horizontal acting pump for charging tanks with acetylene gas under pressure.

Horizontal Punch. See PUNCH, HORIZONTAL.

Horn, Timber. See TIMBER, HORN.

Horning. Setting the frames of a vessel square to the keel after the proper inclination to the vertical due to the declivity of the keel has been given.

Horsepower. The unit of power is a "horse-power," which is taken as "33,000 ft. lbs. of work performed in one minute" or its equivalent.

Horsepower, Boiler. See BOILER HORSEPOWER.

Horsepower, Effective. The actual power available for propulsion which is equivalent to the indicated or shaft horsepower less all losses due to friction of machinery, line shafting, stern bearings, etc.

Pages 202, 203, 205, 206 to 226.

Horsepower, Indicated. A term applied to the horsepower actually developed in the cylinder or cylinders of an engine. The result of the following formula gives the I.H.P. for one cylinder. Where there are two or more cylinders the sum of the results obtained by applying the formula to each cylinder gives the I.H.P.

$$\text{I.H.P.} = \frac{\text{PLAN}}{33{,}000}$$

P = mean effective pressure acting on the piston in pounds per square inch. This may be obtained from an indicator card taken while the engine is running or from a theoretical card plotted from calculations.

L = length of stroke in feet.

A = area of the piston in square inches.

N = number of strokes per minute.

Where refinement is desired the formula should be independently applied to each side of the piston, making allowance on one side for the area of the piston rod.

Horsepower, Shaft or Brake. A term applied to the power of turbines where it is not possible to use an indicator. It is measured from the shaft by an instrument called a torsion meter, and corresponds to brake horsepower.

Horseshoe Plate. A small light plate fitted on the counter around the rudder stock for the purpose of preventing water from backing up into the rudder trunk. When fitted in one piece it has the shape of a horseshoe, but it is frequently made in two pieces to completely surround the stock and at the same time permit its removal.

Horsing. A term applied to the operation of driving oakum into the seams between planks.

Horsing Iron. A wide chisel-shaped tool with a wedge-shaped edge fitted with a long handle. It is placed in a seam which has been calked with oakum and struck with a heavy mallet to drive the oakum down so another thread can be driven or the seam payed with pitch or marine glue.

Hose. A term applied to more or less flexible tubing used to convey water, oil, compressed air, etc.

Hose Couplings. Fittings made in various forms for connecting lengths of hose together.

Hose Nozzles. A tapered pipe having a screw thread cut on the large end for attachment to the end of a hose line.

Hot Bulb Engine. See ENGINE, HOT BULB.

Hot Well. A receptacle for the water condensed from steam.

Hot Press Nut Machine. See NUT MACHINE, HOT PRESS.

Hound Band. A term applied to a band fitted around the upper portion of a mast to provide attachment for the shrouds.

Page 345.

Hound, Mast. See MAST HOUND.

Houseline. A tarred hemp, three-stranded, left-handed, small rope, somewhat larger than marline. It is used for both seizing and service.

Page 825.

Housing. A term applied to an inclosure partially or wholly worked around fittings or equipment. Applied to masts it is that portion below the weather deck and to topmasts, that portion overlapping the mast below.

Hulk. The body of an old, wrecked, or dismantled vessel unfit for sea service, but sometimes used for other purposes, as a coal depot, prison, etc.

Hull. The framework of a vessel, together with all decks, deck houses, the inside and outside plating or planking, but exclusive of masts, yards, rigging and all outfit or equipment.

Humps. Portions of curves of resistance or power where, due to disadvantageous wave formation, the residuary resistance is increased relative to that of the adjacent portions of the curves.

Humps are of relatively little importance until speed length ratios of 1.00 are exceeded.

Admiral Taylor, in "Speed and Power of Ships," page 79, writes:

"It might seem at first sight very important to adopt such length for a desired speed as to be sure of landing in a hollow rather than on a hump, but, though this point should always be considered, in comparatively few cases is it a matter of serious practical importance. In most cases it is desirable to adopt proportions and form such that the humps and hollows up to the speed attained are not prominent, so there is no material saving to be had by landing in a hollow rather than on a hump."

Hurricane or Promenade Deck. See DECK, HURRICANE OR PROMENADE.

Hydrant. An outlet in a pipe line suitable for a hose attachment.

Hydraulic Accumulator. See ACCUMULATOR, HYDRAULIC.

Hydraulic Flanging Machine. See FLANGING MACHINE, HYDRAULIC.

Hydraulic Pressure Pump. See PUMP, HYDRAULIC PRESSURE.

Hydraulic Jack. See JACK, HYDRAULIC.

Hydraulic Riveting. See RIVETING, HYDRAULIC.

Hydrokineter. A device installed near the bottom of a boiler to provide forced circulation of the water when raising steam.

Hydrometer. An instrument for determining the density of the water in a boiler.

Hydrostatic Pressure. See PRESSURE, HYDROSTATIC.

I

I-Beam. A rolled shape, generally of mild steel, having a cross section shaped like the letter I.

In ship work it is used for bulkhead stiffeners, girders, etc.

The size is denoted by dimensions of cross section and weight per running foot.

Ice Lining. A term applied to doubling plates fitted on the bow of vessels at the waterline for the purpose of protection against ice.

Ignition. See GAS ENGINE IGNITION.

Ignition Wires. See ELECTRIC WIRE AND CABLE.

Impedance. The apparent resistance in ohms of an alternating current circuit, i. e., it is that quantity which, when multiplied with the total current in amperes, will give the impressed e. m. f. in volts. It is a term applied to alternating current circuits and is due to resistance and inductance, to capacity and resistance or to all three.

Impulse Reaction, Turbine. See TURBINE, IMPULSE REACTION.

Impulse Turbine. See TURBINE MULTIPLE STAGE, IMPULSE; TURBINE SINGLE STAGE, IMPULSE.

In and Out System. See PLATING, IN AND OUT SYSTEM.

Inboard. Towards the center; within the vessel's shell and below the weather decks.

Inboard Profile. A plan representing a longitudinal section through the center of the vessel, showing heights of decks, locations of transverse bulkheads, assignment of various spaces and all machinery, fittings, etc., located on the center or between the center and shell on the port side.

Pages 370 to 468.

Incandescent Lamp. See LAMP, INCANDESCENT.

Inclining Weights. Known weights placed on board a vessel for use in obtaining a slight list when performing an inclining experiment.

Increaser. See REDUCER.

Independent Piece. A timber bolted to the forward part of the stem above the water line.

Indian Red. See PAINT.

Indicated Horsepower. See HORSEPOWER, INDICATED.

Indicator. An instrument designed to measure and record the variation in the cylinder pressure of steam engines, pumps, etc., throughout the entire length of stroke.

Indicator Card. A diagram showing the variation in pressure in steam cylinders or pumps throughout the entire stroke. This diagram is made upon cards or paper by the indicator pencil.

Indicator Cock. A cock located in the indicator pipe line for the purpose of controlling the supply of steam to the indicator.

Indicator, Direction and Revolution. A device fitted on the bridge and designed to show immediately the actual engine movement, direction, and speed so as to minimize the serious results possible from a misunderstanding of orders.

Pages 1005, 1081, 1083, 1086. Plate LXI.

Indicator Pipe. A small pipe connection with the ends of a steam cylinder fitted for the purpose of supplying steam to an indicator.

Inductance. The property of an electric circuit, which results in an electro-motive force being induced in it due to a change in the valve of the current it is carrying, is called its self-inductance, and the process is called self-induction.

When two conductors or circuits are so related that a change of current in one results in an electromotive force being induced in the other, they are said to have a mutual inductance and the process is called mutual induction.

Induction Coil. An electrical device consisting of a primary and secondary coil on a soft iron core. The most common form of induction coil consists of a primary coil of a few turns of coarse wire wound on the core and connected to a voltaic cell through a vibrator and a secondary coil of a large number of turns of fine wire wound upon the primary coil and carefully insulated from it.

Induction Fan. See BLOWER.

Inertia, Moment of. See MOMENT OF INERTIA.

Initial Condition. The datum condition from which the variations characteristic of any other condition are measured, or with which they are compared.

Initial Stability. The stability of a vessel in the upright position or at small angles of inclination. It is usually expressed by the metacentric height.

Page 230.

Injection Pump. See PUMP INJECTION.

Injector. An apparatus or fitting designed to force feed water into a boiler against the ordinary boiler pressure. The injector does not take the place of the boiler feed pump but is additional thereto.

In principle the injector is an instrument for the mixture of live steam at high velocity with a stream of cold water. This results in the condensation of the steam and the imparting of great velocity to the water. The pressure thus built up is sufficient to open the check valve and force water into the boiler by overcoming the boiler pressure.

As constructed in practice, the injector has almost perfect efficiency as a boiler feeder. The only heat loss involved being due to radiation from the injector itself and its connections.

Many varieties of injectors are in use but all are based on the above principles.

Pages 656, 657, 658, 659, 996.

Inner Bottom. A term applied to the inner skin or tank top plating. The plating over the double bottom.

Inner Bottom Plate. A term applied to any of the plates in the tank top.

Inner Bottom Plating. See TANK TOP PLATING.

Inner Keel. See KEEL, INNER.

Inner Post. A reinforcing timber bolted to the forward side of the stern post.

Inner Skin. See SKIN, INNER.

Inner Stern Post. See STERN POST, FALSE OR INNER.

Inside Strake. See STRAKE, INSIDE.

Inspectors. Men who examine and test the structure or machinery in order to ascertain if it meets the contract requirements.

Insulation, Electric. A poor conductor of electricity, i. e., rubber, fibre, mica, marble, slate, etc.

Insulation, Heat and Cold. Several considerations enter into the proper insulation of pipes and boilers for sea service, which are not always considered of

equal importance for installation ashore. The subject naturally divides itself into two heads: covering for the high pressure main and auxiliary steam pipes and boilers, and covering for plumbing, service pipes, etc.

In selecting the former class of covering, we have not only to consider the relative heat saving efficiency of the material, but also its weight per foot and its ability to resist hard usage, constant vibration, the pounding of heavy seas, steam and water leakage and even possible submersion.

The effect of a properly efficient pipe and boiler insulation is first to save coal or other fuels. By doing so it not only saves the labor of the firing squad but also materially increases the cruising radius of the ship and permits the use of smaller bunkers. A second but equally important result is to secure an ample supply of hot, dry steam to the engine at all times. Every engineer knows the discomfort, loss of time, and the potential danger of a water logged steam supply, especially in the turbine engine room. In order to secure the greatest possible amount of energy per pound of fuel, the insulating material must have the highest efficiency.

The most important characteristic of a good insulation is its capacity to resist the factors of heat. Time has definitely established the fact that "dead air" is a non-conductor of heat and, therefore, the more dead air that is held enmeshed in a sector of the insulation, the greater is its heat saving value. Magnesia and sileceous minerals are the best non-conductors of heat, as these materials are made up of millions of microscopic air cells, each of which forms a "dead end" from which heat can not escape. In case of flooding of the engine room by stranding, collision or other accidents, an insulation is desirable that will withstand prolonged immersion without being destroyed.

For boilers and main steam headers, the covering is usually applied in flat blocks or slightly curved segments, but for all pipes up to ten inches in diameter it is generally supplied in sectional form, each section consisting of two halves for easy application, the internal diameters of which are equal to the size of the pipe it is to cover. For exposed deck pipes to steam winches, windlasses, capstans, etc., it is customary to add another covering of waterproofing or other material which is cemented at the laps and wound with heavy wire. A casing is also added wherever needed to protect the insulation from injury. For heating systems, the usual course is to apply one of the asbestos coverings which are made in sections similar to those explained above.

In covering the cold water piping, hair felt has proved itself an economical protection against salt water, sweating, the heat of the weather, or the internal heat of the ship itself. In other words, it helps to keep cold in by keeping heat out. A familiar instance of this is where ice water is piped to the various points of a ship for drinking. On the other hand, this material is an efficient protection against the zero temperatures of our North Atlantic winters, and for that reason is largely used as a protection against freezing. Sweating of cold pipes is another unpleasant eventuality which can only be controlled by proper covering. It is caused by a condensation of the warm, always humid sea air on the colder surface of the pipes. Hair felt is also largely used for refrigeration pipes where it is usually applied in layers or plies, each about one inch thick, and varying in number according to the service demanded. The outside is usually given a double covering of roofing as a protection against dampness.

Another material which also has considerable value for the protection of refrigeration pipes is cork, finely ground and molded into sections to fit the pipe. This material, however, is not so well fitted for marine work on account of its tendency to disintegrate under the combined influence of moisture and continued vibrations.

Pages 684, 685, 822, 984, 985, 986, 987.

Insulator, Electric. A support for electric wires or cables made of good insulating material.

Pages 1078, 1079.

Intercommunicating Telephone. A telephone set used as one station in an intercommunicating telephone system. See Intercommunicating Telephone System.

Pages 1065, 1087.

Intercommunicating Telephone System. Two or more telephone sets so arranged as to enable the calling party to signal the party desired and to complete the talking circuit between the calling party's phone and any phone in the intercommunicating system by pushing a "Push Button" and without the assistance of a switchboard operator or any mechanical or electrical switching mechanism.

Intercostal. Occurring between ribs, frames, etc. The term is broadly applied, where two members of a ship intersects, to the one that is cut.

A girder composed of short members running between and attached to continuous members.

Intercostal Floor. See Floors, Intercostal.

Intercostal Girders. See Girders, Intercostal.

Intercostal, Keelson. See Keelson, Intercostal.

Intercostal Plates. See Plates, Intercostal.

Intercostal Stringer. See Stringer, Intercostal.

Interference. See Radio.

Interior Communication. Electrical, mechanical or voice tube systems installed aboard a vessel to provide means of communication between the important stations like the bridge, engine and boiler rooms, and also inter-communication between the officers' staterooms, etc.

Pages 1081, 1082, 1083.

Interior Communication Men. Workmen who install the apparatus which provides communication from one part of the ship to another, as hand and electrical signal devices and telephones.

Intermediate Beam. See Beam, Intermediate.

Intermediate Frame. See Frame, Intermediate.

Internal Combustion Engine. See Gas Engine; Engine Diesel; Engine, Hot Bulb.

Inter-Phone. See Intercommunicating Telephone.

Iridium. Described under Metals.

Iron. Described under Steel and Iron.

Iron Wire Rope. See Rope, Iron Wire.

Isherwood System. A system of ship's framing patented by Isherwood. This system contemplates closely-spaced, light longitudinal frames supported on widespread, transverse members of comparatively great strength.

Isochronous Oscillation. Swinging or rolling back and forth, each swing or oscillation occupying the same time as every other one.

J

Jack. A machine for raising or moving heavy weights. It commonly consists of one or more screws, turned by a lever or ratchet and working in a case, which rests upon the floor or ground.

A term having a variety of dissimilar meanings, as: a flag corresponding to the union of the national ensign; a popular name for a sailor; a term prefixed or compounded with other words in naming various fittings, as jackstay, jackrod, etc.

Pages 748, 769, 770, 771.

Jack, Hydraulic. A machine for raising or moving heavy weights in which the power is exerted by means of the pressure of some liquid acting against a piston or plunger.

Pages 748, 770.

Jack Rod. A term applied to a pipe or a rod to which the edges of awnings or weather cloths are secured.

Jack, Sand. A rectangular cast iron box filled with sand and having a side outlet near the bottom which can be closed with a plug. The box is filled with sand to about one inch from the top on which a block is placed as a support for keel blocks or cribbing. They are placed under the cribbing and keel blocks so that when a vessel is ready for launching it may be lowered on to the cradle by removing the side outlet plugs in the jacks allowing the sand to run out.

Jack, Screw. A device in which the screw is used to overcome great resistances, lift heavy weights, etc.

It consists of a cast cylindrical body, internally threaded, with a broad base worked at one end. A large screw turned by a bar or lever and carrying on its outer end a flat palm works into the threaded body.

Pages 748, 769, 770, 771.

Jackass. A conical shaped canvas bag stuffed with oakum and fitted with a lanyard at apex and base, used for closing the hawse pipes around the chains to prevent shipping water through the pipes; also called a hawse bag.

Jackstaff. A term applied to a flag pole erected in the bow of a vessel.

Jackstay. A rope, rod or pipe rove through eyebolts fitted on a yard or mast for the purpose of attaching sails to the yard or mast. The term is also applied to the outer or boundary rope of a netting or awning.

Jacob's Ladder. A ladder having either wire or fiber rope sides with wood or metal rungs attached at regular intervals. One end is usually fitted with sister hooks or shackles for hooking on. Ladders having chain sides are meeting with popular favor at the present time. These ladders are very flexible and can easily be lowered over the side of a vessel or down into her hold.

Page 812.

Jaw, Boom or Gaff. The semi-circular end fitted to a boom or gaff for the purpose of making a loose attachment to the mast.

Jet Condenser. See CONDENSER, JET.

Jetsam. Goods or cargo thrown overboard from a vessel in order to lighten her when in danger of sinking.

Jewel Block. See BLOCK, JEWEL.

Jew's-Harp. The odd shaped shackle fitted directly to the shank of the old-fashioned anchor.

Jib. A triangular sail bent to a foremast stay.

Jib-Boom. A spar placed on top and projecting forward of the bowsprit for the purpose of holding the end of the outer jib.

Jib-Boom, Flying. A spar placed on top and projecting forward of the jib-boom for the purpose of holding the end of the flying jib.

Jib-Boom Stay. A stay running from the forward end of the jib-boom to the martingale.

Jib Crane. See CRANE, JIB.

Jig Saw. See SAW, JIG.

Jigger. A term usually applied to the after mast in a ship having four or more masts.

Jiggers. Light tackles generally rove as luffs used for miscellaneous work on deck. They are also termed watch tackles and in some cases handy-billy tackles.

Job Clerks. Men who keep account of the material and labor necessary to complete any job.

Job Orders. Numbers assigned to various jobs performed in a shipyard in order to keep account of the cost involved for the work done.

Page 279.

Joggled. A term applied where a frame or plate is offset in the way of a lapped joint. The object of the joggle is to dispense with the necessity of fitting a liner.

Joggled Frame. A frame in which offsets are worked in the way of the laps of the shell plating. By joggling or offsetting the frames at a lap both plates fit snug against the frame.

Joggling Machine. A machine in which two short power driven rolls are used for joggling, or crimping, or offsetting plates. The rolls are offset in such a way that a plate is joggled, or crimped by passing through the machine. These machines are generally operated by an electric motor.

Joggling Press, Hydraulic. See PRESS, HYDRAULIC JOGGLING.

Joiner Door. See DOOR, JOINER.

Joiner Plans. Arrangement plans of quarters and living spaces showing the location and arrangement of vessel's furniture, toilet articles, etc.

Page 592 to 596.

Joiners. Wood workers who make and set up all the wood work requiring considerable skill such as panels, doors, sashes, built in furniture, etc.

Joint, Butt. A term applied where a connection between two pieces of material is made by bringing their ends or edges together and by fastening the same by a strip or strap that overlaps both pieces. Holes for bolts or rivets are drilled or punched in the straps and pieces to be connected.

Butt connections can also be made by welding, both with and without straps.

Joint, Lapped. A term applied where a connection between two pieces of material is made by overlapping the end or edge of one over the end or edge of the other and by fastening the same by bolts, rivets or welding.

Joint, Strapped. See JOINT, BUTT.

Jointer. A type of wood planing machine used for planing the edges of lumber. The table and cutters are usually similar to a planer and a vertical fence is provided for use as a guide while dressing the edge of a plank or other piece of work.

Jolly Boat. A pulling boat of small size.

Journal. That portion of a shaft or other revolving member which transmits weight directly to and is in immediate contact with the bearing in which it turns.

Journeyman. Originally a workman who had completed his service as an apprentice. It was early practice to bind out apprentices for a term of years. Upon completion of apprenticeship, the workman was given a certificate testifying to his qualifications in his craft, and he could then journey where he would and ply his trade. Hence the name journeyman, meaning a workman skilled in his craft or trade.

Jump. To make a flush joint between two planks or plates of iron or other metal. To join by a butt weld in smith work.

Jury Mast. See MAST, JURY.

Jury Rudder. A term applied to any temporary or makeshift appliance that is used to steer a boat when the regular rudder is out of commission.

K

Kayak. A term applied to a canoe made out of seal skin. These crafts are used by the Eskimoes.

Keel. A center line strength member running fore and aft along the bottom of a ship and often referred to as the back bone. In wood ships, it is composed of as long pieces of timber as can be obtained, which are scarphed together at their ends. In steel vessels it is composed either of long bars scarphed at their ends or by flat plates connected together by butt straps.

Pages 476, 477.

Keel, Bar. A keel projecting below the bottom of a vessel consisting of an iron or steel bar. The garboard strakes of shell plating are flanged down and riveted to it. These bars are obtained in as long lengths as possible and their joints are scarphed. The proper size may be obtained from the rules of the Classification Societies.

According to the American Bureau of Shipping Rules, Bar Keels are to be of the sizes given in their table forged in long lengths from unmixed scrap iron or scrap steel scarphed or welded together, or they may be rolled from "Open Hearth" steel ingots. The length of keel scarphs is not to be less than three times the Table depth of keel bar; the scarphs are to be planed and calked; rivet holes in thin ends of scarphs and holes for tack rivets are to be drilled after the bars are fair on the blocks.

Pages 450, 451.

Keel, Bilge. A fin fitted on the bottom of a ship at the turn of the bilge to reduce rolling. It commonly consists of a plate running fore and aft and attached to the shell plating by angle bars.

It materially helps in steadying a ship and does not add much to the resistance to propulsion.

Keel Blocks. See BLOCKS, KEEL.

Keel Condenser. See CONDENSER, KEEL.

Keel, Docking. In dry docking, the weight of a ship is carried almost entirely on the keel and bilge blocks. The keel and keelson provide the means of distributing the pressure on the center line and docking keels composed of doubling strips of plate or built up girders are sometimes fitted on the bottom at a distance from the center line corresponding to the best position for the bilge blocks. The docking keels are fitted in a fore and aft direction, generally parallel or nearly so to the keel. In vessels having a flat bottom doubling strips of plate are used, but where there is a dead rise this keel is composed of plates and shapes built down so that its bottom is on the same level as the bottom of the keel. The number and length of these keels varies with the shape and size of the vessel.

Keel, False. An additional piece bolted on to the main keel and serving the purpose of a renewable rubbing strip or fender.

Keel, Flat Plate. A plate of extra thickness riveted to the bottom angles of the keelson. The flat plate keel has been substituted for the bar keel in most steel ships because it saves draft and is sufficient for docking purposes.

Grounding on a rocky or uneven bottom is a rare occurrence, and when this does happen a bar keel is usually not strong enough to prevent disaster. Where extra strength is required the flat plate keel consists of two plates riveted together and having their butts staggered.

Pages 370 to 466, 476, 477.

According to the American Bureau of Shipping Rules, Flat Plate Keels are to be of the sizes given in their table, fitted in association with center girders, attached to the keel plate by angles of the sizes given in the Table; the angles are to be double throughout the engine space and forward of the midship half length; they may be single elsewhere in Vessels under 380 feet length; in Vessels of 380 feet length and above they are to be double throughout the engine space, the midship half length and the forward quarter length; in Vessels 500 feet length and above they are to be double all fore and aft; they are to be double in each case where the center girder forms a watertight or oiltight division. Plate keels are recommended to be fitted as outside strakes and so arranged as to provide a perfectly flat surface for docking. The keel plates are to overlap the stem and stern frame for a sufficient distance to enable a proper connection to be made and are to overlap the plates on the heel of stern frame and stem for at least one fram space; the heel plates are to be of the same thickness as the keel plate at ends.

Keel, Hollow. A hollow box-shaped keel made up of plates and shapes. On a submarine this type of keel makes a good grounding rest.

Keel, Inner. The inner plate of a double flat plate keel.

Keel, Lower. A piece of timber placed between the main and false keels on wood ships.

Keel, Outer. The outer plate of a double flat plate keel.

Keel Piece. That portion of the stern frame forward of the propeller post in single screw vessels and forward of the stern post in sailing and twin screw vessels. Its function is to make a rigid connection with the keel.

Keel-Plate. A plate used to connect the wood keel to the steel framing in a composite ship. Also applied to any single plate composing the keel.

Keel Rabbet. A groove on each side of the keel into which the edges of planking or plating are fitted.

Keel Rivet. See RIVET, KEEL.

Keel Rope. A rope used to clear the limber holes and inaccessible spaces in the bottom of a ship of waste matter.

Keel, Safety. A term applied where extra plates of thick plating are fitted over the garboard strake adjacent to the keel.

Keel, Side Bar. Either a bar on each side of which vertical plates are riveted or several vertical plates riveted together, the combined thickness equalling the required bar keel. The garboard strakes are flanged down and riveted to it.

Keelson. A term applied to the fore and aft girders in the bottom of a steel ship whether on the center lines, to one side or at the bilge. In wood ships the keelson consists of a strong timber running along the top of the transverse frames parallel to and directly above the keel. It is fastened to the frames and keel with through bolts. Of course, with this method of fastening the keel and keelson work as two beams, while in a steel ship the center keelson combines the keel and rider plates, together with the connecting angles, into a deep girder.

Pages 476, 477.

Keelson Angle Bar. This term applies to the continuous fore and aft bars at the top and bottom of the keelson. The angles connecting floor plates and brackets to the keelson are generally called clips.

Keelson, Bilge. A fore and aft girder placed at the lower turn of the bilge.

Keelson, Box. A keelson made up like a box girder with two vertical plates.

Keelson Bracket. A bracket usually a triangular-shaped plate connecting the keelson and shell plating between frames.

Keelson Casing. A wood ship term applied to the wood box fitted around the keelson to provided a means for keeping it salted.

Keelson, Intercostal. A keelson made up of a range of plates fitted intercostally between floors and attached to the floors, shell and tank top by angle bars or shapes.

Keelson, Rider. A piece of timber placed on top of the main keelson in wood ships.

A term applied to the keelson when it runs along the top of the floors in steel ships.

Keelson, Side. A term applied to the fore and aft girders running along the bottom of the ship parallel, or nearly so, to the keel.

Keelsons, Sister. Pieces of timber placed alongside of the main keelson in wood ships.

Keelson, Vertical Center. The lower middle line girder, which in conjunction with a flat plate keel on the bottom and a rider plate on top, forms the principal fore and aft strength member in the bottom of a ship. In addition to its importance as a "back bone" or longitudinal strength member, it serves to distribute and equalize the pressure on the transverse frames and bottom of the ship when grounding or docking occurs. In steel ships this keelson usually consists of a vertical plate with two angles running along the top and two along the bottom.

The girder, however, may be made up of various combinations of plates and shapes. This member should continue as far forward and aft as possible.

Pages 476, 477.

Keeper, Davit. See DAVIT KEEPER.

Keeper, Rudder. See RUDDER KEEPER.

Kentledge. Pig iron used either as temporary weight for inclining a vessel or as permanent ballast.

Kerf. A term applied in joiner work to a slit or cut made by a saw. Kerfs are made at the junction of timbers where the joints require adjusting Also applied to the channel burned out by a cutting torch.

Kerosene Engine. See GAS ENGINE.

Keying Rings. Lead washers used to secure shackle pin forelocks. The forelock has a recess near the end into which the ring is upset by a special tool. In unshackling, the keying ring is sheared off when the forelock is backed out.

Keyseater. A machine designed especially for cutting keyseats of keyways in shafts, the hubs of pulleys, gears, etc.

Page 720.

Keyway Cutter. See KEYSEATER.

Kid. A small wood tub, as a mess kid, spit kid, etc.

Kilowatt. The practical unit of electrical power. It is 1,000 times greater than the watt.

Kingston Valve. See VALVE, KINGSTON.

King Post; Sampson Post. A strong vertical post used to support a derrick boom.

Pages 320, 342.

Kink. An abrupt bend or short curl or loop in a rope or cable frequently occasioned by excessive lay or twist.

Knee. A block of wood having a natural angular shape or a block cut to a bracket shape and used for the purpose of fastening and strengthening corners of deck openings, intersections of timbers, and supporting deck beams.

Pages 440, 445, 447. Plate XXV.

Knees, Beam. See BEAM KNEES.

Knight-Head. The forward vertical timbers adjacent to the stem post.

. Page 474.

Knot. A unit of speed equalling one nautical mile per hour; a division of the log line which serves to measure a vessel's rate of speed; a term applied to a connection made with a piece of cordage to another piece or to another object.

Knot, Granny. A knot in which the first crossing is reversed from that in a square knot. This knot is insecure, difficult to open when jammed, and is held in contempt by seamen.

Knot, Mathew Walker. A single and a double knot named from the originator. It is made by hitching each of the three strands, in the direction of the lay in such a manner, that the rope can be laid up and continued beyond the knot. The knot is in the form of a transverse collar around the rope and is used on the end of dead eye lanyards.

Knot, Square. A knot in which the ends protrude on the same side of the loop with the standing parts. Sometimes called a "flat knot" and also known as a "reef knot" from its employment in tying reef points. This knot has the advantage of not slipping and is easily untied; however, it does not answer well for uniting ropes of very different sizes since the parts would slip unless stopped down.

Knuckle. An abrupt change in direction of the plating, frames, keel, deck or other structure of a vessel. The term is most frequently used with reference to the line at the apex of the angle dividing the upper from the lower part of the stern or counter of elliptical or round stern vessels.

L

Label Plates, Name Plates. Small plates usually made of brass and embossed or engraved with the name, number, etc., of rooms, compartment, frames, valves and equipment on a vessel, and attached to or located near the article to which it refers. Pages 604, 625.

Laborers. Men who do all the heavy or rough work not requiring knowledge of any trade.

Lace Piece. A piece of timber joining the bobstay piece and cutwater.

Lacing. A cord or rope used to lash the head of a sail to a gaff, the leech of a staysail to a stay, or a bonnet to a sail; to secure sections of awnings or sails to each other and to replace reef points in a gaff sail. Eyelet holes or grommets are placed near the edge of the awning or sail through which the lacing is rove.

Ladder. A framework consisting of two parallel sides connected by bars or steps which are spaced at intervals suitable for ascending or descending.

On shipboard the term ladder is also applied to staircases and to other contrivances used in ascending or descending to or from a higher or lower level

Pages 571, 572, 573.

Ladder, Accommodation. A term applied to a staircase suspended over the side of a vessel from a gangway to a point near the water, to provide an easy means of access from a small boat to the deck of a vessel.

Pages 568, 569, 570.

Ladder, Bridge. A ladder providing access to a bridge

Ladder, Companion. A staircase fitted as access from a deck to the quarters.

Ladder, Jacob's. See JACOB'S LADDER.

Ladder, Mast. A ladder attached to a mast to provide means for going aloft.

Pages 320, 332, 342.

Ladder, Pillar. A term applied to a ladder formed by fitting rungs extending out from a pillar or stanchion. They are commonly used as a means of securing access to cargo holds.

Ladder, Poop. A term applied to a ladder leading from the Upper Deck to the Poop Deck.

Ladder, Sea. A term applied to rungs riveted to the side of a vessel to form a ladder from the weather deck to the water.

Lag Screw. See SCREW.

Lagging. A term applied to the insulating material that is fitted on the outside of boilers, piping, etc. See Insulation.

Lamp, Arc. An electric lamp in which the light is produced by an electric arc drawn between two electrodes. The arc lamp is arranged to separate the electrodes automatically when the current begins to flow and to feed them toward each other as they burn away at the tip.

Lamp Black. See PAINT.

Lamp Cord. See ELECTRIC WIRE AND CABLE.

Lamp, Incandescent. An electric lamp in which the light is produced by the electric current heating to incandescence a filament which is enclosed in a glass chamber from which the air has been exhausted as completely as is practicable or which is filled with some inert gas such as nitrogen.

Lamp, Pilot. A lamp mounted on or near a switchboard for giving the operator a signal when a circuit breaker opens, a fuse blows, the voltage in a circuit becomes zero, or that conditions in some circuit have changed.

Lamp, Smoking. A small lamp kept lighted during smoking hours on board naval vessels to furnish lights for the smokers.

It is under the charge of the Chief Master-at-arms.

Land Boards. A term applied to planks used near the hatches for the purpose of receiving the cargo and protecting the deck.

Landing, Landing Edge. That portion of the edge or end of a plate over which another plate laps.

Landing Place. Any quay, pier or wharf affording facilities to vessels for the discharge of passengers or cargo.

Lanyard. A length of rope or cord used in numerous dissimilar ways, i. e., as a fall rove through the dead eyes in setting up the shrouds or other standing rigging; as a knife-lanyard to prevent a knife falling from aloft. In this case it consists of a small cord attached to the ring in the end of the knife, the other end being worn around the neck; a port lanyard is a light line used to haul a port into the closed position or to support it when open. The term is also applied to the rope handle of a bucket. The present tendency seems to limit the application of the term to any line having a loose end the other being attached to any object for the purpose of either near or remote control.

Lanyards. A short piece of rope rove through dead eyes, connecting shrouds to side of vessel.

Lap. A term applied to the distance that one piece is laid over another in making a lap joint.

Lap. The distance which the valve edge on the steam side extends over the port, the piston being at mid-position.

Lapped Frame. See FRAME, LAPPED.

Lapped Joint. See JOINT, LAPPED.

Lapstrake. A term applied to boats built on the clinker system in which the strakes overlap each other. The top strake always laps on the outside of the strake beneath.

Lap-Weld. A term applied to a pipe or tube which is constructed by welding a longitudinal scarphed seam.

Lateral Resistance. See RESISTANCE, LATERAL.

Lathe. A machine used for producing various machine and tool parts and which is adapted to a great many operations, such as turning circular work, boring holes, cutting screw threads and for many other classes of work, the extent and variety of which depend upon the type of lathe and its auxiliary equipment.

Pages 700, 701, 702, 703, 716, 717, 718, 731.

Lathe, Double Spindle. A type of lathe having two working spindles arranged so that one gives a larger swing than the other.

Lathe, Engine. The most common type of lathe. The term "engine" as used in this connection, simply means a machine, and it serves to designate that particular class of lathe which is used by machinists for general work, and which may be considered as the standard type. In ordinary shop usage the word "lathe" is commonly used to indicate a lathe of this class.

Pages 717, 718, 731.

Lathe, Gap. A lathe designed with a gap or space in front of the head stock to allow a larger swing for face-plate work.

Lathe, Screw Cutting Engine. See SCREW MACHINE.

Lathe, Speed. A simple lathe having no carriage or attachments operated by mechanical means.

Lathe, Turret. A lathe equipped with a turret which is mounted upon a carriage and contains the tools which are successively brought into the working position by indexing or rotating the turret. In many instances, all the tools required can be held in the turret, although it is often necessary to use other tools, held on a cross-slide for cutting off the finished part, facing a radial surface, knurling or for some other operation.

Pages 700, 701, 702, 703, 716, 731.

Lathe, Vertical Turret. A turret lathe having its turret on a vertical axis. See LATHE TURRET.

Pages 705, 706, 707, 708, 709, 710, 711.

Lathe, Woodworkers. A lathe used for turning wood spindles, columns, etc. These machines are generally provided with a tool support shaped like a tee and the workman rests the cutting tool on this support and feeds it to its cut by hand.

Launch. A term applied to a small power or motor boat. See Launching.

Launching. A term applied to the operation of sliding a vessel into the water. There are two methods by which this operation may be accomplished, one of which is called end launching and the other side launching.

End launching is used when it is desired to slide a vessel into the water stern first and where the vessel is built at an angle, usually 90°, to the water front. A track of two heavy timbers, about one third of the vessel's beam in width, is constructed on the ground or foundation prepared for it, running under the ship and for a distance out under the water. Sliding timbers or ways are then placed on the track under the vessel and temporarily fastened to it. Upon these timbers a cradle is built up to support the vessel to be launched. The vessel may then be raised from the stocks by wedging up the cradle, which operation transfers the weight of the ship to the cradle and allows the keel and building blocks to be removed. As the ways are laid at an inclination, usually from ½" to ⅝" to the foot, and launching grease placed between them, the force of gravity is sufficient to launch the vessel when the sliding timbers are released.

Side launching is used when it is desired to slide a vessel into the water sideways, or where the vessel is built parallel to the water's edge. This method is popular on the Great Lakes and where the size of the waterway is restricted. Ground ways are built at intervals under the ship and out above the water to a depth sufficient to receive the vessel. No sliding ways are necessary as the cradle may be built up directly on the ground ways. The cradle is then wedged up as in end launching, the blocking removed, and the ship allowed to slide off the ends of the ground ways into the water. Launching grease is used as in end launching and the inclination of the ways is steeper.

Launching Grease. A lubricant applied to the sliding and ground ways in launching a vessel. In addition to the grease so designated, tallow, stearine, etc., are also used either mixed in various proportions or else applied unmixed in layers to the ways.

Page 801.

Launching Tallow. Tallow used as a lubricant for the sliding and ground ways when launchting a vessel.

Law of Comparison. Otherwise known as Froude's Law. For similar ships running at speeds in the ratio of the square roots of their linear dimensions, the resistances are in the ratio of the cubes of the linear dimensions. The speeds as above noted are called corresponding speeds.

Lay (of a Rope). A term used to designate both the amount of twist put into a rope and its direction. The amount of twist is usually expressed as sailmakers lay, bolt rope, soft-laid, regular lay, hard-laid, or other special lays as required for a particular use. In general, the softer the lay the greater the strength, but the less the resistance to wear. Wearing quality is sacrificed to facility in handling in soft-laid rope and strength to utility in hard-laid rope. The direction of twist is designated as right-hand and left-hand, or as right-laid and left-laid.

Lay, Rope. See ROPE LAY.

Layers Out. Workmen who indicate on the material the operations necessary to fabricate it.

Laying Off. Work performed by shipfitters nearly identical with "laying out."

Laying Out. Placing the necessary instructions on plates and shapes for shearing planing, punching, bending. flanging, beveling, rolling, etc., from templates made in the mold loft or taken from the ship.

Lazaret. The space above the after peak between decks, used as a store-room for provisions in some merchant vessels.

Lazy Guy. A name given to a light rope or tackle by which a boom is prevented from swinging around.

Lead. A term sometimes used synonymously with the term "trim."

Lead. An apparatus used for determining the depth of water under a vessel. It is generally made of lead of nearly prismatic shape tapering slightly to the upper end through which is made a hole for bending a strap to which a marked line is attached.

Four classes of leads are in use, viz.: boat-leads, weighing from 3 to 5 pounds for use in running lines in shoal water; hand-leads weighing from 7 to 14 pounds and from 6 to 10 inches long; coasting-leads weighing from 25 to 50 pounds and about 18 inches long; and deep-sea leads weighing from 75 to 120 pounds and about 2 feet long. The coasting and deep-sea leads have the lower ends cup-shaped. This cavity is filled with tallow before being cast, known as "arming the lead." To this tallow a specimen of the bottom sticks when the lead strikes, which is examined and compared with the description on the charts.

Pages 1085, 1092, 1093.

Lead. Described under METALS.

Lead. The width of the admission steam or exhaust port opening at the beginning of the stroke.

Lead Line. A fine line marked in fathoms or feet to which the lead is attached and from which the depth of water is read off. Lead lines vary in length depending upon the service and size of lead used with them. In general, a hand-lead line is about 30 fathoms long and is used for depth of 25 fathoms or less; that for a coasting-lead 120 fathoms long for use in depths of 25 to 100 fathoms; while that for the deep-sea lead about 300 fathoms long for use in depths over 100 fathoms. The United States Navy has manufactured for its use lead line of the following lengths, circumferences and materials: Boat-lead lines, ⅝ inch, cotton twine, braided, 25-fathoms: ship's-lead lines, ¾ inch, flax twine, braided, 33⅓ fathoms; costing-lead lines, 1 inch, flax twine, braided, 100 fathoms; and deep-sea lead lines, 1½ inch. American hemp, 150 fathoms.

Leading Edge. Referring to a propeller blade, the edge which cuts the water when the screw is revolving in the ahead direction.

Referring to rudders or strut arms, the edges toward the stem.

Leak. Any orifice or other opening in a vessel's structure which permits water or other fluid to enter or to escape.

The egress or ingress of water or other fluid from or into a container or compartment.

Ledge. A strip along the front of a shelf or table to prevent articles from rolling off.

Ledge Bars. See HATCH REST.

Leech. A term applied to the side edges of a square sail or to the fore and aft edges of a fore and aft sail.

Lee Side. The opposite side to that which is exposed to the wind; the opposite of windward side.

Leeway. The amount of a vessel's deviation from her steered course due to action of wind and tide.

Left-Laid Rope. See ROPE, LEFT-LAID.

Left Rudder. A term recently adopted in the Navy which is applied to the operation of moving the rudder to port and consequently turning the bow of the ship to the left.

Length. By American Bureau of Shipping Rules. The length is the distance in feet on the estimated summer load line, from the fore side of the stem to the after side of the rudder post; where there is no rudder post the length is to be measured to the center of rudder stock.

Page 155, 205, 224.

Length by Lloyd's Rules. The length from the fore part of the stem to the after part of the stern post on the range of the upper deck beams, except in awning or shelter deck vessels, in which cases the length is to be measured on the range of the deck beams next below the awning or shelter deck.

Length on Waterline. The length from the fore side of the stem to the after side of the sternpost or stern contour measured at the designed waterline.

Length Over All. The total length over all, i. e., the length measured from the foremost to the aftermost points of a vessel's hull.

Length, Register. The length from the fore part of the outer plating or planking on the side of the stem to the after part of the main sternpost of screw steamers, i. e., the one to which the rudder is attached, and to the after part of the rudderpost of all other vessels measured on top of the tonnage deck.

The register length of scows and barges with a square bow and stern sloping up from the bottom to the deck and with neither stem, sternpost nor rudderpost is to be taken on the deck from the extreme point of the hull at the bow to the extreme point of the hull at the stern, i. e., the overall length of the hull is to be considered the register length of such vessels.

Lengthening (of a Ship). The act of increasing a vessel's length by inserting a section amidships. The vessel is placed in a dry dock or on a marine railway, then the longitudinal members are cut through in a staggered direction at about amidships, the two resulting parts separated the desired distance, and the intervening space fitted up with frames, stringers, plating, etc., so as to unite the forward and after portions in a new and longer hull.

Letterers. Painters who label compartments, tanks, etc.

Levee. An embankment constructed along a river to prevent overflow.

Lever, Beveling. A lever with a jaw at one end used to bend the flanges of angles or channels to a given inclination with the other flange or web. This tool is most commonly used at the bending slabs.

Life Buoy, Ring. A ring made of solid cork or equivalent buoyant material having an outside diameter of not less than thirty inches and an inside diameter of not less than seventeen inches. The number of buoys a vessel should carry depends on her length. They should not be permanently fastened to a vessel, but should be so placed as to be readily accessible in case of emergency. One of the buoys on each side of the vessel should have a life line attached of at least fifteen fathoms in length. A number of these ring buoys depending on the length of the ship, should have self igniting attachments consisting of a cylinder containing calcium carbide and calcium phosphate, which is so provided with a plug attached to a lanyard or other device that when the buoy is dropped sufficient water will enter the cylinder to produce a bright light.

Life ring buoys are also placed on wharves and along water fronts, and as on a ship they are thrown to persons in the water for the purpose of sustaining them until they can be reached. The luminous buoys are for use at night.

Life Preserver, Life Jacket. A wide belt of good cork blocks, or other suitable buoyant material, made to wrap around the body under the armpits, and having shoulder straps so fitted that the device may be put on like a vest. The object of a life preserver is to keep a person from sinking in case a vessel has to be abandoned. One life preserver should be carried for every person on board and in the case of passenger vessels, there should be added thereto a number of life preservers suitable for children equal at least to ten per cent of the total number of persons carried.

Life Raft. A frame work enclosing two or more air cylinders, to provide sufficient buoyancy to support the number of people it is designed to carry. Each air cylinder should have not less than three watertight compartments.

Page 822, 1101.

The Navigation Laws specify the following conditions for a life raft:

First: It should be reversible and fitted with bulwarks of wood, canvas or other suitable material on both sides. These bulwarks may be collapsible and shall not be less than 4 inches high.

Second: It should be of such size, strength, and weight that it can be handled without mechanical appliances, and, if necessary, be thrown from the vessel's deck.

Third: It should have not less than three cubic feet of air cases or equivalent buoyancy for each person whom it can accommodate.

Fourth: It should have a deck area of not less than four square feet for each person whom it can accommodate, and the platform should be not less than six inches above the water level when the raft is loaded.

Fifth: The air tanks or equivalent buoyancy should be placed as near as possible to the sides of the raft.

Rafts shall never be allowed a greater number of persons than for which there is a proper seating capacity without interfering with the use of oars. At least one-half of the number of life rafts on all steam vessels shall each have a capacity exceeding fifteen persons.

Tule and all other types of life rafts shall meet the requirements herein specified.

Lifeboat. A small boat carried on davits or on one of the upper decks of a vessel where it can be easily lowered into the water in case of an emergency.

Every lifeboat should be of sufficient strength to enable it to be safely lowered into the water when loaded with its full complement of persons and equipment.

The Navigation Laws prescribe definite rules as to the number and size of the lifeboats a vessel is required to carry and also other details of construction that must be observed.

A lifeboat should be fitted with watertight compartments, air cases, or with layers of cork or equivalent material.

The term is also applied to small boats used at lifesaving stations for removing persons from shipwrecks.

Lifeboat Falls Controller. A type of winch installed aboard ships for controlling the falls when lowering or hoisting lifeboats.

Page 821.

Lifeboat, Metallic. A lifeboat having its shell constructed of light metal plates. The keel, stem, sternpost and gunwales should be of oak or other suitable wood.

Pages 818, 822.

Lifeboat, Motor. A lifeboat with an internal combustion type of engine substantially and permanently installed inside the boat. All ocean steam vessels of more than 2,500 gross tons carrying passengers, whose route at any point lies more than 200 miles offshore, should carry at least one motor propelled lifeboat.

Lift. The act of constructing a template of any part of a ship thereby transferring the required size, form and other necessary details to the material to be worked into the fabricated object.

Lifting Gear, Engine. Gear designed for the purpose of lifting cylinder covers, crank shafts, and other heavy engine weights. It consists of tackles, screws, etc.

Lifting Gear, Turbine. See Turbine Lifting Gear.

Lifts. Ropes supporting the yards at the yard arms being led through blocks or fairleaders at the mast head and thence to the deck or the top.

Light, Anchor. A vessel under one hundred and fifty feet in length when at anchor shall carry forward, where it can best be seen, but at a height not exceeding twenty feet above the hull, a white light, in a lantern so constructed as to show a clear, uniform and unbroken light visible all around the horizon at a distance of at least one mile.

A vessel of one hundred and fifty feet or upwards in length, when at anchor, shall carry in the forward part of the vessel, at a height or not less than twenty and not exceeding forty feet above the hull, one such light, and at or near the stern of the vessel, and at such a height that it shall be not less than fifteen feet lower than the forward light, another such light.

The length of a vessel shall be deemed to be the length appearing in her certificate of registry.

A vessel aground in or near a fair-way shall carry the above light or lights, and in addition it shall carry at the same height as the mast head light, where they can best be seen, and if a steam vessel in lieu of that light, two red lights, in a vertical line one over the other, not less than six feet apart, and of such a character as to be visible all around the horizon at a distance of at least two miles.

Minor changes in the above rules are made for vessels plying inland waters and the Great Lakes.

Page 1074.

Light, Blue. A light used for signalling purposes and which is obtained by igniting a mixture.

Light Cable. See Electric Wire and Cable.

Light Cruiser. A naval vessel of moderate displacement carrying a battery of guns of medium size, light protection and having high speed.

These vessels are intended for scouting, blockade, and convoy work.

Light, Flare-Up. Every vessel may, if necessary in order to attract attention, in addition to her regular lights, show a flare-up light as a distress signal.

Pilot vessels when engaged on their station on pilotage duty shall not show the lights required for other vessels, but shall carry a white light at the mast head, visible all around the horizon, and shall also exhibit a flare-up light or lights at short intervals, which shall never exceed fifteen minutes.

Sailing vessels engaged in trawling shall, on the approach of or to other vessels, show where it can best be seen a white flare-up light or torch in sufficient time to prevent collision. Fishing vessels and boats may at any time use a flare-up light, as well as the regular lights, and they may also use working lights.

A vessel which is being overtaken by another shall show from her stern to such last mentioned vessel a white light or flare-up light.

Light, Flood. See Flood Light.

Light, Masthead. Masthead lights on seagoing vessels should be installed as follows:

A light on or in front of the foremast of steam vessels, or if a vessel without a foremast, then in the fore part of the vessel, at a height above the hull of not less than twenty feet, and if the breadth of the vessel exceeds twenty feet, then at a height above the hull of not less than such a breadth, so, however, that the light need not be carried at a height greater than forty feet above the hull, a bright white light, so constructed as to show an unbroken light over an arc of the horizon of twenty points of the compass, so fixed as to throw the light ten points on each side of the vessel, namely; from directly ahead to two points abaft the beam on either side and of such a character as to be visible at a distance of at least five miles.

Sailing vessels do not carry masthead lights.

In the fore part of steam vessels of less than forty tons or in front of the funnel, where it can best be seen, and at a height above the gunwale of not less than nine feet, a bright white light as described above and of such a character as to be visible at a distance of at least two miles.

Small steamboats, such as are carried by seagoing vessels, may carry the white light at a less height than nine feet above the gunwale, but it shall be carried above the side lights.

Rowing boats, whether under oars or sail, shall have ready at hand a lantern showing a white light which shall be temporarily exhibited in sufficient time to prevent collision.

Pilot vessels when engaged on their station on pilotage duty shall not show the lights required for other vessels, but shall carry a white light at the masthead visible all around the horizon. A pilot vessel of such a class as to be obliged to go alongside of a vessel to put a pilot on board may show the white light instead of carrying it at the masthead.

Pilot vessels, when not engaged on their station on

pilotage duty, shall carry masthead lights similar to those of other vessels of their tonnage.

A steam pilot vessel, when engaged on her station on pilotage duty and in waters of the United States, shall, in addition to the lights required for all pilot boats, carry at a distance of eight feet below her white masthead a red light, visible all around the horizon and of such a character as to be visible on a dark night with a clear atmosphere at a distance of at least two miles. She should carry this red light whether at anchor or not.

Open fishing boats, by which it is to be understood boats not protected from the entry of sea water by means of a continuous deck, when engaged in any fishing at night, with outlying tackle extending not more than one hundred and fifty feet horizontally from the boat into the sea way, shall carry one all-around white light, but where the outlying tackle extends more than one hundred and fifty feet horizontally from the boat into the sea way they shall carry one all-around white light, and in addition, on approaching or being approached by other vessels, shall show a second white light at least three feet below the first light and at a horizontal distance of at least five feet away from it in the direction in which the outlying tackle is attached.

Fishing vessels, with the exception of open boats, when fishing with drift nets, shall, so long as the nets are, wholly or partly in the water, carry two white lights where they can best be seen. Such lights shall be placed so that the vertical distance between them shall be not less than six feet and not more than fifteen feet, and so that the horizontal distance between them measured in a line with the keel, shall not be less than five feet and not more than ten feet. The lower of these two lights shall be in the direction of the nets, and both of them shall be of such a character as to show all around the horizon, and to be visible at a distance of not less than three miles. Within the Mediterranean Sea and in the seas bordering the coasts of Japan and Korea, sailing fishing vessels of less than twenty gross tons shall not be obliged to carry the lower of these two lights. Should they, however, not carry it, they shall show in the same position (in the direction of the net, gear or fishing lines) a white light, visible at a distance of not less than one sea mile, on the approach of or to other vessels.

Fishing vessels, with the exception of open boats when line fishing with their lines out and attached to or hauling their lines, and when not at anchor or stationary as a result of her gear getting fast to a rock, shall carry the same lights as vessels fishing with drift nets. When shooting lines or fishing with towing lines, they shall carry the lights prescribed for a regular steam or sailing vessel, as the case may be.

Steam trawling vessels shall carry in the same position as the mast head light described in the first part of this article, a tri-colored lantern so constructed and fixed as to show a white light from directly ahead to two points on each bow, and a green light and a red light over an arc of the horizon from two points on each bow to two points abaft the beam on the starboard and port sides, respectively; and not less than six or more than twelve feet below the tri-colored lantern a white light in a lantern, so constructed as to show a clear, uniform, and unbroken light all around the horizon.

Sailing vessels, engaged in trawling, shall carry a white light in a lantern, so constructed as to show a clear, uniform and unbroken light all around the horizon, and shall also, on the approach of or to other vessels, show where it can best be seen a white flare-up light or torch in sufficient time to prevent collision.

The lights mentioned above on trawling vessels shall be visible at a distance of at least two miles.

Oyster dredges and other vessels fishing with dredge net shall carry and show the same lights as trawlers.

Every fishing vessel or boat under one hundred and fifty feet in length, when at anchor, shall exhibit a white light visible all around the horizon at a distance of at least one mile.

Every fishing vessel of one hundred and fifty feet and upward, when at anchor, shall exhibit a white light visible all around the horizon for a distance of at least one mile, and shall exhibit another such light at or near the stern, and at such a height that it shall not be less than fifteen feet lower than the forward light. Should any such vessel, whether under or over, one hundred and fifty feet in length, be attached to a net or other fishing gear, she shall on approach of other vessels show an additional white light at least three feet below the anchor light, and at a horizontal distance of at least five feet away from it in the direction of the net or gear.

Fishing vessels or boats that are stationary as a result of their gear getting fast to a rock or other obstruction shall show the lights prescribed for a vessel at anchor.

Motor boats under twenty-six feet in length shall carry a white light aft to show all around the horizon. Motor boats from twenty-six to sixty-five feet, inclusive, in length shall show a bright white light in the fore part of the vessel as near the stem as practicable, so constructed as to show an unbroken light over an arc of the horizon of twenty points of the compass so fixed as to throw the light ten points on each side of the vessel, namely, from directly ahead to two points abaft the beam on either side, and a white light aft to show all around the horizon.

Minor changes in the above rules are made for vessels plying inland waters and the Great Lakes.

Lights, Range. A seagoing steam vessel when under way may carry an additional white light similar in construction to the masthead light. These two lights shall be so placed in line with the keel that one shall be at least fifteen feet higher than the other, and in such a position with reference to each other that the lower light shall be forward of the upper one. The vertical distance between these lights shall be less than the horizontal distance.

Minor changes are made in the above rules for vessels plying inland waters and the Great Lakes.

Lights, Side. Side lights on seagoing vessels should be installed as follows:

On the starboard side a green light so constructed as to show an unbroken light over an arc of the horizon of ten points of the compass, so fixed as to throw the light from directly ahead to two points abaft the beam on the starboard side, and of such a character as to be visible at a distance of at least two miles.

On the port side a red light so constructed as to show an unbroken light over an arc of the horizon of ten points of the compass, so fixed as to throw the light from directly ahead to two points abaft the beam on

the port side, and of such a character as to be visible at a distance of at least two miles.

The said green and red side lights shall be fitted with inboard screens projecting at least three feet forward from the light, so as to prevent these lights from being seen across the bow.

Whenever, as in the case of small vessels under way during bad weather, the green and red side lights can not be fixed, these lights shall be kept at hand, lighted and ready for use; and shall, on the approach of or to other vessels, be exhibited on their respective sides in sufficient time to prevent collision, in such manner as to make them most visible, and so that the green light shall not be seen on the port side nor the red light on the starboard side, nor, if practicable, more than two points abaft the beam on their respective sides. To make the use of these portable lights more certain and easy the lanterns containing them shall be painted outside with the color of the light they respectively contain, and shall be provided with proper screens.

Steam vessels of less than forty tons shall carry green and red side lights as described in the first part of this article, and of such a character as to be visible at a distance of at least one mile, or a combined lantern showing a green light and a red light from directly ahead to two points abaft the beam on their respective sides. Such lanterns shall be carried not less than three feet below the white light. Vessels under oars or sails of less than twenty tons shall have ready at hand a lantern with a green glass on one side and a red glass on the other, which, on the approach of or to other vessels, shall be exhibited in sufficient time to prevent collision, so that the green light shall not be seen on the port side nor the red light on the starboard side. Pilot vessels when engaged at their station on pilotage duty shall not show their side lights. However, on the near approach of or to other vessels they shall have their side lights lighted, ready for use, and shall flash or show them at short intervals, to indicate the direction in which they are heading, but the green light shall not be shown on the port side, nor the red light on the starboard side.

A pilot vessel of such a class as to be obliged to go alongside of a vessel to put a pilot on board may, instead of the colored lights above mentioned, have at hand, ready for use, a lantern with green glass on the one side and red glass on the other, to be used as prescribed above.

Pilot vessels when not engaged on their station on pilotage duty shall carry side lights similar to those of other vessels of similar tonnage.

A steam pilot vessel, when engaged on her station on pilotage duty and in waters of the United States, and not at anchor, shall carry the side lights required by vessels when under way, but when at anchor the side lights should not show.

Motor boats less than twenty-six feet in length shall carry a combined lantern in the fore part of the vessel and lower than the white light aft showing green to starboard and red to port, so fixed as to throw the light from directly ahead to two points abaft the beam on their respective sides.

Motor boats from twenty-six to sixty-five feet inclusive in length shall show on the starboard side a green light so constructed as to show an unbroken light over an arc of the horizon of ten points of the compass, so fixed as to throw the light from directly ahead to two points abaft the beam on the starboard side. On the port side a red light so constructed as to show an unbroken light over an arc of the horizon of ten points of the compass, so fixed as to throw the light from directly ahead to two points abaft the beam on the port side.

Minor changes in the above rules are made for vessels plying inland waters and the Great Lakes.

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Lights, Special. A vessel which from any accident is not under command shall carry at the same height as the masthead light, where they can best be seen, and if a steam vessel in lieu of that light, two red lights, in a vertical line one over the other, not less than six feet apart, and of such character as to be visible all around the horizon at a distance of at least two miles.

A vessel employed in laying or picking up a telegraph cable shall carry in the same position as the mast head light, and if a machinery propelled vessel, in lieu of that light, three lights in a vertical line one over the other, not less than six feet apart. The highest and lowest of these lights shall be red, and the middle light shall be white, and they shall be of such a character as to be visible all around the horizon, at a distance of at least two miles.

The vessels showing these lights when not making way through the water, shall not carry the side lights, but when making way shall carry them.

These lights are to be taken by other vessels as signals that the vessel showing them is not under command and can not therefore get out of the way. They are not to be taken as signals of distress.

For corresponding daylight signals see Black Balls.

Lights, Stern. A seagoing steam vessel which is being overtaken by another shall show from her stern to such last mentioned vessel a white light or a flare-up light.

The white light required to be shown by this article may be fixed and carried in a lantern, but in such case the lantern shall be so constructed, fitted, and screened that it shall throw an unbroken light over an arc of the horizon of twelve points of the compass, namely, for six points from directly aft on each side of the vessel, so as to be visible at a distance of at least one mile. Such light shall be carried as near as practicable on the same level as the side lights.

Minor changes in the above rules are made for vessels plying inland waters and the Great Lakes.

Lights, Towing. A seagoing steam vessel when towing another vessel shall, in addition to her side lights, carry two bright white lights in a vertical line one over the other, not less than six feet apart, and when towing more than one vessel shall carry an additional white light above or below such light, if the length of the tow measuring from the stern of the towing vessel to the stern of the last vessel towed exceeds six hundred feet. Each of these lights shall be of the same construction and character, and shall be carried in the same position as the masthead light, excepting the additional light, which may be carried at a height of not less than fourteen feet above the hull.

Such machinery propelled vessels may carry a small white light abaft the funnel or aftermast for the vessel towed to steer by, but such light shall not be visible forward of the beam.

Minor changes are made in the above rules for vessels plying inland waters and the Great Lakes.

Lights, Visible. A term applied to lights that can be seen on a dark night in a clear atmosphere.

Light Waterline. The line to which a vessel submerges when she is light, i.e., without cargo, or ballast in the case of merchant vessels, and without complement, stores, fuel, ammunition, feed water, etc., in the case of war vessels.

Light and Air Space. Space required for the admission of light and air to the engine room, machinery or other similar spaces so situated as to render the direct admission of light by other means difficult or impossible.

Lightening. The act of discharging cargo in order to lessen the draft.

Lightening Hole. A hole cut out of any structural member, as in the web, where very little loss of strength will occur. These holes reduce the weight and in many cases serve as access holes. This condition is particularly true in floor plates and longitudinals in a double bottom.

Lighter. A full bodied, heavily built craft, usually not self-propelled, used in bringing merchandise or cargo alongside or in transferring same from a vessel.
Page 467.

Lightning Switch. See SWITCH, LIGHTNING.

Lignum Vitæ. A wood of very hard and oily nature. It is used in strips or blocks as a bearing surface for the propeller shaft in stern tubes.

Limber-Boards. Removable boards serving as covers for water-courses.

Limber Chain. A chain used to work back and forth through the limber holes to keep the same from becoming choked up.

Limber Hole. A hole or slot in a frame or plate for the purpose of preventing water from collecting. Most frequently found in floor plates just above the frames and near the center line of the ship.

Limber Strake. See STRAKE, LIMBER.

Linchpin. A metal pin passing through a shaft or axle to hold in position a pulley, wheel, etc. Linchpin and forelock are terms used synonymously by many, though a forelock is the more narrow application of the term.

Line. A general term for a rope of any size used for various purposes; small cords such as log line, lead line and small stuff as marline, ratline, houseline, etc.

Line Throwing Gun. A small gun used for shooting lines from wrecked vessels to the shore or another vessel or vice-versa.
Page 820.

Liner. A piece of metal used for the purpose of filling up a space between a bar and a plate, between two plates.

Liner, Atlantic. A merchant vessel engaged in regular Transatlantic service, usually having high speed, comfortable passenger accommodations, moderate freight capacity, and large size.

The term probably originated with the first efforts to place in service ships which should maintain a regular schedule across the Atlantic Ocean.
Page 1104.

Liner, Bulkhead. A short or diamond shaped plate fitted between the outer flanges of bulkhead bounding bars and the outer strakes of shell plating. On account of watertightness the rivet spacing in bounding bars is closer than in the frames and the bulkhead liner is a compensating plate to make up this deficiency.

Liners, Frame. Small strips of plate, of the same width as the frame flange, inserted between the frame and a shell plate to give contact between the two, where owing to the method of fitting the plate it would not otherwise bear against the frame.

Liner, Frame, Straight. See FRAME LINER, STRAIGHT.

Liner, Frame, Tapered. See FRAME LINER, TAPERED.

Liners, Tapered. A term applied to pieces of plate that are hammered into a wedge shape and used as filler pieces between plating and framing in the way of lap joints.

Lines, Bevel. A representation by means of lines of the inclinations which one set of surfaces make with others or with a datum line.

Lines (on a Drawing). Among the principal lines on a drawing are the following:

Base Line: A horizontal fore and aft reference line for vertical measurements. This line is perpendicular to the vertical center line.

A horizontal transverse reference line for vertical measurements. This line is perpendicular to both the vertical center line and the fore and aft base line.

Buttock Lines: Vertical lines parallel to the vertical center line on the body plan; horizontal lines parallel to the fore and aft center line on the half breadth plan; and curved lines on the sheer plan.

Center Line: A horizontal fore and aft reference line for athwartship measurements dividing the ship into two symmetrical halves. This line lies in the vertical plane passing through the base line.

A vertical reference line in the center of the body plan, midship section or other section. This line is perpendicular to the base line. The projection of a vertical fore and aft plane embracing this line appears on the half breadth plan as a fore and aft line dividing the vessel into halves.

Diagonals: Diagonal lines extending from the vertical center line to the frame lines on the body plan and curved lines on the half breadth and sheer plans.

Frame Lines: Curved lines showing the contour of the frames on body plan; straight vertical lines on the half breadth plan; and straight vertical lines on the sheer plan.

Water Lines: Horizontal lines parallel to the horizontal transverse base line on the body plan; curved lines on the half breadth plan; and horizontal lines parallel to the horizontal fore and aft base line on the sheer plan.

Lines (on a ship). Usually chalk lines whose position may be permanently fixed by center punching; also wires or cords for temporary use.

Lines (Plan). A drawing showing a vessel's form, projected on three planes perpendicular to each other. Conceiving the surface of the vessel cut by planes parallel to each of these three reference planes, the intersections of these with the vessel's form will be curved lines which may be projected on the three reference planes. The projection of any particular intersection will appear as straight lines on two of the reference planes and as a curved line on the third. Lines of decks with a sheer are curved on all three planes. The lines plan comprises these three plans:

A. Sheer or Profile Plan. A drawing or view showing the projections on the vertical fore and aft reference plane of the intersections of planes parallel to and at varying distances from the reference plane with the vessel's form. These intersections are known as

BOW and BUTTOCK LINES, or simply BUTTOCKS, and are curved lines. The bilge diagonal is a curved line when appearing on this plan. The WATER LINES and CROSS SECTIONS appear as straight lines.

B. Half Breadth Plan. A drawing or view showing the projections on the horizontal, fore and aft reference plane of the intersections of planes parallel to and at varying distances from the reference plane with the vessel's form. These intersections are known as WATER LINES and are curved. The BUTTOCKS and CROSS SECTIONS appear as straight lines.

C. Body Plan. A drawing or view showing the projections on the vertical transverse reference plane of the intersections of planes parallel to and at varying distances from the reference plane with the vessel's form. These intersections are known as CROSS SECTIONS and are curved. The WATER LINES, BUTTOCKS and BILGE DIAGONALS appear as straight lines. The cross sections forward of the midship section are usually shown on the right of the plan, those aft of the midship section to the left.

Pages 204, 205, 227, 228, 470, 471, 472, 473, 474, 475. Plates XXX, XXXI.

Linesman. A mold loftsman who is expert on laying down ship's lines and developing work therefrom.

Lining Up. The process of adjusting the various moving parts of an engine so as to insure their functioning in exactly the desired manner both from the standpoint of individual action and from that of the engine as a whole.

For detailed comment relative to the methods employed, see "Practical Marine Engineering," 7th Edition, by Admiral Dyson, pages 716 to 721 inclusive.

Link. A machine member designed to receive and transmit power from one part of an engine to another.

Link Brasses. Brasses fitted in the bearings at the ends of a link.

Link Motion. Synonymous with a portion of the reversing mechanism or gear and referring to that part of the apparatus which is composed of eccentrics, eccentric rods, links, and slide valve rod.

Link, Stephenson. See STEPHENSON LINK.

Linoleum Cement. See PAINT.

Linseed Oil. See PAINT.

List. The deviation of a vessel from the upright position, due to bilging, shifting of cargo, or other cause.

Live Load. A load suddenly applied, a moving load. Examples of live load are wind pressure, a weight being lifted by a crane, a train moving over a bridge.

Lizard. A rope having a thimble, bull's eye, or block spliced into the end. It is used as a leader.

Load Line. The line on the "lines plan" of a ship representing the intersection of the ship's form with the plane of the water's surface when the vessel is floating with her designed load on board. Also applied to the actual intersection of the surface of the water with a vessel's side.

Pages 171, 172, 179, 180, 189, 190, 224.

Load Waterplane. The waterplane at which the vessel floats when in fully loaded condition.

This is essentially a merchant ship term and has no meaning in American naval practice.

Lock Bolts. Bolts or studs used to hold in place a ring, band, bearing, etc.

Lock Chamber. The space or compartment contained between the gates at each end of a lock.

Locker. An enclosed space or small closet used for stowing articles.

Loftsmen. Workmen who lay down the ship's lines full size on the mold loft floor and make templates or molds for the various parts or details of the vessel's structure.

Log. An apparatus either for ascertaining the momentary speed of a vessel in knots or the distance she has traveled in a given time.

The old-fashioned chip-log, now rarely used, consists of a flat piece of wood, triangular or sector-shaped and weighted with lead so that it will float upright, attached to a length of fine line. The line is divided into divisions and tenths having the same ratio to a nautical mile that 28 seconds has to an hour. This type of log gives fairly satisfactory results for speeds up to 10 or 12 knots.

The ground log consists of the common log line having a hand-lead substituted for the log-chip. When the log is hove the lead lies on the ground without dragging and thus gives the speed over the ground.

The speed of modern steamers is ascertained by patent logs of which there are many types.

With very few exceptions, these consist of a "rotator" similar in principle to the propeller of a ship, which is towed through the water and made to rotate with a velocity varying with the speed. This motion as transmitted by a cord to a dial or several dials through a series of gears thus registering the distance corresponding to the revolutions of the rotator and is one of the distance not of speed. In a "taffrail" log the registering mechanism is on the taffrail, a long line connecting it to the rotator; in the "harpoon" log the registering mechanism is towed astern with the rotator and is hauled in for reading. Page 1091.

Log Line. The line connecting a log-chip or harpoon log to the vessel or between the rotator and the registering mechanism of a taffrail log.

The United States Navy has manufactured for its use log lines as follows: For chip-logs, ¾ inch American hemp, 100 fathoms length; for taffrail logs, ¾ inch circumference, cotton twine, braided, in 33⅓, 66 2/3, and 100 fathoms length.

Loll. The action of a ship having small metacentric height, by virtue of which she heels sufficiently to bring her vertical center of gravity over the center of buoyancy. This term is really descriptive of the action of many crank ships.

Long Splice. A splice made without an increase in the rope's diameter. It is required in a rope that must reeve through a block. The strands are first unlaid for a considerable distance, the end of the ropes then brought together, the strands interlaced, the ends of each subdivided and a part of them tucked over and under the full strands, and the remaining unused partial strands trimmed off.

Longboat, Launch. A large pulling boat of full lines and square stern intended for general utility.

Longitudinal. A general term meaning fore and aft, as longitudinal bulkhead, longitudinal strength, etc. A fore and aft girder in the bottom of a ship or a side keelson.

Longitudinal Bulkhead. See BULKHEAD, LONGITUDINAL.

Longitudinal Coefficient. See COEFFICIENT, LONGITUDINAL.

Longitudinal Framed Ship. See SHIP, LONGITUDINAL FRAMED.

Longitudinal Frames. See FRAMES, LONGITUDINAL.

Longitudinal Girder. A term applied to the fore and aft girders in the bottom of a ship. These girders are usually made up from plates and shapes and are sometimes intercostal and sometimes continuous. Where the plates are cut at the floors, either or both, the top and bottom bars may be made continuous by notching out the floor plates in their way and cutting the floor bars.

Longitudinal Number or Numeral. A key number used by Classification Societies in their rules for determining the scantlings of the fore and aft members and the plating. These numbers with the corresponding scantlings are tabulated in the rules and are the results of experience and comparison. The numbers are arrived at in different ways by the various Classification Societies but they are always identification numbers indicating the general size of the vessel as well as the proper scantlings of the structural members.

Longitudinal Stresses. Stresses which act lengthwise of a girder or beam. Similarly for a ship, stresses acting parallel to the center line.

Page 469. Plate XXIX.

Longitudinal Subdivision. The subdivision of a ship resulting from the fitting of longitudinal or fore and aft bulkheads.

Lost Buoyancy. In case of damage to a vessel causing flooding of a compartment or compartments, the amount by which the reserve buoyancy of the vessel is decreased by such flooding is termed the lost buoyancy. In computing the lost buoyancy for any given case, cognizance is taken of the permeability of any cargo in the compartments flooded and only the net loss of buoyancy is taken, credit being given for the inherent buoyancy of the cargo.

Loud Speaking Telephone. See TELEPHONE, LOUD SPEAKING.

Louver. An opening partially closed with slats, which are fitted diagonally so that they overlap, shutting out the view but allowing the free passage of air. They are frequently constructed in the sides of skylights and fidleys.

Lower Deck. See DECK, LOWER.

Lower Deck Stringer. See STRINGER, LOWER DECK.

Lower Deck Stringer Bar. See STRINGER, BAR.

Lower Keel. See KEEL, LOWER.

Lower Rigging. The shrouds, stays, etc., supporting the lower masts including the running rigging for working their yards and sails.

Lubber's Point. A vertical mark on the inside rim of the card chamber of a compass which is held in coincidence with the point of the compass card indicating the desired course to be steered. The installation of the binnacle is such, that with proper adjustment of this mark, the center of the compass card, and the fore and aft center line of the vessel lie in a vertical plane.

Lubrication. Lubrication is effected in various ways; by means of such devices as grease cups, compression cups, wipers and oil cans; by means of manifolds or reservoirs and piping through which the oil flows by gravity to the desired spot; by means of a pump and piping through which the oil is forced to the part to be lubricated.

Pages 708, 709, 963, 964, 965.

Lubricating Oil Cooler. See OIL COOLER, LUBRICATING.

Lubricating Oil Pump. See PUMP, LUBRICATING OIL.

Lubricating System, Gas Engine. See GAS ENGINE LUBRICATING SYSTEM.

Lucky Bag. A locker on board a naval ship provided as a receptacle for such articles belonging to the crew as are found out of place. The owners of the articles can regain possession of them only by bidding them in at auctions.

Luff Tackle. A purchase consisting of a length of rope, a fixed double and a movable single block.

Lug Piece. A short piece of angle bar used to attach keelsons, girders, stringers, etc., to other structural members.

Lug-Rig. The arrangement of sails peculiar to an English and French type of boats known as luggers which have one, two or three masts with quadrilateral or four cornered fore and aft sails bent to a hoisting yard.

Lug-sail. A sail used in small craft. It is triangular in shape.

Lugger. A vessel having from one to three masts rigged with quadrilateral fore-and-aft sails bent to yards.

Lumber, Green. Lumber having about the same moisture content as when cut from live timber.

Lumber, Kiln Dried. Lumber which has been dried by artificial heat.

Lumber, Seasoned. Lumber is seasoned when it has reached a moisture content that is equal to the average condition of the atmosphere without being exposed to artificial heat.

Page 813.

Lumper. An unskilled laborer about a shipyard.

M

Machine Beveling. The operation of bending the flanges of shapes to given inclinations by machinery.

Machine Screw. See SCREW.

Machinery Arrangement. The term "machinery arrangement" applies to the layout of the main propelling unit and its auxiliaries.

Pages 390, 391, 392, 393, 398, 399, 400, 401, 425, 442, 443, 444.

Plates XII, XIV.

Machinery, Auxiliary. See AUXILIARY MACHINERY.

Machinery, Deck. See DECK MACHINERY.

Machinery Steel. See STEEL AND IRON.

Machinists (Inside). Mechanics who operate drills, lathes, boring mills, shapers, etc., in the shop. They prepare the parts of machinery for assembling.

Machinists (Outside). Mechanics who assemble on shipboard the propelling machinery and auxiliaries. On naval vessels they assemble the turret rotating machinery.

Macomb Strainer. See STRAINER, MACOMB.

Magazine. Spaces or compartments devoted to the stowing of ammunition.

Magnesium. Described under METALS.

Magnet Wire. See ELECTRIC WIRE AND CABLE.

Magnetic Field. The space surrounding a magnetized body through which the magnetic force acts.

Magnetism. The property possessed by certain bodies to attract and repel each other according to determinate laws.

Main Body. The hull exclusive of all deck erections, spars, stacks, etc.; the naked hull.

Main Check Valve. See VALVE, MAIN CHECK.

Main Circulating Pump. See PUMP, MAIN CIRCULATING.

Main Deck. See DECK, MAIN.

Main Deck Sheerstrake. The strake of outside plating adjacent to the main deck.

Main Deck Stringer. See STRINGER, MAIN DECK.

Main Deck Stringer Bar. See STRINGER, BAR.

Main Drain. The principal drainage main usually applied only to the pipes arranged for pumping out the machinery spaces.

Main Feed Pump. See PUMP, MAIN FEED.

Main Floor. See FLOOR, MAIN.

Main Frame. See FRAME, MAIN.

Main Hatch. See HATCH, MAIN.

Main Hold. The largest cargo hold.

Main Piece, Rudder. See RUDDER, MAIN PIECE.

Main Truck. See TRUCK.

Mainsail. The principal sail carried by the main mast. In a square rigged vessel it is suspended from the main yard. In a fore-and-aft rigged vessel it is spread on the main gaff and boom.

Male and Female. A term applied to two engaging pieces, one of which is raised and the other recessed.

Malleable Iron. Described under STEEL AND IRON.

Malleability. That quality of a material by virtue of which it may be satisfactorily worked under the hammer or by means of rolls.

Maneuvering Valve. See VALVE MANEUVERING.

Manganese. Described under METALS.

Manger Plate. A term applied to a plate forming part of a breakwater. They are installed on forward weather decks for the purpose of throwing off the water that is shipped over the bow.

Mangle Rolls. See ROLLS, MANGLE.

Man of War. A vessel designed for fighting purposes. Generally applied to naval vessels of the first class. The term is not so commonly used now as formerly.

Manhole. A round or oval hole cut in floors, tank tops, decks, tanks, boilers, etc., for the purpose of providing access.

Pages 556, 557.

Manhole Coaming. See COAMING, MANHOLE.

Manhole Cover. A cover or lid used to close a manhole opening. Manhole covers may be air, water, steam or oil tight. The simplest type consists of a plate and gasket fastened by bolts but for easy access and tightness a hinged cover on a raised frame is more desirable.

Page 817.

Manhole Ring, Boiler. See BOILER MANHOLE RING.

Manholes, Boiler. See BOILER MANHOLES.

Manifold. A casting or chest containing several valves. Suction or discharge pipes from or to the various compartments, tanks and pumps are lead to it, making it possible for several pumps to draw from or deliver to a given place through one pipe line.

Page 884.

Manila. The prepared fiber obtained from the stalk of the wild banana. The principal supply comes from the Philippine Archipelago. It is light and flexible, and does not readily deteriorate, so that when made into cordage it does not require tarring.

Manila Rope. See ROPE, MANILA.

Margin Bracket. See FRAME BRACKET.

Margin Line. A line drawn parallel to the bulkhead deck at side lines and 76 millimeters (equivalent to 3 inches) below the upper surface of that deck. The term is used in connection with the method of subdividing merchant ships described in the Report of the Committee appointed by the president of the British Board of Trade.

Margin Plank. A term applied to a plank forming the boundary of the deck planking.

Margin Plate. The plate forming the sides of the inner bottom tank. This plate is usually fitted normal to the shell to which it is attached by a continuous angle bar and has its top edge flanged over to make a seam lap connection to the inner bottom plating. The side frames are usually attached to this plate by large brackets.

Pages 370 to 430, 484. Plate XXXVI.

Marine Compass. See COMPASS, MARINE.

Marine Engine. See ENGINE, MARINE; ENGINE, RECIPROCATING; TURBINE, ELECTRIC DRIVE; ENGINE, DIESEL; ENGINE, HOT BULB, ETC.

Marine Glue. See GLUE, MARINE.

Marine Hardware. A general term usually applied to spikes, nails, screws, clinch rings, boat hooks, row locks, pipe fittings, hinges, locks, door knobs, draw pulls, etc.

Page 823.

Marine Railway. See DRY DOCK, RAILWAY.

Marine Railway Hoist. See HOIST, MARINE RAILWAY.

Marker. A short piece of brass pipe which is dipped in white lead and pushed through a mold to mark the location of a rivet hole on the material.

Marker, Double Arm. A device consisting of two wooden arms or battens rigidly fastened together at one end in such a manner that they are parallel. Both arms are drilled with holes directly opposite each other.

This device is used when it becomes necessary to transfer the location of a rivet hole from one side of a plate or shape to the other.

Marline. A double-threaded, left-handed tarred cord, made from a good grade of American hemp. In general use on shipboard for purposes similar to other "small stuff." Made in the following grades:

Marline, Common.....222 feet to the pound,
Marline, Medium.....360 feet to the pound,
Marline, Yacht.....520 feet to the pound.

Marline. A tarred hemp, two-stranded, left-handed, small stuff, about ⅛ inch in diameter, used for neat seizings and fine service. Untarred marline is used for making sennit.

Marline Clad Wire Rope. See ROPE, WIRE, MARLINE CLAD.

Marline Hitch. A half hitch in which the hauling part comes out underneath the standing part. Used by riggers in marling down parcelling before serving and for lashing hammocks.

Marline Spike. A tapering pointed metal implement used by riggers and sailmakers to open the strands of rope in splicing and as a lever in marling and seizing. In general, a marline spike is the same as a fid except that the former is metal while the latter is wood, although a marline spike may have a wood handle.

Marling. To hitch marline, spun-yarn, etc., around the parcelling on a rope to keep it in place while the serving is being done.

Marry. To join two ropes end to end in such a manner that the joint will run through a block; also to place two ropes alongside of each other so that both may be hauled on simultaneously.

Martingale or Martingale Boom. A spar erected perpendicular to the forward end of the bowsprit as a strut for the jib-boom and flying jib-boom stays.

Martingale Guys. Stays running from the martingale to each side of the bow.

Martingale Stay. See JIB-BOOM STAY.

Mast. A long pole of steel or wood, usually circular in section, one or more of which are erected vertically on the center line of a ship. The mast may be in one piece or it may be a series of pieces banded together to form one continuous pole.

The masts were originally erected for the sails but they are now used more as supports for the rigging, cargo handling gear and wireless.

Pages 319, 320, 332, 338, 342, 344, 345, 597, 598, 813.

Mast Cap. A band worked around two sections of a mast at the level of the top of the lower section and serving as a support for the upper section. Also applied to the band around a topmast to which the stays are attached.

Page 345.

Mast Cheeks. A term applied to brackets of metal or wood fitted over on each side of a mast underneath the crosstrees or a mast platform.

Mast-Coat. A canvas covering fitted around and lashed or nailed to a wood mast just above the upper end of the mast wedge and also secured at the deck to prevent leakage around the mast.

Mast Collar. A piece of wood or a shape, usually an angle iron, that is formed into a ring and fitted around the mast hole in a deck.

Mast Fittings. Bands, caps, pads, etc., fitted to a mast of supporting topmasts, heels of booms, etc., and to which the shrouds, blocks, etc., are secured.

Pages 320, 321, 332, 335, 338, 344, 345.

Mast, Fore. The mast that is farthest forward in all vessels having two or more masts.

Mast, Heel of. A term applied to the lowest portion of a mast.

Mast Holes. A term applied to the holes in a deck through which the mast passes.

Mast Hounds. The upper portion of a mast at which the outrigger or trestle trees are fitted. Also applied in vessels without outriggers to that portion at which the hound band for attaching the shrouds is fitted.

Mast, Jury. A term applied to any mast temporarily erected to take the place of one that is carried away. Also applied to a temporary mast erected in a new vessel.

Mast Ladder. See LADDER, MAST.

Mast, Lower. A term applied to the lowest part of a mast made up of two or more poles.

Mast, Main. The principal mast in a vessel. It is generally the second mast from the bow.

Mast, Mizzen. A term applied to the third mast in a vessel.

Mast Partner. A term applied to wood planking or steel plating worked around the mast hole in a deck to form a side support for a mast.

Mast Rope. See ROPE, MAST.

Mast, Royal Topgallant. The third section above the lower mast. Its use is confined to square riggers.

Mast Step. A term applied to the foundation on which a mast is erected.

Mast Table. A structure built up around a mast as a support for the cargo boom pivots.

Mast, Top. A term applied to the portion next above the lower mast in a mast made up of two or more poles. Where the mast consists of two poles it is the upper pole.

Pages 597, 598.

Mast, Topgallant. That topmost portion of a mast made up of three poles. The pole next above the topmast.

Mast Trunk. A term applied to a well constructed in a vessel into which a mast may be lowered.

Mast Wedges. A term applied to the wood wedges driven around a mast where it pierces the deck in order to hold it in place.

Masthead. The upper portion of a mast above the hounds.

Pages 597, 598.

Masthead Light. See LIGHT, MASTHEAD.

Mathematical Lines. Lines of a ship, the offsets of which have been developed by mathematical means, i. e., by the use of formulæ, coefficients, etc., rather than by the eye at the dictation only of judgment and experience.

Mathematical Wave. A wave whose contour follows some definite mathematical law. The best known mathematical wave is the Trochoidal wave.

Matthew Walker Knot. See KNOT, MATTHEW WALKER.

Mean Effective Pressure. The total area of the indicator card divided by the length of stroke.

Mean Sinkage. The change in a vessel's mean draft which occurs as the result of an increase in her displacement.

Measurement. The ascertaining of the tonnage of a part or the whole of a vessel either from the plans or from measurements made on the ship according to certain definite rules.

Measurement, New. The measurement of tonnage according to the revised ruling which established 100 cubic feet as the space equivalent of one ton of cargo.

The old rule was based upon 40 cubic feet per ton.

Pages 232, 233.

Measurement, Old. The measurement of a vessel's internal capacity or tonnage was formerly based upon 40 cubic feet as the space equivalent of one ton of cargo. This unit was superseded by that now in use, viz.: 100 cubic feet per ton.

Mechanical Davit. See DAVIT, MECHANICAL.

Mechanical Ventilation. See VENTILATION, MECHANICAL.

Mechanical Work. The product of a force by the distance through which it operates. In the English system of measurements the unit of mechanical work is the foot pound. It is equal to the work required to raise a mass of one pound a distance of one foot against the action of the force of gravity.

Medium Steel. See STEEL AND IRON.

Menhaden Oil. See PAINT.

Merchant Bar. Described under STEEL AND IRON.

Mercury. Described under METALS.

Messenger Chain. A term applied to a chain used in transmitting motion from one machine to another. A chain used in driving a windlass from a winch.

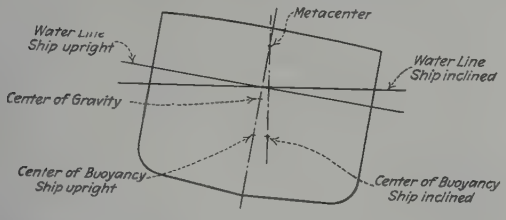
Messenger Wheels. A term applied to wheels that are fitted to two machines for the purpose of allowing one machine to drive the other by means of a messenger chain or rope.

They are more commonly used in driving a windlass from a winch.

Metacenter, Longitudinal. The metacenter corresponding to longitudinal inclination.

Metacenter, Transverse. The point of intersection of the vertical through the center of buoyancy of a ship in the position of equilibrium with the vertical through the new center of buoyancy when the ship is slightly heeled. The displacement is the same in both the inclined and vertical positions referred to.

Pages 175, 176, 183, 184, 185, 186, 193 to 199.



Metacentric Diagram. A curve indicating the height of metacenter (generally above base) for all drafts to which the vessel may be loaded.

Metacentric Height. The distance between the center of gravity and the metacenter.

It is termed transverse or longitudinal as the transverse or longitudinal metacenter is used.

Pages 163, 164.

Metacentric Involute. The locus of the centers of curvature of that curve which is described by the center of buoyancy of a vessel as she is continuously inclined from the upright through all angles of heel.

Metacentric Stability. Initial stability, stability at small angles, which is correctly indicated by the metacentric height.

Metals. Pages 890, 1025.

Antifriction Metal

One of the best known bearing metals for general use has the following chemical analysis: copper, 3 per cent. to 4½ per cent., tin 88 per cent. to 89½ per cent., and antimony 7 per cent. to 8 per cent. When the above metal is used in bearings of small gasoline motors, the antimony content should be increased at least 2 per cent.

Antimony

A metal of bluish-white color. It is brittle and of crystalline or laminated structure. Its specific gravity is 6.7 to 6.8 and melting point 842° F. It burns in the open air with a bluish-white flame. Antimony expands on cooling and thus when alloyed with other metals reduces the shrinking of castings.

It is used as a hardening agency in various alloys which usually contain a high percentage of lead. Among them may be mentioned "type-metal" and "anti-friction" metals under various names. "Brittannia metal" contains 10 parts of antimony to 90 of tin. One per cent. of antimony added to lead increases the hardness of the alloy without materially affecting its other properties.

Brass

Admiralty Metal is a brass to which at least 1 per cent. of tin has been added. It is light yellow in color. It cannot be worked hot except within narrow limits of temperature and for that reason is generally drawn cold from the casting form to the finished product. It resists the corrosive action of sea water.

The chemical properties of Admiralty metal are at least 70 per cent. copper, 1 per cent. tin, not over 0.06 per cent. iron, not over 0.075 per cent. lead and the remainder zinc.

The main use of admiralty metal is in the manufacture of condenser tubes.

Commercial Brass Castings contain from 20 per cent. to 40 per cent. zinc. The straight alloy of copper and zinc with the zinc content below 35 per cent. is soft and ductile and drags severely under the tool. The addition of a small percentage of tin hardens it and the addition of lead improved the machining qualities, causing the chips to break. It is used for the manufacture of oil cups, name and number plates and castings where strength is not required.

Chemical properties of commercial cast brass are usually at least 62 per cent. of copper, at least 30 per cent. of zinc, not over ¾ per cent. iron and from 1½ per cent. to 3 per cent. of lead.

A brass in extensive use for the manufacture of pipe fittings has the following chemical properties: copper, 77 per cent. to 80 per cent., zinc, 13 per cent to 19 per cent., tin at least 4 per cent., iron not over 0.2 per cent. and lead about 3 per cent. The above composition produces a strong fitting, is easy to work in the foundry and although hard and tough, it machines readily, enabling the cutting of true sharp threads.

Page 890.

Commercial Rolled Brass is used for the manufacture of brass sheets for liners, trim, etc., brass pipe hand rails, distributing oil tubes and water pipes. It is also used in the manufacture of brass rod where strength and incorrodibility are not required. It is furnished in the following tempers: "hard," "half hard," "soft," and "spring."

Chemical Properties are similar to the cast brass: copper, 59 per cent. to 68 per cent., tin, not over 1½ per cent., zinc, 32 per cent. to 41 per cent., lead about 3 per cent. and iron not over 0.2 per cent.

Muntz Metal is used in making castings and is rolled into bars, shapes and plates. It is employed in the manufacture of bolts and nuts; it is rolled into plates and used for sheathing ship's bottoms and drawn into tubes for condensers, oil coolers, etc.

Mechanical Properties. In the purchase of Muntz Metal castings, the mechanical requirements are not usually specified. The mechanical properties of rolled Muntz Metal should be at least 45,000 pounds tensile strength per sq. in., 25,000 pounds yield point and 25 per cent. elongation in 2 inches.

Chemical Properties should be: copper, 59 per cent. to 62 per cent., zinc, 38 per cent. to 41 per cent., lead not over 0.6 per cent and iron not over 0.20 per cent.

Naval Brass Castings are employed for making hatch-frames, hatch-cover frames, door frames, scuttle-frames, fittings for mess tables and benches, skylights and chest hinges and fittings; rail and ladder stanchions, brackets, clips, fittings for canopy frames, brass valves and fittings of ventilation systems (except working parts), belaying pins, tarpaulin hooks, brass-pipe flanges, valve hand-wheels, handrail fittings, ornamental and miscellaneous castings and valves in water chests of condensers, etc., aboard ship.

Mechanical Properties are: tensile strength, at least 25,000 lbs. per sq. in., and an elongation in 2 inches of at least 15 per cent.

Chemical Properties. The chemical properties

should be: copper, 60 per cent. to 65 per cent., tin ½ per cent. to 1½ per cent., zinc remainder, iron not over ½ per cent., lead not over 1 per cent. and aluminum not over ½ per cent. The analysis aimed at is copper, 62 per cent., tin, 1 per cent. and zinc, 37 per cent.

Rolled Naval Brass resists corrosion by salt water. It is employed in the manufacture of bolts, studs, nuts, turnbuckles, rolled rounds, pump rods, tube sheets, supporting plates, shafts for valves in water heads and especially for propeller-blade bolts, air pump and condenser bolts and parts requiring strength and incorrodibility. If properly heat treated, the material is suitable for use in automatic or screw machines. It is supplied in rods, shapes, plates and tubing.

Mechanical Properties of rods should be: tensile strength at least 54,000 to 60,000 pounds per sq. in., yield point, at least 25,000 to 27,000 pounds per sq. in., elongation at least 35 per cent. to 40 per cent. in 2 inches, and the ability to withstand bending without cracking through 120° about a radius equal to the thickness of the bar. Rods ½ inch and less in diameter or thickness should equal the greater values stated above. The mechanical properties of shapes should be: tensile strength at least 58,000 pounds per sq. in., yield point equal to at least 40 per cent. of the tensile, an elongation in 2 inches of at least 30 per cent. and the ability to withstand without cracking a bending test about a rod the radius of which is equal to the thickness of the specimen. The mechanical properties of plates should be: tensile strength at least 56,000 pounds per sq. in., yield point at least 25,000 pounds per sq. in., elongation in 2 inches at least 30 per cent., and the ability to withstand bending through 120° without cracking about a radius equal to the thickness of the plate. The mechanical properties of tubes are slightly lower than the above values.

Chemical Properties are: copper, 59 per cent. to 63 per cent., tin, ½ per cent to 1½ per cent., zinc remainder, iron not over 0.06 per cent. and lead not over 0.2 per cent.

Brazing Metal

Brazing Metal is used in the manufacture of flanges for copper pipe and other fittings that are to be brazed. This is not to be confused with Brazing Spelter which has a chemical analysis of about 50 per cent. zinc and 50 per cent. copper, or a brass which is often employed for brazing brass, copper, iron or steel and has a composition of about 80 per cent. copper and 20 per cent. zinc.

Chemical analysis of brazing metal is: copper 84 per cent. to 86 per cent., zinc 14 per cent. to 16 per cent., iron not over 0.06 per cent., and lead not over 0.3 per cent.

Bronze

The bronzes are alloys consisting mainly of copper and tin. It is to be regretted that manufacturers often employ the terms Bronze and Brass indiscriminately. The terms brass (which consists mainly of copper and zinc) and bronze (which consists mainly of copper and tin) should be used in accordance with their firmly established English language meanings.

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Aluminum Bronze is employed in the manufacture of castings such as struts, rudder frames, propeller-blades, worm wheels, gears, etc., in fact, in all castings that require strength and must resist corrosion. In the manufacture of aluminum bronze castings, titanium is usually used as a deoxidizer, and to insure solid castings.

Mechanical Properties of castings are: tensile strength at least 65,000 pounds per sq. in., yield point, at least 35,000 pounds per sq. in., and at least 20 per cent. elongation in 2 inches.

Rolled aluminum bronze may be used for valve stems, propeller-blade bolts, air pump and condenser bolts, etc., and for all purposes requiring great strength. It possesses good bearing qualities and resists corrosion.

Mechanical Properties are: tensile strength of rods and bars at least 72,000 pounds to 80,000 pounds per sq. in., yield point, at least 35,000 pounds to 40,000 pounds per sq. in., depending upon the thickness of the bars, the smaller bars giving the higher values. The elongation in 2 inches should be at least 30 per cent. Shapes and plates have similar mechanical properties.

The Chemical Properties should be: copper 85 per cent. to 87 per cent., iron 2½ per cent. to 4½ per cent., tin not over ½ per cent., aluminum 7 per cent. to 9 per cent., other impurities combined not to exceed 0.1 per cent.

Gun Metal is a bronze that was used for the manufacture of ordnance before steel became available. It is now employed extensively in valve bodies, gear wheels, bronze sleeves for propeller shafts, large bearings, pump manifolds, bolts and nuts, and in fact all miscellaneous composition castings where strength is required. Gun metal cannot be worked hot except within such narrow limits of temperature as to render the process impractical.

Mechanical Properties of Gun Metal should be as follows: It should have a tensile strength of at least 30,000 lbs. per sq. in., a yield point of at least 15,000 lbs. per sq. in., and an elongation in 2 inches of not less than 15 per cent.

Chemical Properties of Gun Metal should be copper, 87 per cent. to 89 per cent., tin 9 per cent. to 11 per cent., zinc 1 per cent. to 3 per cent., iron should not exceed 0.06 per cent. and lead content should not be over 0.2 per cent. The desired analysis is copper 88 per cent., tin 10 per cent., and zinc 2 per cent. The zinc has little effect upon the mechanical properties and is added as a deoxidizer.

Journal Bronze is often specified for use in moving parts subject to considerable wear. It is harder than Gun Metal and is generally used in the smaller bearings. It is also employed for bushings, slippers, guide gibs and in reciprocating engines in valve crosshead bottom brasses, link block gibs and suspension link brasses.

Mechanical Properties are usually not specified except that the fracture shall show a close grained, uniform metal.

Chemical Properties are: copper 82 per cent. to 84 per cent., tin 12½ per cent. to 14½ per cent., zinc 2½ per cent. to 4½ per cent., not over 0.10 per cent. iron and not over 1.0 per cent. of lead. The composition aimed at is copper 83 per cent., tin 13½ per cent. and zinc 3½ per cent.

Manganese Bronze (Cast) is used in manufacture of propeller blades, propeller hubs, engine

framing, and for all casting where great strength is required.

Mechanical Properties are: tensile strength at least 65,000 pounds per sq. in., and elongation at least 20 per cent. in 2 inches.

Chemical Properties. The chemical properties of manganese bronze castings are: copper, 55 per cent. to 62 per cent., zinc, 38 per cent. to 42 per cent., tin not over 1½ per cent., manganese not over 3½ per cent., aluminum not over 1½ per cent., iron not over 2.0 per cent., and lead not over 0.2 per cent.

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Manganese Bronze (Rolled) is used in the manufacture of rolled round rods requiring great strength, where subject to the corrosion of salt water, valve stems, propeller-blade bolts, air pump and condenser bolts, etc.

Mechanical Properties are: tensile strength at least 72,000 pounds per sq. in., yield point at least 36,000 pounds per sq. in., and elongation in 2 inches of at least 30 per cent.

Chemical Properties differ from those of cast manganese bronze and are: copper, 57 per cent. to 60 per cent., tin ½ per cent. to 1½ per cent., zinc 37 per cent. to 40 per cent., iron 0.8 per cent. to 2.0 per cent., lead not over 0.2 per cent. and manganese not over 0.3 per cent.

Phosphor Bronze (Cast) is used in the manufacture of fittings that are exposed to the action of salt water; gears, driving and main nuts of steering gears and parts where strength, good bearing qualities and incorrodibility are requisites.

Mechanical Properties: The mechanical properties of cast phosphor bronze should be as follows: It should have a tensile strength of at least 30,000 lbs. per sq. in. and an elongation in 2 inches of not less than 15 per cent.

Chemical Properties of cast phosphor bronze should be: copper 85 per cent. to 90 per cent., tin 6 per cent. to 11 per cent., zinc 0.9 per cent, iron not over 0.1 per cent., lead not over 1.0 per cent. and phosphorus not over 0.5 per cent.

Phosphor Bronze (Rolled or Drawn) is employed in the manufacture of bolts and nuts, pump rods, valves, valve stems, valve discs, electric contacts, springs and objects exposed to salt water.

Mechanical Properties of rolled or drawn phosphor bronze should be as follows: It should have a tensile strength of at least 50,000 lbs. per sq. in. (spring temper 90,000 lbs. per sq. in.), and an elongation in 2 inches of 12 per cent. to 25 per cent.

Chemical Properties should be: copper at least 94 per cent., tin at least 3.5 per cent., zinc not over 0.30 per cent., iron not over 0.1 per cent., lead not over 0.2 per cent., phosphorus .05 per cent. to 0.5 per cent.

Valve Bronze is used extensively in the manufacture of all sizes of low pressure valve bodies and high pressure valve bodies under 4 inches in diameter. It is easier to produce sound castings with this mixture than with Gun Metal. This is probably due to the higher zinc content. Mechanical properties of Valve Bronze are usually not specified when ordering inasmuch as Gun Metal is used where great strength is required. Chemical properties of Valve Bronze should be: copper at least 87 per cent., tin at least 7 per cent., zinc remainder, iron not over .06 per cent., and lead not over 1.0 per cent.

Vanadium Bronze, like Manganese Bronze, is a misnomer, since it is not a bronze but a brass to which vanadium has been added as a deoxidizer. It is suitable for use in the manufacture of castings subjected to severe stresses and the corroding action of salt water.

Mechanical Properties are: tensile strength at least 55,000 pounds per sq. in., yield point at least 22,500 pounds per sq. in., and an elongation of at least 25 per cent. in 2 inches.

Chemical Properties should be: copper at least 61.0 per cent., tin, vanadium, lead, bismuth, aluminum, and nickel combined not over 1 per cent. and zinc from 37 per cent. to 39 per cent.

Bismuth

The metal has a light reddish color and is so brittle that it can readily be pulverized. Specific Gravity 9.8, melting point 510° F. and boiling point 2300° F. It is slightly repelled by the electro magnet.

It is used only in alloys, usually for the purpose of obtaining a low melting point although it has a hardening effect on lead.

"Wood's Metal" 50 per cent. bismuth, 25 per cent. lead, 12.5 per cent. tin, and 12.5 per cent cadmium, with a melting point of 149° F. is the best known of the Bismuth alloys. Other alloys can be produced to obtain any desired fusing point. Such alloys may be used in connection with electric fire alarms, opening a circuit when melting, or for allowing automatic fire sprinklers to open at the proper temperature.

Cadmium

A lustrous bluish-white metal. Its melting point is 500° F., specific gravity 8.6 to 8.7 and boiling point 680° F. It is used in combination with lead, tin, and bismuth to form alloys when a low fusing point is desired.

Copper

A metal readily distinguished by its peculiar reddish color. It is very ductile and malleable and second to iron in tenacity and in commercial importance.

Properties: Tensile strength and ductility vary with the size of the specimen and method of working; the following values should be readily obtainable:

	Tensile Strength lbs. per sq. in.	Elongation.
Hard drawn Wire .04" dia.	67.000	.85% in 60 inches
Hard drawn Wire .204" dia.	60,000	1.24% in 60 inches
Hard drawn Wire .229" dia.	59,000	1.79% in 10 inches
Hard drawn Wire .460" dia.	49,000	3.75% in 10 inches
Rods or bars 1.00" dia.	45,000	12% in 2 inches
Rods or Bars 2.00" dia.	40.000	15% in 2 inches
Sheets	35,000	18% in 2 inches
Annealed sheets, or rods	30,000	25% in 2 inches

Its specific gravity is 8.81 to 8.95. Its melting point is 1930° F. Its heat conductivity is 73.6 per cent. that of silver and superior to other metals, being 6.1 times that of iron. Its electrical conductivity is equal to silver and superior to other metals, being 6.1 times that of iron. On account of its high ductility, sheet copper can readily be worked while cold into complicated shapes by means of the hammer; hammering tends to harden the metal and finally cause it to crack but annealing at a low temperature restores the original ductility. Castings of pure copper are usually imperfect; 1 per cent. of boron suboxide flux added to the molten copper gives a fair casting. Copper

castings are rarely used except for purposes where high electrical conductivity is required.

Copper resists the corrosive action of the elements although it is attacked by ammonia and to some extent by the more common acids.

Grades: Ingot copper, for reworking, is furnished in the three grades noted below. The grade of wrought copper is not usually specified; it should contain as much as 99.5 per cent. pure copper. An electrical conductivity of 98 per cent. is frequently specified for annealed copper, which is so readily attained in commercial products that the test is seldom made.

"Lake Copper" ingots are produced only from the high grade ores of northern Michigan, U. S. A. They generally command a slightly higher price than "electrolitic" ingots but show no superiority in chemical analysis or other properties, the preference apparently being due to prejudice. Either grade should contain 99.9 per cent. pure copper.

"Electrolitic Copper" ingots are made from ingots refined by the electrolitic process and have the same appearance and properties as "Lake Copper."

"Casting Copper" ingots are of lower grade and may be made in whole or in part from copper scrap. They should contain at least 99 per cent. pure copper. A still lower sub-grade "Secondary Casting Copper" made from inferior scrap should contain at least 98 per cent. pure copper.

Copper Alloys

Copper is the principal constituent of the various grades of brass and bronze and enters to a greater or less extent in the various alloys used for bearings. It is alloyed in varying proportions with gold and silver to increase the hardness of the resultant alloys.

Uses: In addition to the use of copper in the alloys noted above, wrought copper is extensively used for electrical purposes on account of its high electrical conductivity, for tubes in feed water heaters and similar purposes where high heat conductivity is desired, and for pipes and sheathing where considerable ductility or resistance to the corrosive action of the elements is desired. The Alloys (brass and bronze) possess greater strength than copper alone, and are more easily machined, which renders them superior to copper for many purposes.

Cupro Nickel or Benedict Nickel

Cupro Nickel or Benedict Nickel is employed in the manufacture of tubes for condensers, distillers and feed-water heaters. The addition of a small percentage of manganese facilitates the proper working of the alloy in ingots and under rolls.

Chemical Properties desired are: Copper 85 per cent., and nickel 15 per cent.

Gold

Gold has a reddish yellow color. Its Specific Gravity is 19.34. Its melting point is 1915° F. The average thickness of gold leaf is $\frac{1}{280000}$ of an inch, —100 square feet to the Troy ounce. Gold is hardened by alloying with silver and copper. Gold coins are about 90 per cent. pure, the remainder being copper with a little silver. The amount of gold in alloys is stated in "karats" by jewelers and others, 24 karat being 100 per cent. gold, 22 K = 91.7 per cent., 20 K = 83.3 per cent., 18 K = 75 per cent., 14 K = 58.3 per cent., etc.

Iridium

A rare metal with white luster resembling steel. It is very hard and brittle. Its specific gravity is 22.38, iridium being heavier than gold or platinum. It is extremely infusible and almost absolutely inoxidizable. It is used for points on gold pens and in other places where the above properties are desirable and the expense not prohibitive.

Lead

A metal of bluish-gray color and dull metallic luster. Its color turns to dull gray on exposure to air.

Properties: Tensile strength; rolled or cast, 1,780 lbs. per sq. in., hard wire 3,130 lbs. per sq. in., soft wire 2,420 lbs. per sq. in. Specific gravity 11.25 to 11.40. Melting point 625° F. Resists the action of most acids and the ordinary corrosive effects of air and moisture, but is readily attacked by alkalies. Has a tendency, increasing with an increase in temperature, to flow under slight pressure continuously applied and therefore must be rigidly supported to retain its shape.

Grades: Commercial lead is supplied in No. 1 and No. 2 grades. The former should contain 99.5 per cent. of pure lead; the latter 97.5 per cent. Grade No. 2 should be used only for weights and similar purposes.

Lead Alloys

Lead is alloyed with tin in various proportions to form common solder, "half and half" being a standard commercial brand suitable for general use. The alloying of lead with a small percentage of antimony, makes the hardness of the alloy considerably greater than that of the lead alone, without materially affecting the other properties. Lead is alloyed in various proportions with a number of other metals to form "bearing metals"; as it possesses valuable antifriction properties but is far too soft to be used alone. From 1 per cent. to 10 per cent. of lead is frequently added to brass or bronze, making the material easier to work with machine tools and less likely to leak under hydrostatic pressure; it has in all cases a tendency to weaken the alloy to which it is added although with less than 2 per cent. of lead there is but slight weakening of the alloy and a material increase in ease of its machining.

Uses: In alloys, as noted above; in the form of sheets and pipe, lead is extensively used for handling acids as protection against acid fumes. A lead sheathing is frequently used on insulated wires and cables as a protection against the action of moisture and acids. Lead pipe is convenient for use for ordinary plumbing purposes on account of ease in manipulation but on account of its mechanical weakness, it is inferior to iron pipe.

Magnesium

A silver white metal. It is malleable and ductile. Its specific gravity is 1.69 to 1.75, about two-thirds that of aluminum. Its melting point is 1,200° F. It burns in air with intense white light. It is used in the form of ribbon or powder for flashlights and signals. It is used as an alloy with aluminum, the use of 5% of magnesium having a hardening and

strengthening effect on the alloy equal to 10 per cent. of copper.

Manganese

Is never used in its pure form, but usually to form an alloy with iron, called "speigeleisen" when less than 25 per cent. manganese is present and "ferro-manganese" when containing a larger quantity. It is used in the manufacture of steel for removing oxygen from the metal. Both of the above alloys have a very brilliant crystalline fracture.

Mercury

A silver-white metal. It is a liquid at ordinary temperature, but freezes at —39° F., and boils at 680° F. Its specific gravity is 13.58. It is not affected by the atmosphere at ordinary temperatures but oxidizes when near its boiling point. It is tarnished by sulphur fumes and by dust, but may be cleaned by straining through cloth or chamois skin. It readily amalgamates with gold, tin, lead, zinc, and to a less extent copper and most of the other metals except iron and platinum, causing it to tarnish and lose its perfect fluidity. Glass containing a considerable amount of lead will affect mercury if left in contact with it for a long period.

Monel Metal

Monel metal is a natural alloy of nickel and copper. The ore from Ontario, Canada, when smelted produces an alloy consisting of about 65 per cent. nickel, 1.5 per cent. iron and the remainder copper. Monel metal is silver-white in color, machines similar to medium steel, will take a high polish and like nickel is not affected by dry air. It also resists the corrosive effects of fresh or salt water and acid fumes. Its specific gravity is about 8.87. It is employed for valve seats, plumbers fittings, propellers, propeller blades, pump liners, valve stems and valve bodies when great strength is required.

Mechanical Properties: The mechanical properties of cast Monel metal are a tensile strength of at least 65,000 lbs. per sq. in., a yield point of at least 32,500 lbs. per sq. in., and an elongation in 2 inches of at least 25 per cent. The mechanical properties of rolled monel metal bars are a tensile strength of at least 75,000 lbs. per sq. in., a yield point of at least 40,000 lbs. per sq. in. and an elongation in 2 inches of at least 30 per cent. The mechanical properties of monel metal sheets and plates are slightly lower than those above stated for bars.

Nickel

A metal with a white luster, strongly resembling silver in appearance and not tarnishing under ordinary atmospheric conditions.

Properties: Commercial nickel should have a tensile strength of approximately 70,000 lbs. per sq. in.; for annealed bars an elongation in 2 inches of 40 per cent.; for castings a tensile strength of 40,000 lbs. per sq. in., an elongation of 18 per cent. and an elastic limit of about ⅓ the tensile strength. Melting point 3,000° F. Specific gravity 8.27 to 8.93. Is attracted by a magnet, but less strongly than iron and can retain magnetism. It can be used in castings or rolled into sheets or rods. It can be welded either on itself or on iron.

Nickel is unaffected by alkalies and but slightly affected by the action of the elements; being superior in this respect to any other commercial material of equal strength.

Grades: Commercial nickel is likely to contain a considerable percentage of impurities which may affect its physical, properties.

Commercially pure nickel, giving the tensile strength and elongation quoted above, showed the following analysis, which should not be exceeded in impurities for ordinary use:

98.13 per cent. Nickel; 1.15 per cent. Cobalt; .043 per cent. Iron; .08 per cent. Silicon; .11 per cent. Magnesium.

Nickel Alloys

Nickel is a very important constituent of many alloys, in most cases having a tendency to impart ductility, strength and toughness to the alloy

"Nickel Steel" and "Chrome-Nickel Steel" (See Steel) are of the greatest commercial importance.

"Monel Metal" (See separate article) strongly resembles pure nickel in its characteristics.

"German Silver" contains from 18 per cent. to 25 per cent. nickel, 20 per cent. to 30 per cent. zinc, and the remainder copper and somewhat resembles silver, in appearance. It has high electrical resistance, and considerable strength and elasticity, all of these qualities varying with the composition, which as noted above is rather variable. The desirability of the alloy for most purposes depends upon the amount of nickel which it contains. It is used in the manufacture of instruments of various kinds and as a "resistance metal" in electrical work.

"Resistance Metals" include a number of alloys of nickel with copper, iron, chromium, or manganese. They are used for electrical purposes and are generally superior to German Silver for such use. "Nicrome" or "Nickel-Chromium Alloy" is used principally on the resistance element of electrical heating apparatus; it possesses high resistance and will stand long and repeated heating to a white heat without oxidation or other changes in its characteristics.

Uses: In addition to its use in alloys, and for nickel plating, by the electrolitic process; pure nickel is used to a considerable extent where ability to stand high temperature and corrosion, combined with great strength is desired. Among these uses are valve stems, seats, and discs for use with high pressure superheated steam; and keys and bolts in locations where some other metals have failed.

Platinum

A whitish steel-gray metal. Its specific gravity is 21.15. Its melting point is 3,200° F. When pure, platinum is as soft as copper but forms a very hard alloy with iridium which is used for standard weights, for chemical alloys and for gun-vents. Platinum has a cubical coefficient of expansion with heat of .0027 which is less than that of the common metals and practically the same as that of glass; for this reason it is used when it is necessary to maintain an air-tight joint by fusing glass about a metal, as in the connecting wires for incandescent lamps. On account of its ability to withstand heat and the corrosive action of most chemicals, it is used in laboratories for crucibles and similar purposes.

Silver

The whitest metal. Its specific gravity is 11.1 Its melting point is 1,750° F. Silver is malleable and ductile, and superior to all other metals as a

conductor of heat, and equal to copper as a conductor of electricity. Silver alloys with other metals but is used commercially only for ornamental purposes.

Tin

A metal of silvery white luster with slightly bluish tinge. It is malleable but possesses little strength of ductility.

Properties: Tensile Strength about 3,500 lbs. per sq. in. for cast tin; 5,000 lbs. per sq. in. for wire. Melting point 442° F. Specific gravity 7.29. Tin may be rolled or hammered into thin sheets while cold but it is brittle while hot.

Resists the chemical action of the elements and of weak organic acids to a high degree.

Grades: Commercial tin is generally designated by the name of the location of the mine from which it is produced. "Banco" tin is generally considered the highest grade, with "Straits" tin second. The best quality of ingot tin should show at least 99.75 per cent. pure tin, should be free from zinc and cadmium, and contain not over .10 per cent. of Lead, Antimony, Arsenic, Copper or Sulphur. Second grade tin should contain 98 per cent. of pure metal and be free from zinc or cadmium.

Tin Alloys

Tin is alloyed with copper and zinc to form various grades of bronze and brass and with lead to form solder; and with various metals to form "Babbitt" or bearing metals. Its addition to an alloy has generally a hardening effect on the alloy, which is its principal value for these uses.

Uses: In addition to its use in alloys, tin is used for fusible plugs in steam boilers and, to a limited extent, for tubes and cooking utensils where a high degree of resistance to corrosion is desired. The term *"block tin"* as distinguished from *"tin plate"* is used to denote an article made of pure tin.

"Tin plate" is thin sheet steel or iron with a coating of tin applied by a process similar to hot galvanizing. It is used for making "tin" cans and similar purposes. It offers higher resistance to corrosion and the coating is less likely to crack, than with the galvanized (zinc coated) plate. Tin plate is packed in boxes containing 112 sheets 14″ x 20″ in size; 5 pounds of tin are required to coat the total surface of these plates.

"Terne plate" carries 20 pounds of an alloy of 3 parts lead to 1 part tin to the same surface, and is used principally for roofing.

Zinc

A metal of bluish-white color that tarnishes and whitens slightly on exposure to the air.

Properties: Tensile strength of cast zinc 5,000 to 14,000 lbs. per sq. in. rolled sheets 27,000 to 36,000 lbs. per sq. in. Melting point 780° F. Specific gravity 7.14. Boiling point 1.700° F. Vapor burns in the air with a bluish-white flame forming white clouds of zinc oxide.

Zinc is but slightly affected by the action of air and moisture but is attacked readily by acids or alkalies.

Grades: Zinc or "Spelter" in the form of small flat slabs or ingots may be obtained in three grades which should have the following chemical compositions:

	Grade A Per-cent	Grade B Per-cent	Grade C Per-cent
Zinc, minimum	99.85	99.35	98.00
Cadmium, maximum	.05	.50	.75
Iron, maximum	.03	.03	.08
Lead, maximum	.07	.20	1.00
Sum of Cadmium, iron and lead, max.	.10	.50	1.50
Aluminum, maximum	None	None	Trace
Other elements	None	Trace	Trace

Grade A should be used for the manufacture of cartridge cases and manganese "bronze" and other high grade alloys. Grade B is suitable for general use and Grade C for galvanizing. Sheet zinc should contain at least 98.5 per cent. zinc and not more than .08 per cent. iron.

"Secondary Spelter" is made from the dross of galvanizing and other impure zinc and may contain as high as 5 per cent. of iron and 3 per cent. of lead.

Zinc Alloys

Zinc is used principally for the manufacture of brass, bronze, and bearing metals; for which purpose it is alloyed with copper, tin or other metals. On account of its volatility there is always a loss of weight during the hot galvanizing process and in melting brass or bronze.

Uses: Aside from its use in alloys, zinc is used principally for galvanizing iron or steel, as described under galvanizing. The practice of suspending slabs of zinc in steam boilers to prevent corrosion of the boiler through electrolitic action has been found to be of but little value.

Table Showing the Order of

Malleability	Ductility	Tenacity	Infusibility
Gold	Platinum	Nickel	Platinum
Silver	Silver	Iron	Nickel
Aluminum	Iron	Copper	Iron
Copper	Nickel	Aluminum	Copper
Tin	Copper	Platinum	Gold
Lead	Gold	Silver	Silver
Zinc	Aluminum	Zinc	Aluminum
Platinum	Zinc	Gold	Zinc
Iron	Tin	Tin	Lead
Nickel	Lead	Lead	Tin

Metal Furniture. Berths, cabinets, lockers, etc., made of light metal. They are often decorated and finished so that they resemble wood.
Page 817.

Metal Polishers. Men who put the required finish or polish on parts of machines, fittings, etc., by means of a power-operated wheel turned at high speed and known as a buffer.

Metal Specialties. Includes such items as the end strips for linoleum and matting, moldings, tubes, special shapes, etc.
Page 817.

Metallic Cabinet. See CABINET.

Metallic Flooring. See FLOORING, METALLIC, and also GRATINGS.

Metallic Paint. See PAINT.

Metallic Zinc. See PAINT.

Meter, Electric. A measuring instrument for determining the magnitude or relation of the quantities in an electric circuit. Electrical measuring instruments may be classified in several different ways:

1. With regard to their construction and manner of use, into laboratory, portable, and switchboard

types. 2. With regard to quantity measured, into ammeters, voltmeters, wattmeters, etc. 3. With regard to principle of operations, into electromagnetic, electrostatic, electrothermal and electrochemical. 4. With regard to field of use, into direct current, alternating current and universal. 5. With regard to manner of showing result, into indicating, recording and integrating.

Indicating instruments show the value of a quantity directly at the time of measurement. Recording instruments, sometimes called "curve-drawing" or "graphic," give a curve or similar record of the variation of the quantity with time. Integrating instruments take into account the element of time as well as the electrical quantity. The "watt-hour" meters used by electric lighting and power companies upon the consumer's premises are examples of this type. They are usually called "meters," the term "instrument" being applied more specifically to indicating and recording instruments.

Microfarad. The practical unit of electrical capacity. It is the millionth part of the farad.

Middle Body. That portion of the ship adjacent to the midship section.

When it has a uniform cross section throughout, its length its water-lines being parallel to the center-line, it is called the parallel middle body.

Middle Line. Sometimes used in lieu of center line, particularly with reference to bulkheads, floors or other transverse members of the vessel.

Midship Deep Tank. A compartment located near the middle length of a vessel used for carrying liquid cargo, fuel or water ballast, and having bulkheads and flats for its sides and top, as distinguished from a double bottom tank having the inner bottom for its upper limit.

Midship Floor. See FLOOR, MIDSHIP.

Midship Frame. See FRAME, MIDSHIP.

Midship Section. The vertical transverse section located at the mid-point between the forward and after perpendiculars. Usually this is the largest section of the ship in area.

Pages 370 to 468.

Midship Section Coefficient. See COEFFICIENT, MIDSHIP SECTION.

Midships. Same as Amidships.

Mild Steel. See STEEL AND IRON.

Mile, Nautical. See NAUTICAL MILE.

Mill Men. Men who work in a saw mill operating wood working machines.

Milling Cutter. A tool usually of cylindrical form, but also shaped to meet requirements, having teeth or edges for cutting. Milling cutters are mounted on an arbor or have an integral shank for holding them in a machine.

Milling Machine. A machine in which the tool or cutter rotates and the work is fed automatically in the required direction. The cutter has a number of teeth or cutting edges which successively mill away the metal as the cutter rotates.

Pages 699, 722, 733, 734, 765.

Milling Machine, Key Seating. A machine designed for milling keyways.

Keyways located in shafts, etc., where the ends are not open, are generally milled.

Milling Machine, Universal. A milling machine, the work table and feeds of which are specially arranged for doing all classes of plane, circular, helical, index or other milling. Page 699.

Milling Machine, Vertical. A milling machine designed with a vertical spindle for holding the cutter. Page 699.

Mitre Gear. A bevel gear wheel, the sides of which are beveled to an angle of 45°.

Mitred. The operation of making a joint between two timbers, that lie at right angles to each other, by cutting the ends of each to an angle of 45°.

Mixture. See GAS ENGINE, MIXTURE.

Mold. To draw out to full size the lines of a vessel or part of its structure; a pattern or form built up to show the contour or shape of anything.

Mold, Beam. A pattern showing the curvature, commonly called camber, of the beams for a deck.

Mold Loft. A space used for laying down the lines of a vessel to actual size and making templates therefrom for the structural work entering into a hull.

The second floor of a large building is usually used as a mold loft, the floor being cleared and planed true. A vessel's lines are drawn in and faired on the floor, the body lines being scrieved in to insure their being preserved until the structural work is completed. Practically all the templates for shaping and laying out the structural work in a ship are made in the mold loft from the lines on the floor.

Upon the completion of the mold loft work on a vessel the floor is planed clean before laying down the next ship.

On account of the desirability of having the mold loft as level as possible and to prevent warping it generally consists of two layers of planking laid diagonally and opposite. This method prevents the floor from warping, provides a top facing that may be renewed after being planed thin and on account of the seams running diagonally there is less likelihood of the lines laid down following a seam in the floor.

Mold, Skeleton. A template or pattern, made up of open framework instead of solid, to show the outline of some part.

Molded Breadth. The ship's maximum breadth measured to the outside or heel of frame bar and occurring generally, though not always, at the midship section.

Molded Depth. The vertical distance from the base line to the molded line of main deck at side measured at the midship section.

Molder. See MOLDING MACHINE.

Molding. Ornamental strip either of wood or metal used for finishing purposes.

Molding, Knuckle. A batten or strip of wood or steel usually cut to a half round cross-section and used to cover the knuckle line.

Molding Machine. A machine for making wood molding. The knives are usually attached to a cutter head carried on a horizontal spindle which is supported over the work table. Rolls and springs are provided for feeding the work to the machine and holding it in place during the operation.

Molding Machine, Variety. A wood working machine designed to cut moldings on the edges of the work.

The cutting tools or knives for this type of machine are carried on a vertical spindle projecting through the work table and the work rests on the upper surface of the table and is fed to the cutters by hand.

Molding of a Floor. Its depth.

Molding of a Frame. The measurement of the athwartship flange or web of a frame.

Molding of a Keel. Its depth, or dimension perpendicular to the bottom line.

Molding of a Keelson. Its depth.

Molding of a Stem. Its depth or dimension fore and aft.

Molding of a Sternpost. Its depth or dimension fore and aft.

Moment. The moment of an elementary mass about a plane is the product of the mass times its algebraic distance from that plane. The algebraic distance is plus when on one side and minus when on the other side of the reference plane. The moment of a body about a plane is the algebraic sum of the moments of the elements of mass constituting that body. If the body is of infinitesimal thickness, the reference plane becomes a line, which line is termed the axis of moments.

If now the mass of elementary thickness be assumed of uniform density throughout, the conditions for considering geometrical moments of plane areas are fulfilled. Geometrical moments of plane areas are measured in units of area times units of length, no account whatsoever being taken of mass. Likewise, the geometrical moment of a volume is measured in units of volume times linear units, the volume being considered of uniform density, but no definite value being assumed.

The moment of any body or volume about a plane or of any area about an axis is numerically equal to the product of the mass of the body or of the volume or area times the algebraic distance of the reference plane (or line) from the center of gravity of the body (volume or area).

The moment of a force about any point is the product of the force times the distance of its line of action from the point. The moment of a force is measured in units of weight times units of distance as foot tons or foot pounds.

Moment of Inertia. The moment of inertia of an elementary mass about a plane or an axis is the product of the elementary mass times the square of its distance from the reference plane or axis.

The moment of inertia of a body about a plane or an axis is the sum of the moments of inertia of all its elements of mass about the reference plane or axis. The moment of inertia of a body about an axis is ordinarily termed its polar moment of inertia. If the body is of an indefinitely small and uniform thickness and is of uniform density, the conditions are fulfilled for considering the geometrical moment of inertia of a plane area. Under these conditions the reference plane becomes a line termed the axis, and in the case of the polar moment of inertia the axis becomes a point. Geometrical moments of inertia of plane areas are measured in units of area times linear units squared. In a similar manner geometrical moments of inertia of volumes are measured in units of volume times linear units squared.

The moment of inertia of any body (volume or area) about a plane (or axis) is equal to the mass of the body (or volume or area) times the square of the distance between the reference plane (or axis) and a parallel plane (or axis) through the center of gravity of the body (volume or area) plus the moment of inertia of the body (volume or area) about the parallel plane (or axis) through its center of gravity.

Moment of Inertia of Section. The sum of the products formed by the multiplication of the mass of every particle of a material system by the square of its distance from a straight line known as the axis.

Moment to Alter Trim. The moment, i. e., the weight times the distance which it is moved which is required to effect a change in the trim of a vessel of one inch; usually expressed the formula:

$$w \times d = \frac{W \times GM}{12 \times L} \text{ foot-tons.}$$

where

w = the weight moved in tons
d = the distance in feet
W = the displacement in tons
GM = the longitudinal metacentric height in feet
L = length in feet

Monel Metal. Described under Metals.

Monitors. A type of war vessel intended principally for work against shore batteries and fortifications. Its principal characteristics are moderate displacement, low speed, very low freeboard, heavy main battery guns, and good cruising radius. The modern type of heavy gun emplacement known as the turret was first used on vessels of this type.

Monkey Forecastle. A small forecastle. The enclosed space is generally used for the accommodation of anchor handling appliances and the deck proper for the stowage of the anchors themselves.

Monkey Tail. A term applied to a curved bar fitted to the upper, after end of a rudder and used as an attachment for the rudder pendants.

Monorail Hoist. A type of hoisting gear, usually electric, designed to travel along a single overhead track.
Pages 791, 959.

Mooring. A term applied to the operation of anchoring a vessel in a harbor, securing her to a mooring buoy or to a wharf or dock by means of chains or ropes.

Mooring. To make a vessel fast to a buoy, quay or wharf or by anchoring. Technically, a vessel is moored when she has two anchors down at a suitable distance apart with such a length of chain on each that she is held with her bow approximately stationary on a line between them, although allowing the stern of the vessel to swing with the tide and wind.

Mooring Anchor. See Anchor, Mooring.

Mooring Bitts or Bollards. See Bitts, Mooring.

Mooring Buoy. See Buoy, Mooring.

Mooring Machine. A term applied to a machine that is similar in construction to a winch and which is used for the purpose of docking and warping vessels. Automatic control of the tension in the mooring lines to take care of the change in trim, draft, and the tides are obtained in some makes of these machines.
Page 845.

Mooring Pipe. A round or oval casting or frame inserted in the apron plate or bulwark plating of a ship through which the mooring chains, hawsers or warps are passed.
Page 545.

Mooring Staple. A single or double ring shaped fitting attached to the shell of a ship for the purpose of securing mooring lines.

Mooring Swivel. A device generally used by men-of-

war in mooring to prevent a foul hawse. The cables are disconnected and shackled to the swivel just forward of the stem. When the ship swings the swivel turns and the cable is kept clear. The swivel is similar to the usual form, but larger and heavier, and is fitted at either end with two links and shackles for attaching to the cables.

Moorings. Heavy chains permanently anchored in a harbor to which vessels may ride. To these are attached buoys having chains of the proper length and strength to haul the fast on board through the hawse pipes.

Mortising Machine. A wood working machine in which an auger and a chisel are worked automatically in performing the operations necessary to produce the square or rectangular mortise usually employed in wood work.

Motor Boat. Any vessel propelled by an internal combustion engine. According to the rules to prevent collisions in the navigation laws, all vessels under sixty-five feet in length, propelled by machinery, except tug boats and tow boats propelled by steam, are to be considered as motor boats.

The term is usually applied to small boats propelled by internal combustion engines.

Motor, Compound. A direct current motor which has both a shunt and series field coil.

Motor Controller. See CONTROLLER, MOTOR.

Motor, Electric. A machine which transforms electrical energy into mechanical energy.

Lloyd's Rules suggest that great care should be taken that generators, motors and electric leads on board ship are not located in such a place that they will influence the compasses.

Pages 909, 938, 955, 956, 1065.

Motor Generator Set. A combination consisting of an electric motor and generator on the same shaft.

Page 954.

Motor, Main. The large motor direct connected to the line shafting in a vessel fitted for electric drive.

Page 934.

Motor, Series. A direct current or alternating current motor in which the field coil is connected in series with the armature winding, thus allowing the armature current to flow through the series field. The high starting torque and the variable speed of the direct current motor make it specially suitable for cranes and traction purposes.

Motor Ship. A ship driven by some form of internal combustion motor.

In its broad sense the term may be considered to include small vessels driven by gas or gasoline engines. It is generally applied, however, to slow cargo vessels having lengths up to five hundred feet and driven by oil engines. For this service oil engine installations have the following advantages over steam or electrical machinery:

The elimination of boilers, stoke holds, and coal bunkers with a resultant increase in cargo space.

Greatly decreased consumption of fuel.

Decrease in the size of operating force with resultant saving in wages.

Reduction in machinery space temperatures with resulting increase in comfort and efficiency of operating force.

During recent years this type of ship has increased in popularity largely on account of the successful operation of ships already in service.

Pages 438, 439, 440, 441, 442, 443, 444, 1104, 1105. Plate XXIII.

Motor, Shunt. A direct current motor in which the field coil is shunted across the armature winding. The speed of a shunt motor is practically constant from no load to full load.

Motor, Synchronous. An alternating current motor, the speed of which bears a certain fixed relation to the frequency of the circuit independent of the load on the motor. Such a motor must be brought up to synchronous speed by external means or by a special winding before the field winding is energized.

Mouillage. A French term applied to a vessel's berth in a harbor.

Mouse a Hook. To pass several turns of wire or small stuff around the point and back of a hook to prevent its unhooking in lowering or canting.

Mousing. The small stuff or wire used to mouse a hook.

Movable Propeller Blades. Propeller blades cast separate from the boss and attached thereto by bolts. These bolts are sometimes worked in such a manner as to permit of a slight adjustment of the pitch of the blade.

Muck Bar. Described under Steel and Iron.

Mud Drum, Boiler. See BOILER MUD DRUM.

Mudhole. A handhole in the mud drum of boilers to provide access for cleaning purposes.

Muffler. See GAS ENGINE, MUFFLER.

Mullion. A member running parallel with the stiles on a panel door used to receive the inner edges of the panels where two or more panels are used.

Multiple Drill. See DRILLING MACHINE.

Multiple Punch. See PUNCH, MULTIPLE.

Mult-au-matic. An automatic machine designed for boring, facing, turning or threading operations either singly or in combination.

Page 712, 713.

Mushroom Anchor. See ANCHOR, MUSHROOM.

Mushroom Ventilator. A ventilator shaped like a mushroom, and designed so that the air will be drawn up under the overhanging umbrella of the mushroom and thence into openings into the vertical pipe leading down into the vessel. The object of the mushroom is to permit access of air but prevent access of water.

Page 673, 1053.

N

Natural Ventilation. See VENTILATION, NATURAL.

Nautical Mile. A distance approximately equal to 6,080 feet, or exactly one-sixtieth of a degree on the equator.

Naval Architect. Primarily, one responsible for the design and alteration of ships or for the investigation and carrying out of important projects in connection therewith.

Frequently he is charged with responsibility for the maintenance of vessels in service, for valuation proceedings, for the construction of new vessels, etc., though these duties do not fall strictly within his province.

The Naval Architect is responsible for the strength, stability, speed, trim and weight of the vessel in hand. It is, therefore, necessary that he should have an ade-

quate knowledge of the principal items entering into the vessel such as machinery, cargo, fittings, etc., although he is concerned with the details of hull, fittings, etc., only.

Naval Constructor. Primarily, one responsible for the building and maintenance of ships or for the investigation and carrying out of important projects in connection therewith.

He is sometimes charged with responsibility for the design of new vessels and for the alteration of those already in service. This is true in the United States naval organization.

The Naval Constructor is responsible for the proper interpretation of plans and specifications, for the fabrication of the vessel's structure, installation of fittings, and testing of parts, systems and equipment in accordance with the specifications and the best practice both as to general intent and as to detail.

Navigating Bridge. See BRIDGE, NAVIGATING.

Navigating or Flying Bridge. See BRIDGE, NAVIGATING.

Needle Valve. See VALVE, NEEDLE.

Net Tonnage. See TONNAGE, NET.

Netting. Nets made of either fiber or wire rope and used as a covering for hawse pipes, chock openings, etc., as landings in cage masts, and under spars in lieu of foot-ropes.

Neutral Axis. Consider the cross section of a beam, girder, or ship which is stressed by bending. The extreme fibers on one side are in compression while the extreme fibers on the other side are in tension. At some axis between them exists neither tension nor compression. This is termed the neutral axis for the section. The neutral axis passes through the center of gravity of the section.

Neutral Equilibrium. See EQUILIBRIUM, NEUTRAL.

Newel Post. An ornamental upright pillar about which winding stairs are formed.

Nibbing Plank. See PLANK, MARGIN.

Nickel. Described under Metals.

Nickel Steel. See STEEL AND IRON.

Nicrome, Nickel-Chromium. Described under Metals.

Nigger Head. See GYPSY OR WINCH HEAD.

Nipple. A piece of pipe, having an outside thread at both ends, used for making pipe connections. Close nipples are those that are threaded throughout. Short nipples are those having a small amount of unthreaded surface between the threaded ends.

Shoulder nipples are those having a shoulder between the two pipe threads.

Sub-nipples are those having different threads on the ends.

Long nipples are those having a length of from 4 to 12 inches.

Reducing or swaged nipples are those having one end smaller in diameter than the other.

Non-Condensing Engine. See ENGINE, NON-CONDENSING.

Non-return Valve. See VALVE, NON-RETURN.

Nosing. The molding or part of the tread of a staircase which projects over the riser.

Nozzle, Boiler. A fitting with a finished face and fitted with stud bolts for the attachment of a pipe line to a boiler.

Nozzle, Turbine. See TURBINE NOZZLE.

Numbers or Numerals, Longitudinal, Transverse or Equipment. See LONGITUDINAL, TRANSVERSE OR EQUIPMENT NUMBER.

Nut Facing Machine. A machine designed to automatically face and machine finish nuts.

Nut Machine, Hot Press. A machine designed to automatically heat and forge nuts from bar stock.

Nut of Propeller Shaft. A nut attached to the after end of a propeller shaft to prevent the propeller from backing off.

Nut Tapper. A machine similar in design and operation to a drilling machine, provided with tools for tapping the thread in nuts. Such machines are made with single or multiple spindle.

O

Oakum. A substance made from soft vegetable fibre such as hemp and jute impregnated with pine tar. It is principally used for caulking the planking on wood decks of steel vessels and for caulking all the planking on wood ships where watertightness is desired. It is also used for caulking around pipes.

Pages 825, 827.

Oakum Spinners. Men who take the bulk oakum from the bales and roll or spin it into a loose or soft rope, called a thread, of the proper size to allow it to be driven into the seams between the planks.

Office Wire. See ELECTRIC WIRE AND CABLE.

Offing. That distance out from shore which permits the proper maneuvering of a vessel without danger of her taking the ground or of encountering other obstacles to her freedom of movement.

Offset. A term used by draftsmen and loftsmen for ordinate to ship's curves. See JOGGLE, for its meaning in structural work.

Ohm. A practical unit of electrical resistance. It represents the resistance of a column of pure mercury 106.3 cm. long, of uniform cross section and weighing 14,4521 gm. at 0° C.

Ohm's Law. The current in a direct current circuit is proportional to the e. m. f. and inversely proportional to the electrical resistance (*i.e.*, the current is equal to the voltage divided by the resistance).

Oil Burner. A device for vaporizing or atomizing oil so that it burns like a gas. There are three general types. The spray burner atomizes the oil by steam or compressed air. The vapor burner converts the oil into vapor before passing it into the furnace. The mechanical burner atomizes the oil by high pressure and by passing it through a small orifice.

Pages 988, 996.

Oil Cooler, Lubricating. A device on the order of a condenser, except that the cylinder is installed with its axis vertical. Numerous brass tubes, through which cold water circulates, pass between the top and bottom tube sheets and the oil is cooled by coming in contact with their cold surfaces. Baffles are generally installed compelling the oil to pass back and forth among the cold tubes in travelling from the top to the bottom.

Page 997.

Oil, Creosote. An oil obtained by the redistillation of crude tar which, in turn, is derived as a distillate in the destructive distillation of wood.

Oil Forge. A forge in which oil is used as fuel. See FORGE.

Oil, Fuel. A heavy mineral oil used extensively in place of coal for firing the boilers.

The advantages of oil fuel are as follows, viz:

(a) Oil requires less bunker space than coal for a given steaming radius.

(b) It can be carried in the double bottom and other places where neither coal nor cargo can be stored.

(c) Bunkering can be effected with greater dispatch and can be carried on in darkness or bad weather.

(d) The space usually given to coal can be occupied by freight-paying cargo.

(e) It is not attended with dirt and other discomforts incident to coal bunkering.

(f) Labor and machinery are not required for handling ashes.

(g) Oil fuel eliminates stoking, thus reducing the size of the fireroom crew.

(h) It possesses greater thermal efficiency than coal and reduces fuel costs.

(i) Uniform steam pressure is easily maintained, thus insuring a steady rate of speed and reducing the deterioration of furnaces and boilers resulting from uneven temperatures.

Oil Furnace. See FURNACE, OIL.

Oil, Hard Wood. Oil obtained from the tar of a hardwood by redistillation.

Oil, Pine. An oil, lighter than water, obtained by distillation from the crude resins and turpentine gathered from the pine tree.

Oil Piping. See PIPING, OIL.

Oil, Pump. See PUMP, OIL.

Oil, Resin. An oil obtained from resin by redistillation at high temperatures.

Oil Service Tank. In a lubricating oil system the tank from which the oil feed pipes lead in supplying the various journals, etc. In a fuel oil system the tank or tanks from which oil is drawn direct to the burners.

Oil Tight Bulkhead. See BULKHEAD, OIL TIGHT.

Oiltight. Having the property of resisting the passage of oil. In shipwork this is accomplished by packing or calking after careful riveting of the joints.

Oilers. Members of a ship's engine room force who attend to the lubrication of all parts of the engines.

Oiltight Bulkhead. See BULKHEAD, OILTIGHT.

Old Man. A piece of heavy bar iron bent to the form of a "Z." One leg of the "Z" is bolted to the material that is to be drilled, and the drill top placed under the other leg and adjusted so the "old man" holds the drill against the material.

On Board. Aboard; in or on a ship, but having a different significance from "on deck" in that "on board" applies to any location in or on the ship, as any of its parts, while the term "on deck" is generally limited to a location on the weather deck.

On Deck. On the weather deck; frequently used to imply "on duty."

Open Bridge House. A bridge house open to the weather at each end.

Open Hearth Steel. See STEEL AND IRON.

Operating Engineers. See ENGINEERS, OPERATING.

Operating Gear, Turbine. See TURBINE OPERATING GEAR.

Ore Carrier. A vessel designed to carry ore in bulk and similar in construction to a collier. See COLLIER.

Orlop Beam Stringer. See STRINGER, ORLOP BEAM.

Orlop Deck. See DECK, ORLOP.

Orlop Deck Stringer. See STRINGER, ORLOP DECK.

Orlop Deck Stringer Bar. See STRINGER, BAR.

Orlop Stringer. See STRINGER, ORLOP.

Oscillating Engine. See ENGINE, OSCILLATING.

Oscillation. The roll of a ship from the extreme angular position on one end to the corresponding position on the opposite side.

Oscillation, Arc of. The total angle swept through by a ship in one oscillation.

Oscillation, Period of. The time occupied by a ship in performing one complete oscillation.

Pages 162, 163.

Outboard. Away from the center toward the outside; without the hull.

Outboard Delivery Pipe. See PIPE, OUTBOARD DELIVERY

Outboard Profile. A plan representing the longitudinal exterior of a vessel showing the starboard side of the shell, all deck erections, masts, yards, rigging, rails, etc.

Pages 370 to 468.

Outer Bearing. A term applied to the bearing on the sponson supporting the outer end of the paddle wheel-shaft.

Outer Keel. See KEEL, OUTER.

Outer Skin. See SKIN, OUTER.

Outlet Cock. A cock or valve with a circular channel through the valve stem arranged so that a clear opening is obtained by 90 degrees rotation, located so as to drain any receptacle.

Outermost Fibre. In calculating the strength of vessels, that part of the vessel's strength girder which is farthest away from the neutral axis of the strength section.

Outrigger. A term applied to a small racing boat having the oarlocks located on framework extending beyond the sides.

Outriggers. A term applied to bars bolted to the outer ends of the cross-trees on each side of a mast for the purpose of spreading the stays to the topmasts.

Also applied to the upper mast tables which form a support for the topping lifts operating the cargo booms.

Pages 320, 343.

Outside Plating. See SHELL PLATING.

Outside Strake. See STRAKE, OUTSIDE.

Oven, Bake. A commissary appliance used on board ship for baking bread, pastries, etc. The oven proper consists of one or more chambers externally heated, electrically or by burning coal or fuel oil.

Pages 1095, 1096, 1098, 1099.

Oven, Core. An oven in which cores used in foundry work are baked to insure their holding their form while pouring the molten metal.

Oven, Drying. An enclosure or room in which green timber is seasoned by the application of dry heat for a given period of time.

Overflow Pipe. A pipe fitted on a tank or compartment to permit excess liquid to escape, thus preventing undue pressure on the tank.

Overhang. That portion of a vessel's bow or stern which projects beyond a perpendicular at the waterline.

Overhaul. To repair or to put in proper condition as to overhaul a tackle.

Where two vessels are going in the same direction and where one vessel is ahead of the other, the vessel behind is said to be overhauling the vessel in the lead when it is closing up the distance between the two by going at a faster speed.

Oxide of Iron. See PAINT.

Oxter Plate. See PLATE, OXTER.

Oxygen Compressor. See COMPRESSOR, OXYGEN.

Oxy-Hydrogen Torch. An apparatus through which oxy-hydrogen gas flows and is ignited to burn away or weld metal.

P

Pacific Iron. A fitting consisting of a Y-shaped piece hinged to a bearing pin. The inner end of a cargo boom is secured between the prongs of the Y and the bearing pin is passed through a pad eye on the mast, an eye on a mast ring or inserted through a hole in a pedestal. The cargo boom can be raised or lowered by means of the hinge and rotated by means of the pin. Also called Gooseneck.

Pages 336, 337.

Packers. Men who fit lamp wicking, tarred felt or other material between parts of the structure to insure water or oil tightness.

Packet Bunkers. A ready service bunker of small dimensions.

Packing, Gland. Packing for use in a stuffing box and against which the gland is forced.

Packing material varies in character according to its use.

Pages 1030, 1031.

Packing, Metallic. Metal rings fitted in cylinders, cylinder stuffiing boxes, etc., also bronze or white metal segments assembled in the form of an internal and external cone, fitting into each other and held in place by springs, thus floating them on the rod, to eliminate friction.

Page 1030.

Pad Eye. A fitting having an eye integral with a plate or base in order to distribute the strain over a greater area and to provide ample means of securing. The pad may have either a "worked" or a "shackle" eye or more than one of either or both. The principal uses of such a fitting is that it affords means for attaching rigging, stoppers, blocks, and other movable or portable objects. Pad eyes are also known as lug pads, the two terms being practically synonymous.

Paddle Beams. Athwartship supporting girder at each end of the paddle box.

Paddle Box. A semicircular structure, placed at the stern or one on each side of a vessel, for the purpose of housing the paddle wheel.

Paddle Box Annex. A continuation of the paddle box structure faired into the sides of the ship and generally used for staterooms, toilets, etc.

Paddle Box Cabin. Staterooms or other living quarters built into the prolongation of a paddle box.

Paddle Box Stays. Inclined struts running from the planking or plating of a vessel to the sponson and spur beams supporting a paddle box structure.

Paddle Wheel. A large wheel consisting of two or more sets of arms and rims with radial boards or floats attached to the outer ends of the arms and running between the rims. The floats may be fixed in position, or feathered so that they enter and leave the water at the most efficient angles.

Paddle Wheel, Feathered. A paddle wheel having floats that are controlled by a mechanism so that they enter and leave the water at the proper angle.

Paint. A viscous or plastic mixture of solids and liquid applied in thin coats for protection or decoration or both. Paint may be defined as a close union of solids or pigments and liquids or binder.

Pages 802, 803, 804, 805, 806, 807.

The American Bureau of Shipping requires that all steel or iron work should receive at least two coats of good oil paint, and no outside steel work, such as shell plating, etc., should be painted until shortly before the vessel is launched, in order that the removal of the mill oxide or scale may be assisted by a full exposure to the weather, during the construction of the vessel. All faying surfaces throughout the structure of the vessel are to be well coated with red lead, or other approved composition.

Aluminum Paint

Consists of a mixture of finely divided aluminum powder and a special vehicle containing hard varnish resin, raw linseed oil and turpentine. This paint has very good heat resisting properties and when applied to iron and subjected to a dull red heat is only slightly affected.

Anti-Corrosive Ship's Bottom Paint

This paint is generally made of metallic zinc, zinc oxide, shellac, alcohol, pine tar and turpentine and is designed to insulate the metal in the anti-fouling coat from the steel plating, preventing corrosion and pitting. Anti-corrosive and anti-fouling ship's bottom paints differ radically from oil paints in that the vehicle portion consists of shellac, alcohol, and pine tar solution. This produces a very rapid drying paint which can be submerged a few hours after application.

Anti-corrosive ship's bottom paint is designed to prevent corrosion from electrolysis. This coat does not offer resistance to the flow of electric current but contains a metal which is electropositive to iron. Electrolysis decomposes this metal and deposits it on the steel hull. Insulation or protection from electrolysis is not obtained by paint which offers resistance to the flow of electric current since abrasion and movement of the plates will prevent the maintenance of a continuous film necessary to prevent the passage of current. A number of proprietary paints are on the market and are reported as giving satisfactory service. Anti-corrosive paint also provides a solid base for the anti-fouling paint.

Anti-Fouling Ship's Bottom Paint

This paint is intended to prevent marine growth from adhering to the underwater surface of the hull. This is effected by the presence of a poisonous compound in the film, usually mercuric oxide, copper oxide, copper cyanide, etc. An efficient anti-fouling paint is so designed that it will exfoliate, thereby presenting new surfaces at regular intervals. In this class falls the so-called copper paint for wooden hulls. This paint usually contains a substantial percentage of copper oxide ground in a special vehicle.

Asphalt Solution

Is a viscous asphaltic solution in mineral spirits or turpentine substitute and is applied to metal surfaces as a priming coat for the bituminous cements and enamels. The enamel is solid and is applied hot, ranging in thickness from 1/16″ to 1/4″. Asphaltic compounds are specially prepared to resist fairly high temperatures without running or sagging, and low temperatures without being unduly brittle. Asphaltic enamels made of a properly balanced mixture of asphalts or tars having various melting points and other specific characteristics, admixed with rosin, Portland cement and mineral spirits produce compositions which have been found to give excellent service. Bituminous compositions are usually applied to places difficult of access upon completion of new construction and to bulkhead surfaces, shaft alleys, coal

bunkers, storage lockers, trimming tanks, drainage tanks, gravity tanks, reserve feed water and ships' fresh water tanks.

In the application of all bituminous mixtures or compositions, great care should be taken to obtain a clean dry surface. The bituminous or asphaltic solution is applied with a brush and when nearly dry a coat of the enamel or cement is applied hot. The cement is usually applied to horizontal surfaces and spread on to a minimum thickness of ¼"; the enamel applied to vertical surfaces is usually 1/16" or ⅛" in thickness.

Boottopping Paint

Boottopping paint is generally a mixture of zinc oxide, lamp black and a special varnish. This paint is applied at the waterline of steel vessels, and will last for several months, whereas an ordinary oil paint would be washed off or destroyed in a few days by the alternate action of the water and the air. The special varnish used in the preparation of boottopping paint requires careful consideration and should be tested for its suitability in the manufacture of this type of paint. Tung oil varnishes are very water resistant but have a tendency to thicken up or "liver" when mixed or ground in zinc oxide.

Canvas Preservatives

White and tinted—is usually a mixture of crude paraffine, paraffine oil, turpentine substitute and kerosene; if a tinted preservative is desired a quantity of zinc oxide and sufficient tinting material to produce the desired color is added. This type of preservative can be applied by painting with a brush, spraying with an air gun or by dipping the fabric.

Cork Paint

Known also as under cork, consists of varnish, a small quantity of linseed oil and drier and a good grade of whiting. This mixture is painted on the surface to be corked and allowed to become tacky. Ground cork of fairly large grain is blown or pressed on and the paint allowed to set hard. Cork paint is usually applied to interior surfaces in living quarters, store rooms, etc., which become chilled by the conduction through the metal, and sweating occurs due to the extremes in temperature; over the cork the usual interior finishing paint is applied.

Deck Paint

This type of paint is usually prepared with spar varnish, turpentine drier and coloring pigment, which dries rapidly forming a hard water resisting coating.

Linoleum Cement

Is usually a mixture of shellac, crude rubber, whiting, alcohol and gasoline and in some respects is similar to certain brands of marine glue on the market. This cement is used to bind the linoleum to the deck or other surfaces without the use of fastening appliances. It is of such a character that it allows the linoleum to spread without buckling or injury.

Metallic Oxide of Iron Paints

Are dark in color, usually red or brown, and when properly prepared are extremely durable. Red lead or zinc chromate or both of these pigments when added to an iron oxide base produces an excellent metal preservative paint which will give service equal to red lead. In connection with the application of paints intended for use as metal preservatives, it will readily be seen that an ordinary paint giving good protective service on wood will not be satisfactory to iron and steel, since the characters of the two surfaces are entirely different, steel presenting a relatively smooth, non-porous surface which makes it necessary for the excess oil or other vehicle to harden by oxidation or evaporation, whereas wood, having many pores, absorbs the excess oil which amalgamates with the fibers of the wood forming an inseparable bond. In this connection it is recommended that skilled labor be employed for the application of paint, and especially paint intended or designed for metal surfaces. Many failures of paint can be traced to careless handling or improper application.

Priming Paint

Red lead, free from coarse vitrified particles mixed with pure linseed oil makes the best priming coat for iron and steel. Consumers are cautioned, however, not to purchase or use red lead paste which has been ground sufficiently long enough to over oxidize the oil. When pure dry red lead (containing a substantial amount of litharge as a natural constituent) is mixed with pure raw linseed oil within 18 hours before application it can be applied to iron and steel without the addition of a thinner or drier. This practice is not recommended, however, since the drying conditions usually encountered in marine painting are not very favorable and the addition of a thinnner and drier will enable the operator to apply a thin uniform coat which will dry rapidly, forming a very tenacious, hard, elastic weather resisting film. Rust resisting or preservative coatings are usually dark in color, since the white pigments (basic carbonate, basic sulphate white lead and zinc oxide) have certain physical and chemical characteristics which make them unsatisfactory for priming paints for iron and steel.

Smoke Stack Paint

Smoke Stack Paint is usually made of zinc oxide, white lead, litharge and Damar varnish thinned with kerosene and a substantial amount of dryer added. This paint is very resistant to high temperatures. Another type of smoke stack paint is made as follows: white lead, silica, litharge, boiled linseed oil and mineral spirits. This mixture is tinted to the desired shade and applied in the usual manner.

Spar Varnish

It is pale in color, very rapid drying, water resistant, elastic and durable; it is used to coat the "bright work" of ships and due to its rapid drying qualities it is frequently used on repair work. This varnish brushed on a surface spread out to a very thin film. which accounts for its rapid drying properties. It is somewhat deficient in durability, however, owing to the thinness of the film.

Pigment

The solid portion of paint usually white lead, red lead, oxide of zinc, oxide of iron, Van Dyke brown, Venetian red, Indian red, vermilion, Prussian and Chinese blue, ultramarine blue, blacks and lakes. In addition to the above mentioned pigments, the following *Extenders* are used: Barytes, silica, Asbestine, aluminum silicate, calcium carbonate, etc.

Extenders have specific value and are used to re-

duce the spreading power and increase the thickness of the paint film.

Pigments—Color

Color pigments are used for tinting the base pigment and are usually as follows:

(a) Natural Earth Colors: Ochers, siennas, umbers, metallic brown, Indian red and mineral blacks.
(b) Chemical colors: Prussian and Chinese blue, lead chromate, chrome green, ultramarine blue, vermilion, etc.
(c) Carbon blacks made by carbonizing animal and vegetable substances.

Basic Carbonate—White Lead

Corroded white lead was first commercially produced in the United States about 100 years ago. This pigment is manufactured by two principal processes, known as the Dutch process, or stack method, and the chamber process, or quick method. The Dutch process probably produces about 75 per cent. of the corroded white lead used in the United States. Briefly described, this method is as follows:

A series of clay pots surrounded with tan bark and containing dilute acetic acid (vinegar) are filled with discs of metallic lead. Carbonic acid from the fermenting tan bark acts on the lead, converting it into hydrated carbonate of lead. This process requires about 90 days. In the Chamber process the dilute acetic acid acts on the finely divided metallic lead in the presence of carbon dioxide gas, producing a white pigment similar in every respect to the Dutch process white lead. This process requires from one to two weeks.

Basic Sulphate—White Lead

Sublimed white lead or basic sulphate white lead is obtained from Galena, a lead sulphide ore. The mined ore is roasted and the fumes given off combine with the oxygen of the air and form a white powder. Basic sulphate white lead, a product of sublimation, exceeds the basic carbonate in fineness. It is considered by some to be superior to basic carbonate white lead in that it is relatively non-poisonous and resists the darkening action of sulphur gas to a great extent.

Zinc Oxide

This pigment has been commercially used as a paint pigment for a short time. It has, however, assumed a very important position in the paint industry and is a pigment of exceptional merit. Paints containing zinc oxide in appreciable quantities dry with a hard enamel-like surface, which is highly impervious to water. It is therefore very desirable in the manufacture of marine paints. In the manufacture of zinc oxide, the mineral is first mixed with powdered coal and spread on a bed of glowing coal. Air is blown through the charge volatilizing the zinc in the ore. This vapor is carried into the upper part of the furnace and converted into oxide of zinc by contact with the atmosphere. This oxide is drawn through cooling pipes, being finally deposited as an extremely fine powder in fabric bags.

Red Lead

This pigment is prepared by heating litharge to approximately 700 degrees Fahr. in contact with the air. It then takes up more oxygen and turns red. The composition of red lead varies from 65 per cent. (Pb_3O_4) to practically pure red lead, little or no litharge being present. The latter type is more expensive to make and is therefore sold at a higher price. Red lead is used extensively for the protection of metal and is usually applied as a priming coat.

Venetian Red

A brick colored pigment in which the ferric oxide content varies from 20 per cent. to 40 per cent., the balance being calcium sulphate, also used in the manufacture of metal paints.

Indian Red

An earth pigment analyzing from 75 per cent to 90 per cent. (Fe_2O_3), the remainder being silica. Indian red when mixed with pure raw linseed oil and drier produces an excellent paint and tinting pigment.

Vermilion

A precipitated dye on a lithol barium or orange mineral base used for striping and tinting purposes, being one of the so-called permanent reds.

Sienna

This is a natural earth pigment, which contains as high as 70% ferric oxide, the remainder being silicate of aluminum, or clay. The best grades are obtained from Italy, and are used largely for tinting purposes and in the making of stains.

Umber

This is a natural earth pigment very much darker than sienna. This pigment is obtainable in commercial quantities in the United States, but the best grade comes from the Isle of Cyprus. It is used for tinting and staining purposes.

Ultramarine Blue

Ultramarine blue in its natural state (lapis-lazuli) is found in Tibet, Prussia, China and in the Andes of South America. It is usually found in the form of pebbles. This natural pigment is not used in the paint industry on account of its harsh granular texture. Artificial ultramarine blue is a chemical color and has great tinting power, is soft in texture and relatively opaque.

Prussian or Chinese Blue

This is a dark blue pigment which is a ferro-cyanide of iron and is prepared by chemical precipitation. This blue cannot be used in the tinting of white lead paints successfully. When Prussian blue is used for tinting white lead paints, it is acted upon and a chemical change in its composition takes place.

Chrome Green

This color is a mixture of Prussian blue and Chrome Yellow (lead chromate) and unless chemically pure is found mixed with an inert base such as barytes. Chrome green contains Prussian blue which undergoes a chemical change when used for tinting white lead paints. Salt atmosphere attacks chrome green and bleaches it.

Chromium Oxide

This is a permanent green but is seldom used in the manufacture of commercial paints. It is used in special marine and railway paints and is unaffected by salt atmosphere or the white lead pigments. It is used on vessels in repainting the receptacle on which the port light rests.

Lamp Black

Lamp black is the condensed smoke of petroleum oils and is considered one of the most permanent blacks used.

Carbon Black

Carbon black is similar to lamp black in that it is intensely black in color. Its staining power is very great and due to its extreme fineness fairly large amounts of pigment have a tendency to separate from the paint and rise to the top of the liquid thereby making it difficult to incorporate and produce a uniform tint.

Metallic Zinc

Metallic zinc used in the paint industry is in finely divided form and is used in the manufacture of anti-corrosive ship's bottom paint.

Shellac

Shellac is the exudation deposited by a lac bug; it is soluble in alcohol and when cut in this solvent in the proportion of 2½ lbs. of gum shellac to one gallon of alcohol a good working shellac varnish is produced. Shellac varnish is applied to furniture, and to cover decks where the application of paint or varnish is not practical on account of the length of time required in drying. The use of shellac on woodwork exposed to the water is not recommended since the heat of the sun's rays will soften shellac and form blisters.

Vehicle

The spreading medium or liquid portion of a paint which combines or holds in close union the solids or pigment portion. Linseed Oil is usually used as a base to which is added turpentine mineral spirits (or turpentine substitute) and a liquid drier.

Linseed Oil

Linseed Oil is obtained from the flaxseed, which grows in practically all parts of the world. It is of interest to know, however, that oil extracted from the flaxseed from the various sources varies greatly in quality. South American flaxseed produces a slow drying oil which forms a relatively soft film; North American flaxseed yields a higher percentage of oil, which dries more rapidly, forming a very tough, elastic, hard film. Oil obtained from India flaxseed varies in its drying properties, but is more desirable than South American oil and is generally preferred to North American oil for varnish making, since it resists discoloration on prolonged heating. At the present time there is no substitute which will entirely replace linseed oil, although quite a number of preparations are sold for this purpose. Some of these substitutes can be used as extenders of linseed oil. Since the durability of paint depends largely upon the vehicle it is very important to select the best materials obtainable as this will prove to be economical.

Boiled Linseed Oil is obtained by heating pure raw linseed oil to over 180 degrees C. with oxides of lead and manganese until combination of the metals is obtained. Boiled linseed oil manufactured as indicated above dries rapidly, forming a hard, glossy-film highly impervious to water and very durable. The following tests are of value in determining the purity of raw and boiled linseed oil.

	Raw		Boiled	
	(Max.	(Min.)	(Max.)	(Min.)
Iodine number	190	174	.....	178
Acid number	6	.....	10	.....
Saponification No...	192	189	198	185
Unsaponifiable matter	1.5	.....	1.5	.....
Specific Gravity 15/15	.937	.932	.945	.937
Refractive Index.....	1.4085	1.479	1.488	1.479

Kettle Boiled Linseed Oil is not easily obtained since it is necessary to use well-settled, perfectly clear raw oil free from foots and suspended matter. This type of boiled oil has been largely replaced by the so-called "bung hole" boiled oil, which consists of a small mixture of raw linseed oil and dryer. Other oils occasionally used in the manufacture of paint are:

Soya Bean Oil

This oil is obtained from the soya bean which is readily cultivated in all parts of the United States. It is a semi-drying oil but when treated with dryers it dries rapidly. When mixed with linseed oil in the proper proportion it has been found to give excellent service.

Cotton Seed Oil

This oil has a very limited use in the manufacture of paint.

Corn Oil

This oil is very slow drying and is used principally in the making of paste colors.

Sunflower Seed Oil

This oil is very pale in color, dries rapidly and is occasionally used in the manufacture of very pale, high grade varnishes. It is more extensively used in the preparation of artists' colors.

Menhaden Oil

This is a fish oil of light amber color and is obtained by steaming and pressing "pogey" fish which are caught in large quantities off the Atlantic Coast. Menhaden oil possesses good drying properties and is used to a large extent in the manufacture of low grade paints.

China Wood Oil

This oil is of light amber color and is obtained from the tung nut. The raw oil has a peculiar, characteristic odor, is very viscous and dries rapidly, producing a fairly hard film with a frosted opaque surface. Heat treated tung oil dries rapidly, forming a clear, hard transparent film and is used as the base for a large number of waterproof varnishes.

Perilla Oil

This oil is obtained from the small, round seed of a plant growing extensively in China and Japan. The oil is amber colored, possesses a very pleasant odor and its drying qualities are equal to linseed oil.

Poppy Seed Oil

This oil is considered next in quality to linseed, being used for grinding artists' colors and for special zinc oxide pastes. Poppy seed oil obtained from the ripe seed is very light in color, spreads freely and dries rapidly, and is said to resist darkening to a greater extent than linseed oil.

Turpentine

Turpentine is obtained from the pine tree by direct or steam distillation of the sap collected from the growing tree. Wood turpentine is produced by steam distillation of finely cut or macerated pine wood. The lower grades of wood turpentine have an objectionable, sharp odor and are not desirable in the manufacture of interior paints. Turpentine has a high oxidizing value which causes the rapid drying of paints and varnishes. Turpentine is used to reduce the consistency of the oil paint so as to allow it to be spread in thin fine coats.

Petroleum Spirits (Turpentine Substitute)

Petroleum spirits are produced from Pennsylvania or Texas crude oil. High boiling petroleum spirits have a wide use in the manufacture of paint and varnish and are interchangeable with, and can be used in the same manner and for the same purposes as turpentine.

Driers

In most cases the drying effect of the pigment is not sufficient and liquid dryers are added to accelerate the drying. The most commonly used dryers are composed of lead, manganese and cobalt or a mixture of these metals combined with pure linseed oil and a hydrocarbon solvent.

Paint Gun. A pneumatic tool with which paint can be sprayed by compressed air over the surface to be coated.

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Paint Sprayer. A device for the application of paint by means of an air blast.

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Painter. A length of rope secured at the bow of a small boat for use in towing or for making it fast. It is sometimes termed a bow-fast.

Painters. Inside workmen who mix paint, also those who paint, varnish and polish joiner work in the shop.

Outside, workmen who apply the paint aboard ship.

Pall, Pawl. A term applied to a short piece of metal hinged to engage in a revolving mechanism for the purpose of preventing recoil. Usually fitted to capstans, winches and windlasses.

Palm. The fluke, or more exactly, the flat inner face of the fluke, of an anchor; a sailmaker's protector for the hand used when sewing canvas. It consists of a strong canvas or leather strap to which is secured a flat metal disc thimble to drive the needle through the canvas; a flat surface at the extremity of a strut or stanchion for attachment to plating, beam or other structural member.

Panel. The part of a door or bulkhead, the edges of which are inserted in the stiles and rails.

Panel, Flush. A panel, the surface of which is flush with the surface of the stiles and rails.

Panel, Molded. A panel which is set in and the stiles and rails projecting beyond the surface.

Panel, Raised. A panel, the surface of which projects above the surface of the stiles and rails.

Panel Raiser. A wood working machine designed to dress down the edges of the work so as to leave a raised panel.

The general design of this machine is similar to a molding machine, the principal difference being a wider table on account of the greater width of work.

Panting. The in and out vibrations of the frames and plating. Most noticeable in the bow and stern.

Panting Beams. See Beams, Panting.

Panting Stringer. See Stringer, Panting.

Parallel Middle Body. That portion of a vessel's body throughout the extent of which the cross sections retain the same area and shape as the midship section.

Parbuckle. An improvised purchase used in hoisting and lowering casks or other cylindrical objects where a tackle or crane is not available.

The middle of a rope is secured above the object to be hoisted or lowered, the two ends passed over and under it and then brought back again. Hauling on the two ends raises or lowers the object as desired.

This method is extensively used in handling shells in the turrets of men-of-war. The shells being stowed upright, base downward, on the turret floor are easily parbuckled horizontally in the bight of a single rope.

Parcelling. Narrow widths of canvas which when tarred are wound around ropes, following the lay and overlapping in order to shed water.

The parcelling is applied after worming preparatory to serving.

Parent Form. A ship's form from which a series of forms are derived by the systematic variation of certain characteristic features.

Parrel. A rope or metal collar attached to a band on either side of a yard near its middle and encircling the mast. By this means the yard is attached to the mast though allowed a vertical movement.

Part Double Bottom. Descriptive of a vessel which is fitted with a double bottom extending throughout a portion of her length only.

Partial Bulkhead. See Bulkhead, Partial.

Parting Strip, Window Frame. The narrow strip fastened to the inside of the stiles for the purpose of dividing the paths of the outer and inner sashes or blinds.

Partner, Mast. See Mast Partner.

Partner Plate, Rudder. A term applied to plates fitted around the rudder stock where it pierces a deck.

Passers. Usually boys who receive the heated rivets from the heaters and deliver them to the holders-on.

Passing Tongs. Long handled tongs used by rivet passers to handle the heated rivets.

Pattern Makers. Workmen who fashion the wood forms or patterns for the use of the foundrymen in setting up molds.

Inside pattern makers prepare those patterns which can be made from plans such as machinery parts.

Outside pattern makers prepare patterns for those castings which are to be fitted to the hull such as stems, stern posts, and hawse pipes.

Pattern Makers' Lathe. See Lathe, Woodworkers'.

Paulin. See Tarpaulin.

Pawl. A small part or member of a mechanism used to prevent overhauling. Pawls engaging ratchet wheels are fitted on windlasses, capstans, etc.

Paying. A term applied to the operation of filling the seams between planks, after the calking has been inserted, with pitch, marine glue, etc. Also applied to the operation of slackening away on rope or chain.

Peak. A term applied to the outer and upper end of a gaff.

Peak, Fore or After. The space at the extreme bow or stern below the decks.

Peak, Purchase. A tackle applied to the peak halyards to haul them taut and straighten the leech of the sail.

Peak Tank. A tank or tank space built into or formed

in the extreme forward or after lower portion of a vessel's hull.

Pelican Hook. A type of quick releasing hook used at the lower end of shrouds, boat gripes, etc.
Page 349.

Pelorus. A navigational instrument similar to a binnacle and mariner's compass but without a magnetic needle. The instrument is used for taking bearings, especially when the object to be sighted is not visible from the ship's compass. Also known as a Dumb Compass.
Page 1093.

Pendant. A length of rope usually having a thimble or block spliced into the lower end for hooking on a tackle, and when suspended from a masthead, yard, or gaff, is known as a mast head pendant, brace pendant, etc. See also Clear Hawse Pendant.

Pendants, Rudder. See Rudder Pendants.

Perfect Fluid. A theoretical fluid without viscosity or surface tension and incapable of internal friction or of friction against any object.

Perilla Oil. See Paint.

Period of Roll. The time occupied in performing one double oscillation.
Pages 162, 163.

Permeability. The percentage of a given space which can be occupied by water. The value of this factor is of great importance in all considerations of the effect of damage upon floatability and stability.
Pages 233 to 236.

Permissible Length. That length of a vessel which may be flooded without causing her to sink below the margin line.
Pages 233 to 236.

Perpendicular, After. See After Perpendicular.

Perpendicular, Forward. See Forward Perpendicular.

Pet Cock. See Cock, Pet.

Petroleum Spirits. See Paint.

Photostat. A machine for making photographic reproductions of tracings, blueprints, etc. The reproduction may be to the same, a greater or a smaller scale. The term is also applied to the photographic reductions made on these machines.
Pages 695, 696.

Picklers. Men who put steel plates through an acid bath in order to remove the mill scale preparatory to laying out and working the material into the ship.

Pier. A structure of iron, wood, or concrete, resting on piles built out into the water for use as a landing place for vessels, pleasure resorts, etc.

Pig Iron. Iron cast in the form of a rough oblong or bar. See Steel and Iron.

Pigment. See Paint.

Pilaster. An ornamental column or false stanchion on a light bulkhead. It usually extends out from the bulkhead for a distance of about one half its diameter.

Pile. A pole or post generally of wood, though sometimes of metal or concrete, driven into the earth along the bank or in the bed of a body of water for the support or protection of bridges, piers, etc.

Pillar. A post constructed of wood or steel and used as an intermediate support for girders and deck beams. Also used as reinforcement under decks in the way of guns and heavy foundations, thus helping to distribute the load to the lower structural members.

Where a ship is fitted with one or more rows of pillars supporting the deck beams it relieves the sides of the vessel and the brackets at the ends of the beams of considerable stress. Also the size of the deck beams can be materially reduced on account of the shortened span.

In addition to the above, pillars serve to tie the bottom and top of a ship together and are an efficient aid against deformation of the bottom and sides.

Pillars may be constructed from tubes, pipes, solid round bars, channel bars riveted back to back, four angle bars riveted together, or of various built up sections. Their size depends on whether they are closely or widely spaced, their height, and the weight to be carried. In figuring the weight to be carried loads attached to the under side of the deck as in ships carrying beef should be considered.

Closely spaced pillars give a more even distribution of the load but are more or less in the way when stowing the cargo. On the other hand they prevent, to a certain extent, the shifting of cargo, and are useful when erected on the center line in grain carriers or where shifting boards are used.
Page 520.

Pillar, Built-up. A term applied to a column that is constructed by riveting plates and shapes together.

Pillar Crane. See Crane, Pillar.

Pillar, Deck. A term applied to a pillar supporting a deck. It is usually given the name of the deck that it supports, as Upper or Main Deck Pillar.

Pillar Head. A term applied to the upper end of a pillar.

Pillar Heel. A term applied to the lower end of a pillar.

Pillar, Hold. A column fitted in the hold of a ship for the purpose of supporting the lowermost deck. They are generally much longer and of greater sectional area than the pillars fitted between decks.

Pillar, Middle Line. A term applied to a column erected on the center line of the ship.

Pillar, Movable. A term applied to a portable pillar that can be easily shifted.

Pillar, Pipe. A term applied to a column constructed of piping or tubing.

Pillar, Portable. A term applied where the pillars are removable. A disadvantage of this type of pillar in a hold is, that if it is taken out while the cargo is being stowed, that it is difficult to get back in the proper position.

Pillar, Quarter. A term applied to a column fitted from about one third to about one half the distance from the center line to the side of a vessel and to columns in the way of the sides of hatches.

Pillar Socket. A receptacle, usually a casting, for taking the end of a pillar. A common type consists of a hollow cylindrical piece set up on and connected to a flat base piece by triangular shaped webs.

Pillow. A block of timber used as a rest piece for the lower end of a mast or the inner end of a bowsprit.

Pilot Bridge. See Bridge, Navigating or Flying.

Pilot House. A house designed for navigational purposes. It is usually located forward of the midship section and so constructed as to command an unobstructed view in all directions except directly aft along the center line of the vessel where the smoke stack usually interferes.

Pilot Lamp. See Lamp, Pilot.

Pin, Marking. A short piece of pipe of approximately the same diameter as the rivet holes in a template.

The pin is dipped in whiting and then thrust through the holes in the template to mark their location on a plate or shape.

Pintle, Heel. A term applied to the lower pintle.

Pintle, Locking. A term applied to a pintle having a head turned on the bottom end to prevent the rudder from unshipping.

It is well to place this pintle at the top so that the rudder may be unshipped without dry docking, by trimming the vessel by the bow.

Pintles. A term applied to the pins or bolts which hinge the rudder to the gudgeons on the stern post. These pins are cylindrical in shape in the way of the gudgeons up to the rudder lug. Through the rudder lug they are given a conical taper and above the lug a thread is cut for a nut. The taper provides a shoulder which, by tightening on the nut, firmly fixes the pintle to the rudder lug.

It is to be noted that the weight of the rudder should be carried by the rudder stock to a bearing above, and that the pintles should serve as a hinge and as a bearing only for the side pressure of the water. The pintles are often fitted with a brass sleeve in the way of the gudgeon which is provided with a white metal bearing surface. The upper pintle sometimes has a head turned on the bottom for the purpose of preventing the rudder from moving upward and unshipping itself.

Page 577.

Pipe, Air. See AIR PIPES.

Pipe, Auxiliary Steam. A steam pipe leading from the steam down to auxiliary engines.

Pipe Berths. See BERTH.

Pipe Bending Machine. A machine designed for bending pipe or conduit. Pipe bending machines are similar to bending presses except that special dies are used to suit the size of pipe being bent.

Pages 749, 765.

Pipe, Bilge Suction. A pipe leading from the well, which collects bilge water, to the bilge pump.

Pipe Coverers. Workmen who fit the insulating material on pipes. They also fit insulating material wherever necessary, as on boilers and engines.

Pipe Covering. See INSULATION.

Pipe Cutting Machine. A machine designed for cutting pipe.

Pipe Cutting and Threading Machine. A combination machine designed for both cutting and threading pipe.

Pipe Cutting Tool. A tool consisting of a small cutting disc working in a jaw and a spindle which is turned by hand. The cutter is rotated by hand and the disc fed forward by turning a handle on the end of the spindle.

Page 773.

Pipe, Double Extra Heavy; Double Extra Strong. A term applied to very thick pipe.

Pipe Down. The signal on board a naval ship for the crew to sling their hammocks preparatory to retiring for the night. Used as a slang phrase, meaning to stop some annoying act.

Pipe, Exhaust. Piping designed to carry exhaust steam from the main engines and various auxiliaries to the condenser or overboard. The materials used for exhaust piping and the advantages and disadvantages of each are the same as for steam piping.

Pipe, Extra Heavy; Extra Strong. A term applied to a pipe having a thickness greater than standard but less than double extra strong pipe.

Pipe Fitters. Workmen who fit and install the steam, fresh and salt water mains and drainage pipes on shipboard.

Pipe Fittings. See under particular fitting desired.

Page 823.

Pipe, Jacket Steam. A pipe by which steam is led from the main steam pipe to a steam jacket.

Pipe, Main Exhaust. The principal steam lead from the engine to the atmosphere or condenser.

Pipe, Main Feed. A pipe by which water supplied by the feed pump is led from the hot well to the boilers.

Pipe, Oil Lubricating. A small oil supply pipe leading from a lubricator to some working part.

Pipe, Outboard Delivery. A term applied to the pipe leading from the outboard delivery valve to the shell or sea chest.

Pipe, Sea Injection. A term applied to the pipe leading from the sea chest to the outboard valve controlling the intake of water.

Pipe, Smoke. See SMOKE STACK.

Pipe, Standard. A term applied to a pipe having a thickness equal to the standard adopted by the Wrought Pipe makers.

Pipe, Steam Escape or Waste. A pipe attached to and leading nearly to the top of the smoke stack from the upper deck. The steam from the safety valve is led into this pipe and escapes through it into the atmosphere.

Pipe Stocks and Dies. See DIE.

Pipe, Suction. A pipe connected to the suction side of a pump and led to the compartment to be pumped.

Pipe Threading Machine. A machine for cutting thread on pipe. There are two general types of pipe threading machines. The most common type is so arranged that the pipe is revolved while the thread is cut by stationary dies; with the other type, the pipe is held stationary while the die head is revolved.

Page 773.

Pipe Vise. See VISE, HINGED PIPE.

Pipes, Scupper. See SCUPPER PIPES.

Piping. The American Bureau of Shipping requires that the minimum thickness for steel pipes which have to be bent, or to have screwed ends, is to be 3/16 of an inch.

The thicknesses of steam and feed pipes are to be in accordance with the following formulæ:

$$T = \frac{D \times W}{6{,}000} + 1/16 \text{ for brazed copper pipes.}$$

$$T = \frac{D \times W}{6{,}000} + 1/32 \text{ for solid-drawn copper pipes.}$$

$$T = \frac{D \times W}{10{,}000} + \tfrac{1}{8} \text{ for welded iron and steel pipes.}$$

$$T = \frac{D \times W}{12{,}000} + \tfrac{1}{8} \text{ for solid drawn steel pipes.}$$

Where T = Thickness of pipe, in inches.
D = Internal diameter of pipe, in inches.
W = Working pressure, in lbs., per square inch for steam pipes.
W = Boiler pressure, in lbs. per square inch $\times$ 1.2 for feed pipes.

Pipes having screwed flanges are to be screwed with

vanishing threads and the thread is not to extend beyond the back of the flange collar.

Main steam pipes are to have efficient provision for expansion and are to be so arranged that water cannot lodge in any part of them, or, if this be impracticable, so that they can be properly drained.

Auxiliary steam pipes which exceed 4 inches in diameter, and all main and refrigerator machine steam pipes, are to be tested by hydraulic pressure, in the presence of the Surveyor, to at least twice the working pressure; boiler feed pipes are to be subjected to a hydraulic pressure at least 20 per cent. greater than is required for steam pipes.

Page 1039.

Piping, Oil. Systems of piping for loading, discharging, supplying, transferring, etc., fuel, cargo and lubricating oil.

Pages 442, 443, 444, 614 to 626.

Plate XLVI.

Piping, Steam. Piping designed to carry live steam from the boilers to the main engines and to the various steam driven auxiliaries.

The principal materials now in use for steam piping are steel, wrought iron and copper.

Wrought iron and steel possess the advantages of great tensile strength, and durability in service, but are heavy and subject to corrosion.

Copper possesses the advantages of ductility and freedom from corrosion, but it is expensive, of relatively low tensile strength, and likely to deteriorate in service.

Pages 612, 613, 627 to 637, 643 to 649, 651 to 657.

Plates XLVII, XLVIII, XLIX, L.

Piping System. Any system of pipes such as bilge and ballast, steam and exhaust, water, sanitary, steam heating and cargo and fuel oil systems that is installed aboard a ship for conveying water, oil, steam, etc.

Pages 390, 391, 392, 393, 398, 399, 400, 401.

Plates XII.

Piping, Water. Systems of piping installed aboard ship for supplying, draining and transferring fresh and salt water. The sanitary, bilge and ballast, fire, condenser circulating and feed water systems, etc., come under this head.

Pages 600 to 605, 610, 611, 643, 644, 645, 646, 647, 649, 650, 651, 654, 655, 658, 659.

Plates XLIII, XLIV, XLIX, L.

Piragua. A term applied to a large canoe-shaped boat used by the Indians. Made by hollowing out a log.

Piston. The movable part upon which the steam in the cylinder exerts its pressure to produce rectilinear motion in alternate directions. It consists in general of a central disc with a heavy circumferential portion for the reception of the piston rings and a central boss to take the shouldered end of the piston rod.

There are numerous forms of piston, each depending upon the working conditions contemplated. The requirements to be met may, however, be broadly stated as follows: (1) Strength sufficient to support the load due to the steam pressure and hold the end of the piston rod rigidly; (2) Type such as to permit easy passage up and down the cylinder without steam leakage and sufficiently robust to insure against failure under ordinary working conditions; (3) With round circumference sufficient to prevent undue wear on the walls of the cylinder barrel.

Piston, Gas Engine. See GAS ENGINE PISTON.

Piston or Packing Rings. Rings fitted into annular channels in the cylindrical surface of the piston and designed to secure steam tightness between piston and cylinder barrel. They are turned from cast iron to a diameter somewhat in excess of the cylinder bore. A piece of sufficient length to permit their entrance into the cylinder bore is cut out. This gives the rings a tendency to spring out against the cylinder barrel. Piston rings in marine engine practice are generally two in number and the cuts referred to above are placed at different points on the circumference so as to prevent the direct passage of steam through the openings. In addition a tongue piece is attached to the ring so as to overlap the cut.

In large cylinders it is customary to back the piston rings internally by heavy steel springs.

The corners of piston rings are chamfered to prevent damage to the cylinder walls.

In order to prevent actual contact between the piston circumference and the cylinder wall the piston is turned somewhat smaller than the bore of the cylinder.

A follower plate, sometimes known as a junk ring, is fitted to the piston by means of bolts working into nuts so that the springs may be easily examined and replaced as necessary.

Modern practice favors the conical form of piston on account of the saving of weight effected by reason of the strength of this shape.

Piston Rod. That member which, being at one end securely attached to the piston, transmits the motion of the piston to the other moving parts of the engine. The piston rod projects through the cylinder stuffing box and terminates at its lower end in the cross head. It is a cylindrical rod designed to meet the following general requirements: Sufficient strength and stiffness to take the load imposed by the piston, this load being alternately compressive and tensile. Properly shaped to take the piston and crossheads at its ends; Uniform shape or size throughout in order to preserve steam tightness at the stuffing box.

Piston Valve. See VALVE, PISTON.

Pitch. A term applied to the distance a propeller will advance during one revolution, the distance between centers of the teeth of a gear wheel, the spacing of rivets, etc.

Pitch Chain. See SPROCKET CHAIN.

Pitch, Coal Tar. The residue obtained from the redistillation of coal tar.

Pitch, Hard Wood. The residue obtained by the redistillation of a hard wood tar.

Pitch, Pine. The black or dark-colored viscous residue from the distillation of resin oil or the residue after distilling the oils from crude pine tar.

Pitch Pockets. A pitch pocket is an accumulation of pitch occurring between the annular growth at any place in the timber.

Pitch, Propeller. See Propeller, Pitch.

Pitch of Rivets. See RIVET SPACING.

Pitching. The alternate rising and falling motion of a vessel's bow in a nearly vertical plane as she meets the crests and troughs of the waves.

Pitting. The rapid corrosion of iron and steel in certain spots, thereby producing small indentations.

Pitting, Boiler. See BOILER PITTING.

Pivoting Point. That point during the progress of a vessel's launch at which the moment of buoyancy about

the fore poppets becomes equal to the moment of the vessel's weight. At this point the stern begins to lift the vessel pivoting about the fore poppet.

Plain-laid Rope. See Rope, Plain-laid.

Plan Lines. See Lines, Plan.

Plane of Flotation. The water plane at which a vessel is floating.

Planer. A machine used principally for the production of flat or plane surfaces on metals. Shapers and slotting machines are included in the general definition for planers but a planer is usually considered as a machine in which the platen slides back and forth on the bed in V-shaped grooves or ways which cause it to move in a straight line. While the reciprocating movement takes place, the work, which is clamped to the platen, is planed by one or more tools held in position by clamps attached to the tool blocks. Each tool remains stationary while cutting, and, when the platen is near the end of the return stroke, the tool head and tool feed sufficiently for taking a new cut.

Pages 714, 737.

Planer, Closed Slide. See Planer.

Planer Hands. Men who operate planing machines.

Planer, Open Side. A planer which has one side open to allow for planing work that is too wide to go in an ordinary planer.

In this machine an overhanging arm, which takes the place of the usual cross rail, is carried by a single upright or housing.

Planer, Plate Edge. A machine used to plane the edges of plates. This type of planer is so designed that the tool moves against the work, the work being held by hydraulic, pneumatic or screw clamps.

Pages 738, 741.

Planer Traveling Head. A plane in which the works remain stationary, the cutter travelling back and forth.

Page 721.

Planer, Wood. A machine designed to dress or plane wood. The table of the machine is divided and a rotating shaft, carrying the knives or cutters, is carried between the two halves of the table. The portion of the table on the side from which the work is fed is adjustable for regulating the depth of cut while the other portion is fixed in a plane tangent to the cutting edge of the knives. Rollers are usually provided for regulating the size of the finished work and holding the work securely in position to insure a smooth true surface.

Planer, Wood Portable. A wood planing machine, power operated, used for dressing down wood decks.

Usually built in the form of an inverted planer carried on four small wheels and fittted with handles for rolling along a deck. The knives are adjustable in a vertical direction for varying the depth of the cut. These machines usually are built with knives about 18" long.

Portable wood planing machines are also used for smoothing and fairing up the bottom of wood vessels. This style is usually about the size of a carpenter's smoothing plane and the knives are generally operated by a small electric motor.

Planing Mill Exhauster. See Exhauster, Planing Mill.

Plank, Margin or Nibbing. The extreme outer plank of a wood deck generally fitted just inboard of the waterways and sometimes notched out to receive the ends of the deck planks. Also placed around the outside of coaming of hatches, and around manhole frames where wood decks are fitted.

Planking. A term applied to wood decks and to the outside planking in wood or composite ships.

Planking, Bottom. A term applied to the outside planking between the garboard plank and the side planking.

Planks, Parting. The centerline planks of the deck near the bow.

Planksheer. A term applied to the plank fitted horizontally on top of the sheerstrake in wooden vessels. It generally has a rounded edge on the outboard side projecting a little beyond the planking and giving a finished appearance to the vessel.

Plastering Trowel. A flat diamond-shaped trowel used to handle plaster or cement.

Plate. Steel or other metal rolled or cast into form such that it has in general a constant thickness which is small relative to its length and breadth.

In ship work mild steel plates cut to proper form are used for the shell, decks and bulkheads.

Plate is generally referred to by thickness only (either pounds per square foot or fraction of an inch).

Plate, Apron. A plate fitted in continuation of the shell plating above the forecastle sheerstrake at the stem. These plates are sometimes fitted, one on each side of the stem, and serve as a foundation for the bow mooring pipes.

Plate, Bolted, Portable or Detachable. A plate fitted to a deck, tank top or bulkhead with bolts permitting its removal. These plates are used for the purpose of preserving water-tightness and at the same time providing for occasional access.

Plate, Boss. A term applied to the plate fitted around the boss of a propeller post or around the curved frames in way of stern tubes. These plates usually require furnacing and are thicker than the adjoining plating.

Plate, Bow. Any shell plate fitted in the bow of a ship.

Plate Bracket. See Bracket, Plate.

Plate, Butt. A plate used for end connections between the ends of planking on a composite ship.

Plate Castors. See Castors, Plate.

Plate, Doubling. A term applied where an extra plate is fitted over the regular plating either for extra strength or to compensate for openings in the structure.

Plate, Face. See Face Plate.

Plate Flanged. A term applied where one or more edges of a plate are bent over to more or less of an angle. It also applies where an aperture is made in a plate with its edges stiffened by bending them at right angles to the plate.

Plate Furnace. See Furnace, Plate.

Plate, Furnaced. A plate that requires heating in order to mold it into shape. The most common types are the oxter and boss plates. The work is done by making a template or bed to the shape required, then heating the plate and quickly pulling it on to the template or bed, where it is hammered into shape.

Plate, Garboard. Any plate in a garboard strake. See Strake, Garboard.

Plate Keel. See Keel, Flat Plate.

Plate, Margin. See Margin Plate.

Plate, Oxter. The plate that is riveted to the stern frame immediately below or on the transom. On account of the shape of the ship at this point it usually

requires furnacing and molding into shape. The oxter plate is given extra thickness to compensate for the stretching and heating necessary in bringing it to shape.

Plate, Rider. See RIDER PLATE.

Plate Scarphing Machine. A machine for scarphing or tapering the corner of a plate. Shell plates are often scarphed where a seam crosses a butt lap to reduce the thickness of metal that the rivets penetrate and make a better job for water-tightness.

Plate, Sheerstrake. A plate forming part of a sheerstrake.

Plate, Stealer. A term applied to a plate taking the end of a drop strake or a plate combining two strakes into one. Stealer plates occur at the bow and stern, where the narrowing girth compels a reduction in the number of strakes.

Plate Straightener. A workman who removes from sheet metal any kinks, bumps or bulges so they will present a smooth even surface.

Plate, Stringer. See STRINGER PLATE.

Plate, Swash. See SWASH PLATE.

Plate, Tuck. A flat plate riveted to the arch piece and stern post of a stern frame, and having its forward edge flanged out to take the stern plating. It is advantageous when the propeller aperture is low, making the sides of the ship above the arch piece approximately flat.

Plate, Web. A wide girder plate as in a web frame or hatch beam. Angle bars are usually fitted on each edge.

Plate, Wood. The horizontal timbers which are fitted above the studding and which run parallel with the sill forming a part of the framing of a deck house.

Platen. A work bench or table the upper surface of which lies in a true plane,

Plates, Intercostal. The plates in an intercostal member. Where the plates are cut and attached to each continuous structural member that lies in their path. The continuous members are usually at or nearly at right angles to the intercostal members, and in order to pass each other one or the other of the girders must be composed of a range of short plates attached by angle bars or other means to the continuous members.

Platform, Deck. See DECK, PLATFORM.

Plating, Clinker System. Where the edges of outside plating form lap joints so that one edge of a plate is inside while the other is outside. In this case tapered frame liners are used.

Plating, Flush System. Where the edges of the outside plating form butt joints so that a flush surface is formed. The connections between plates are made by seam straps and butt straps.

Plating, In and Out System. Where the edges of the outside plating form lap joints so that both edges of the plates are alternately inside and outside. In order to do this, the frames have to be joggled in the way of the outside strakes or frame liners of the thickness of the plating have to be fitted between the frames and outside strakes.

Plating, Rounded Gunwale. Plates bent to fit a rounded gunwale and connecting the side and deck plating.

Plating, Shell. The plating forming the outer skin of a vessel. In addition to keeping the water out of the hold, it contributes largely to the strength of the vessel.

Pages 478, 479. Plates XXXIII, XXXIV.

The American Bureau of Shipping requires that all the thickness of shell plating shall be in accordance with their rules and tables.

The American Bureau of Shipping requires that butts are to be arranged so as to provide the best possible shift; and in no case is there to be less than two frame spaces between butts in adjoining strakes within the midship three-fourths length. The width of plates having a length of 14 feet should not exceed 52 inches, the maxima for longer plates may be taken at the rate of 1.5 inches addition to the 52-inch width for each addition of 1 foot to 14 feet length; the length is to be taken between butts or centers of endlaps. Plates situated between the extreme ends of the Vessel are to be at least six frame spaces in length.

Breaks in Vessels having partial superstructures are to be specially strengthened in order to avoid local increases in stress at the breaks. The sheerstrake, stringer plate and topside strake at the lower level are to be extended well into the superstructure and local doubling plates fitted if necessary; the sheerstrake and topside strake at the higher level are to be increased in thickness at the break; they are to extend well beyond the superstructure in such fashion as to provide a long and gradual taper from Strength Deck to Strength Deck; the upper Strength Deck stringer plate and gunwale angle are to extend well beyond the superstructure, following the line of the taper in the topside plating and being gradually tapered into it; the seam riveting in the neighborhood is to be based upon the requirements for butt riveting at ends. Gangways, large freeing ports, and other openings in bulwarks are to be kept well clear of breaks and any holes which must unavoidably be cut in topside plating which forms part of a bulwark are to be circular or oval in form.

Gunwale Angles are to be of the thickness of the Strength Deck stringer plates and are to have flanges of not less width than given in Table 15, American Bureau of Shipping Rules; at the ends of detached superstructures the size of the flanges of Strength Deck gunwale angles, is to be increased or the angle doubled where necessary so that rivet area may be proportional to that required for seam riveting in this neighborhood. Butts of gunwale angles are not to be covered by bosom pieces but compensating angles are to be fitted below the stringer plate; similar compensation is to be provided where scuppers are cut in the gunwale angle.

Boss Plates and heel plates on stern frames and stern posts, are not to be less in thickness than given in Table 2, American Bureau of Shipping Rules for ends of plate keels; the after hood plating on stern frames is not to be less than the Table thickness for side plating amidship; the plating of spectacle bossing, clear of the actual boss plates, is to be at least 10 per cent. thicker than is permitted for shell plates at ends.

Compensation is to be made where necessary for holes in shell plates where the effective sectional area is less than 80 per cent. of the solid plate. Holes for inlet and discharge valves are to have rounded corners; where the valve chests of suitable form are made of steel, further compensation may not be required. Openings in the shell plating for coal ports, gangways, etc., are to have well rounded corners; local provision is to be made to avoid changes in stress and to maintain the longitudinal and transverse

strength of the hull unimpaired; details of the proposed arrangements are to be submitted for approval.

Moldings on shell and superstructure side plating are to be solid and are to be made thoroughly watertight.

Plating, Side. See SIDE PLATING.

Plating Stern. The shell or outside plating covering the stern frames.

Plating, Tank Top. The plating forming the top of the double bottom. It is fitted to the tops of the floor plates, longitudinals and center keelson, and makes a complete inner skin extending over the bottom and sometimes up the sides of a vessel.

Pages 384, 385, 484. Plates XXXV, XXXVI.

Platinum. Described under Metals.

Plimsoll Mark. A mark stencilled in and painted on the side of a vessel designating the depth to which the ship may be loaded. Lord Plimsoll originated the idea of so marking vessels.

Page 232.

Plough Steel Rope. See ROPE, PLOUGH STEEL.

Plug, Fusible. See FUSIBLE PLUG.

Plug, Watertight Electric. An electric device for connecting an extension circuit with the main circuit and so arranged that the connection is watertight.

Page 1071.

Plugs, Drain Hole. Plugs sometimes of wood but usually of special design with screwed ends for closing drains from tanks and other compartments.

Plumber Block, See SPRING BEARINGS.

Plumbers. Workmen who install the water closets, urinals, baths, lavatories and other sanitary fixtures and their connections to the mains installed by the pipe fitters.

Pneumatic Accumulator. See ACCUMULATOR, PNEUMATIC.

Pneumatic Calking Tools. See TOOLS, PNEUMATIC CALKING.

Pneumatic Drill. See DRILLING MACHINE.

Pneumatic Hammer. See HAMMER, PNEUMATIC.

Pneumatic Hoist. A hoist actuated by compressed air. A direct hoist may consist of a cylinder in which a piston travels up and down lifting the weight by means of a piston rod. A compact and more powerful type consists of cylinders actuating the hoist through gears. Steam can be used as well as air.

Pages 783, 787.

Pneumatic Power Hammer. See HAMMER.

Pneumatic Riveter. See RIVETING MACHINE, and RIVETING HAMMER, PNEUMATIC.

Pointing Trowel. A flat light trowel used by bricklayers to place the mortar or cement.

Pole Mast. A term applied where the lower and topmast is in one piece.

Pontoon. A scow-shaped boat used in connection with engineering and military operations for the transportation of men and equipment or for the construction of bridges, etc.

The term is sometimes applied to cylindrical airtight floats and ordinary scows used in salvage operations.

Pontoon. A large boat of especial design generally used in connection with military operations for the support of temporary bridges.

Poop Bulkhead. See BULKHEAD, POOP.

Poop Deck. See DECK, POOP.

Poop Deck Stringer. See STRINGER, POOP DECK.

Poop Deck Stringer Bar. See STRINGER, BAR.

Poop Gunwale. See GUNWALE, POOP.

Poop Sheerstrake. The strake of outside plating adjacent to the poop deck.

Poop or Poop House Frame. See FRAME, POOP OR POOP HOUSE.

Pooped. A term descriptive of a vessel which has shipped a wave over the stern.

Poppy Seed Oil. See PAINT.

Port. An opening in the plating or planking of a vessel for the purpose of providing access for passengers, loading and discharging cargo, taking on coal, discharging ashes and water, etc.

Port, Air. An opening in the side or deck house of a vessel, usually round in shape, and fitted with a hinged frame in which a thick glass light is secured. The purpose of the air port is to provide light and ventilation to the interior. See also FIXED LIGHTS.

Pages 1055, 1103.

Port, Ballast. An opening in the side of a vessel provided for the purpose of loading and unloading ballast. A watertight cover or door should be provided.

Port, Bar. A strongback fitted on the inside of a port to hold the cover or door in position.

Port, Bow. An opening cut in the bow plating or planking to provide means of loading long timbers, piles, rails, etc. This opening must have a watertight cover as it is constantly under the pressure of head seas.

Port, Bulwark. The American Bureau of Shipping requires that freeing ports of ample area are to be provided in all bulwarks enclosing wells; it is recommended that open rail gangways be adopted as a means of rapidly freeing the wells from large bodies of water, and that the freeing area should be about 5 per cent. of the bulwark area, taking 5 feet as the greatest height that need be considered. It is also recommended that freeing ports be made not more than 9 inches deep and left uncovered by doors; they should be cut immediately above the gunwale angle and have rounded ends. If doors are fitted they are to have strong hinges with brass pins; there should be no fittings for keeping the doors closed; large ports are to be protected by strong bars not more than 9 inches apart.

Port, Bulwark, Clearing or Freeing. A rectangular or oval opening in the bulwark just above the deck. These ports are necessary when seas break over the deck so that the ship can clear itself quickly. As these openings are about the size of a manhole, rods or bars are generally fitted across them. Flap doors are sometimes fitted on the outside hinging outboard.

Port, Cargo. An opening in the side plating or planking provided with a watertight cover or door and used for loading and unloading cargo.

Port, Coaling. An opening in the side of a vessel provided with a watertight cover used for loading coal aboard a vessel.

Port Flap or Lid. A cover or door hinged over a port so that it can only open outboard.

Port Frame. A term applied to the bars fitted around the edges of a port to compensate for the aperture and to hold the opening in shape.

Port, Gangway. An opening in the side plating, planking or bulwark for the purpose of providing access through which people may board or leave the ship or through which cargo may be handled.

Port, Hawser. An opening in the bulwark through which a hawser may be passed.

Port Lid. A cover hinged on the inboard side of an air port. It can be closed when the glass in the air port is broken or in danger of being broken.

Port, Raft. See PORT, BOW OR STERN.

Port Side. That side of a vessel to the left hand when looking from the stern toward the bow.

Port Sills. The horizontal members of a port frame.

Port, Stern. An opening in the stern plating or planking to provide means of loading long timbers, piles, rails, etc. This opening must have a watertight cover.

Port the Helm. A term originally applied to the operation of putting the tiller over to the left or port side, causing the rudder and ship to turn to the right or starboard. The operation of turning a steering wheel to port may cause the vessel to turn to either the right or left according to whether the leads are open or crossed or otherwise mechanically arranged.

Different localities and countries and also different branches of the marine in the same locality have their own rules as to whether the ship turns with or against the wheel. Thus an order to port the helm on a vessel plying the inland waters or harbors or on the ship of a foreign country might be interpreted in the opposite direction from the same orders issued on board our deep sea and naval vessels.

Portable Countersinking Machine. See COUNTERSINKING MACHINE, PORTABLE.

Portable Hand Bending Machine. See HAND BENDING MACHINE, PORTABLE.

Portable Pillars. See PILLARS, PORTABLE.

Portable Scarphing Machine. A scarphing machine designed to permit its being moved around to suit the work instead of requiring the work to be brought to the machine.

Post Crane. See CRANE, PILLAR.

Post, Propeller. See PROPELLER POST.

Post, Stern. See STERN POST.

Power Cable. See ELECTRIC WIRE AND CABLE.

Power Factor. The ratio of the electric power in Watts to the apparent power in volt amperes in an alternating current circuit.

Power Forging Hammer. See HAMMER, POWER FORGING.

Precession. See GYROSCOPE.

Press. A machine designed to exert pressure on a given area for purposes such as drawing, embossing, trimming, punching, forging, etc.

Press, Bending. A vertical press with two supports located below and equi-distant each side of a pressing head. Used for bending or straightening bars, shafts, pipes, etc.

Horizontal types of bending presses are also used. See BULLDOZER.

Press, Cold. See BULLDOZER.

Press, Embossing. A machine designed to produce raised figures or letters on name plates, label plates, etc.

Press, Flanging. A press for flanging plate metal. The flanging may be done hot or cold.

Page 751.

Press, Forcing. A press designed to force one part into another. A valve seat press is a press of that type.

Page 749.

Press, Forging. See FORGING MACHINE.

Press, Hydraulic Joggling. A hydraulic machine designed for joggling, or crimping, or offsetting structural shapes. Forms or dies are set in the machine and a shape is pressed into the desired offset by a ram.

It is possible to joggle plates in a press but this is not desirable because the machine can only joggle a small portion at a time, necessitating the joggling of a plate edge in bites. Plates are usually joggled in a joggling machine. See JOGGLING MACHINE.

Press, Inclinable. A press designed to be used in a vertical or inclined position.

Pressure Gage Glass. The glass forming a cover over the face of a pressure gage.

Pressure, Hydrostatic. Pressure induced by a liquid. Usually hydrostatic pressure is due to and in direct proportion to the difference in elevation between the free surface of the liquid and the point at which the pressure is indicated, the difference in atmospheric pressure at the two points being neglected. The difference in atmospheric pressure may, however, be appreciable, especially in cases of enclosed vessels in which the pressure may be increased by mechanical means. Hydrostatic pressure may be measured in pounds per square foot, but is also often measured in "feet" or "inches of water" or "inches of mercury," in which cases a pressure is signified equal to the pressure induced by a column of water (or mercury) of the stated height. One foot head of water is equivalent to 62.4 pounds per square foot or .43 pounds per square inch.

Preventer. A supernumerary member, such as a stay, shroud, or any rope, chain, etc., whose only function is to assist or be substituted for another when under unusual stress or when damaged or lost.

Preventer Bolts. Bolts used to secure the preventer plates.

Preventer Plates. Metal plates secured to the lower ends of the chain plates in large sailing vessels to assist in taking the stress.

Preventer Stay, or Preventer Backstay. An additional stay so secured as to be easily slacked away to allow a boom to swing around. Usually attached to the deck on or near the center line.

Pricker. A cone shaped tool used to make holes in canvas or to spread eyelet holes for working.

Primary Battery. See BATTERY, ELECTRIC PRIMARY.

Priming, Boiler. See BOILER PRIMING.

Priming Paint. See PAINT.

Prismatic Coefficient. See COEFFICIENT, LONGITUDINAL.

Profile Plan. See LINES PLAN.

Progressman. A man assigned to follow up work in a shipyard and make reports concerning the progress of the same.

Pages 279, 285, 290.

Progressive Rupture. A rupture or break which starts at the point of maximum unit stress and then spreads with the recurrence of the strain. Progressive rupture may occur in such members as plates which are stressed to rupture at one point only. When failure

occurs at this point the total stress is then perforce concentrated over a smaller area of cross section which naturally increases the unit stress resulting.

Progressive Speed Trials. A series of speed trials over a measured course, successive trials being run at varying speeds. For each run the time is recorded, and this, with suitable data (revolutions, horse power, etc.) obtained regarding the machinery, makes possible the relating of the horse power required to the speed obtained. Generally complete data relative to machinery performance is obtained and recorded for use in the form of curves.

Promenade Deck. See DECK, PROMENADE.

Promenade Deck Stringer. See STRINGER, PROMENADE DECK.

Promenade Deck Stringer Bar. See STRINGER, BAR.

Pro-Metacenter. A term used by some authors to designate a point on the metacentric involute directly above the center of buoyancy for any inclined position of the vessel.

Proof Strain. The test load applied to anchors, chain or other parts, fittings or structure to demonstrate proper design and construction and satisfactory material.

Proof Strength. The proof strength of a material, part or structure is the strength which it has been proved by tests to possess. The term is often used in referring to chain cable, wire rope and the like.

Propeller. A propulsive device consisting of a boss or hub carrying radial blades, from two to four in number, the rear or driving faces of which form portions of an approximately helical surface, the axis of which is the center-line of the propeller shaft.

The propeller is ordinarily located at the after end of the propeller shaft. The rotary motion imparted to this shaft by the engine turns the propeller, thereby exerting a rearward thrust upon the water which reacts to force the ship ahead.

The selection of proper characteristics, such as diameter, revolutions, pitch, etc., the accurate determination of blade thickness, shape, etc., and the great care in construction and finish are essential to the securing of the best results from the propeller in service.

Pages 547, 883, 884, 886, 887, 888.

Propeller Aperture. See APERTURE.

Propeller Blade, Back of. The forward side of the propeller blade.

Propeller Blade, Developed Area of. The actual area of the surface of the blade.

Propeller Blade, Projected Area of. The area enclosed by the trace on an athwartship plane of the perpendiculars drawn from the edge of the propeller blade.

Propeller Blade, Rake. The sloping aft from a position at right angles to the axis of propeller shaft of the propeller blades.

This practice results in better clearances between hull and propeller.

Radial blades, however, are simpler of construction, have less surface friction, and are stiffer.

Propeller Blade, Root of. That portion of the blade closest to the hub or boss. It is made relatively very thick in order to provide for the bending moment of the entire blade.

Propeller Blade Tip. The outermost portion of the propeller blade. It is made very thin in order to avoid eddies.

Propeller Blade Tip Clearance. Generally the shortest distance between the skin of a vessel and the circle swept by the propeller tips.

Recent practice favors the provision of liberal tip clearances, wherever possible, in the interest of propeller efficiency and reduction of hull vibration. Allowable lengths of strut arms and reasonable shaft angle tend to limit the extent to which this can be carried.

Propeller Blades, Screw. The radial arms, attached to the propeller hub, the faces of which form portions of an approximately helical surface the axis of which coincides with that of the propeller shaft.

Blades are either cast in one piece with the hub or cast separately and designed to be attached to the hub with bolts. In this latter case provision is usually made for a slight adjustment in pitch by means of the shape of the bolt holes.

Propeller Boss. The central portion of the screw propeller which carries the blades and forms the medium of attachment to the propeller shaft.

It is taper bored for the reception of the propeller shaft and slotted for the key. When properly placed upon the shaft it is forced home and secured in its final position by means of the propeller lock nut.

Propeller Cavitation. That condition of screw performance in which increase of torque fails to produce a corresponding or reasonable increase in thrust.

The cause or causes of this phenomenon are not clearly understood. Among the factors intimately connected with it may be mentioned: the character of the vessel's after body, amount of tip clearance, the projected area ratio of the screw, thrust deduction, effective thrust, blade speed through the water, and shape of blade section.

For discussion of this subject in detail see:

"Screw Propellers for Hydraulic and Aerial Propulsion," by Admiral C. W. Dyson, Edition 1918, pages 130 to 145.

"Speed and Power of Ships," by Admiral D. W. Taylor, Edition 1910, pages 182 to 195.

"Ship Form, Resistance, and Screw Propulsion," by G. S. Baker, Edition 1915, pages 216 to 220.

Propeller Diameter. The diameter of the circle tangent to the tips of the propeller blades.

Propeller Disc Area. The area of the circle swept by the blade tips of a propeller.

Propeller Driving Face or Face. The after face of the propeller blade; that face which acts directly upon the water when driving the vessel ahead.

Propeller Efficiency. The ratio of the thrust horse power delivered by the propeller to the shaft horse power as delivered by the engine to the propeller.

Propeller Following Edge. The after edge of a propeller blade.

Propeller Frame. See STERN FRAME.

Propeller Guard. A frame work fitted somewhat below the deck line of narrow, high speed vessels with large screws and so designed as to overhang or house the projecting propeller tips. Propeller guards are generally built up of pipe or structural shapes.

Propeller Leading Edge. The forward edge of a propeller blade.

In propellers of very high speed it is very important that the leading edge approach mathematical

sharpness as nearly as possible in order to avoid the setting up of great pressures.

Propeller Pitch, Nominal. The distance (measured parallel to the axis of rotation) between similar positions of a point on the driving face of a propeller blade in successive revolutions. When the driving face of a propeller blade lies entirely in a true helical surface the blade is said to have uniform pitch. When the pitch at the following edge is greater than that at the leading edge, the blade is said to have axially increasing pitch. When the pitch near the tip is greater than that near the hub the blade is said to have radially increasing pitch.

Propeller Pitch, Virtual. The pitch of a theoretically perfect blade of no thickness which would act as does the actual blade.

The pitch of the back of a propeller blade varies greatly from that of the face of the blade. Inasmuch as the back exercises a material influence upon propeller performance, correct conclusions are impossible unless proper allowance is made therefor. The virtual pitch as above defined meets this requirement.

Propeller Post. The forward post of a stern frame on vessels having a center line propeller. It provides a support for the stern tube and propeller shaft as well as a joining frame for the converging sides of the ship at the stern.

Propeller Racing. The sudden increase in the number of revolutions made by the engine when the propeller blades or paddle wheels are lifted clear of the water, or nearly so, due to the roll or pitch of the ship.

Propeller Shaft. That length of shafting in a screw steamship which carries the propeller. It is the aftermost piece of shafting and at its outermost end is coned, slotted and threaded for the attachment and proper securing of the propeller itself.

This piece of shafting is carried directly by the propeller strut or stern bearing and is made slightly larger than the line shafting as a precaution against corrosion and shock. It is generally encased in a brass sleeve to provide proper bearing surface and to protect the shaft from corrosion.

Pages 548, 549.

Propeller Slip Angle. The angle between plane of blade face and its direction of motion.

Slip angles met in practice are very small. In ordinary propellers with nominal slips of 15 to 20 per cent the slip angle is from 2½ to 5 degrees only according to Admiral D. W. Taylor.

Propeller Slip, Apparent. The value of the fraction

$$\frac{\text{Propeller speed—speed of ship}}{\text{Propeller speed}}$$

Propeller Slip or Slip Ration; Apparent True Slip. The ratio of speed of slip to speed of propeller or, expressed in the form of a fraction,

$$\frac{\text{Propeller speed—speed of propeller advance}}{\text{Propeller speed}}$$

If the effective or real pitch of the propeller were that of the propeller face this fraction would represent the real slip of the propeller.

This fraction is generally termed the slip and expressed as a percentage. It is more accurately designated slip ratio or slip fraction.

The fact that revolving propellers do not advance through the water a distance equal to this pitch for each revolution, as would be the case with a screw turning in a solid nut, but under given conditions advance a constant proportion of the pitch, makes the recognition and consideration of slip importance in all problems of propeller design.

In practice most propellers show maximum efficiency at slips between 15 and 20 percent.

Propeller Speed Ratio. The speed of advance divided by the speed of propeller.

Propeller Sweeping Up. The process of preparing molds for the casting of a screw propeller in the foundry. It ordinarily consists of the generation of a helical surface by the revolution of a horizontal straight edge, called a sweep, about a central vertical column to which the sweep is so attached as to permit of vertical motion. At its outer end the sweep follows the helical edge of a guide board erected at the proper radial distance from the central column. The foregoing applies to propellers having a vertical generatrix. For those having an inclined generatrix, the straight edge is set at an angle other than 90° to the central column.

Screws with a vertical generatrix are to be perferred on several accounts where there are ample clearances between blade tips or edges and hull, struts, etc., and are in general used except for single screw vessels.

Propeller Thrust. The effort delivered by a propeller in pushing a vessel ahead.

The power resulting from the propeller effort is termed thrust horse power. It is equal to the actual thrust in pounds multiplied by the distance in feet moved by the ship per minute divided by 33,000.

Propeller Thrust, Deduction. The actual thrust of the propeller minus the tow rope resistance of the ship or the net thrust of the propeller.

In driving a ship ahead the screw exerts a suction upon the afterbody of the ship, thereby virtually increasing its resistance over what it would be without the screw. The wake created by the ship's hull in moving through the water affects the action of the screw favorably. These two factors work against and partially offset each other.

Propeller Tip Speed. The speed in feet per minute swept by the propeller tips generally used as that corresponding to the maximum designed revolutions of the machinery.

Propulsive Coefficient. See Coefficient, Propulsive.

Propulsive Efficiency. The ratio of effective to indicated (or shaft) horse power. Admiral Dyson in "Screw Propellers for Hydraulic and Aerial Propulsion," Edition of 1918, page 18, states that the ratio of shaft to indicated horse power may be taken as .92.

Many factors such as hull form, appendange resistance, propeller tip clearance, shaft angle, etc., affect the value of the propulsive efficiency.

Protection Plate. A term applied to the plate fitted in the way of the hawse pipe for protection against blows from the flukes of the anchor.

Prussian Blue. See Paint.

Puddening, Pudding. Pads constructed of old rope, canvas, oakum, etc., in any desired shape and used on rigging to prevent chafing or on the stem of a boat to lessen the force of a shock.

Puddling. Described under Steel and Iron.

Pulley or Sheave. See Sheave.

Pulsometer. An apparatus for pumping water consisting of chambers in pairs, wherein steam is con-

densed, making a vacuum in alternate chambers. The water drawn into a chamber is forced out by the admission of steam under pressure.

Pump. A machine actuated by hand or power for raising and transferring fluids or gases and for inducing a vacuum. Pumps on shipboard are used for so many purposes that they will be individually described under their separate headings.

Pages 865, 885, 921, 1012, 1024, 1038, 1040,1041, 1044, 1047, 1048, 1049.

Pump, Admiralty. A direct acting simplex or duplex pump with the piston and plunger on a vertical rod. In this type of pump the valves for the admission and discharge of water are easily examined and removed.

Pump, Air. The main air pump is for the purpose of reducing the back pressure in the low pressure cylinders or turbines and also for removing the condensed steam and vapor from the condenser. These pumps are driven either by a connection with a crosshead (usually the low pressure) on the main engine or by an independent engine. They are also made single and double acting. The single acting, direct driven type is the most common. As the vacuum in the condenser with the above described pump is dependent on the temperature of the hot well and as water will absorb only about 1/20 of its volume of air, dry vacuum pumps, augmentors, rotary and air ejector systems are being installed where a high vacuum is desired. See various headings.

Pages 391, 399, 656 to 659, 1038.

Pump, Air and Circulating, Auxiliary. This pump is composed of three cylinders: a steam cylinder for power, a water cylinder for circulating water through the auxiliary condenser, and a water cylinder for extracting the condensed steam in the auxiliary condenser and delivering it to the feed tank. This pump is an extravagant user of steam.

Plates XIV, XLVII, XLVIII.

Pump, Air, Bucket Valves. Non-return valves placed in the moving bucket of the air pump and providing communication for the air, water and vapor from the suction to the discharge end of the pump cylinder.

Pump, Air, Discharge Valves. See PUMP, AIR, HEAD VALVES.

Pump, Air, Dry Vacuum. A pump for discharging the air and vapor from a condenser into the atmosphere. The suction from this pump is located as high as possible on the suction line to the condensate pump or to a dry suction pad on the condenser. These pumps may be operated at a high speed, and they also keep a uniform head of water to the condensate pump.

Pump, Air, Dual. A combined wet and dry pump. A wet cylinder takes care of the condensate, and a dry air cylinder, which has an independent cooling system, densifies the air and vapor. This keeps the temperature of the hot well close to the temperature of the vacuum.

Pump, Air Ejector. A steam ejector connected to the condenser dry suction for the purpose of discharging the air and vapor into the atmosphere. A condensate pump handles the condensed steam.

Page 1042. Plate XIV.

Pump, Air, Foot Valves. Air foot valve. Non-return valves placed at the suction end of the cylinder.

Pump, Air, Head Valves. Non-return valves placed in the discharge end of the air pump cylinder for the purpose of delivering the condensate to the hot well and allowing the air and vapor to escape.

Pump, Air, Suction Valves. See PUMP, AIR, FOOT VALVES.

Pump, Auxiliary Circulating. A pump to force water through the tubes of the auxiliary condenser. It is often combined with the auxiliary air pump. These pumps deliver to the main feed line only.

Pump, Auxiliary Feed. A pump with the following suctions: From the main feed tank, the reserve feed tank, the sea, the bilge, and from the bottom of the condenser. It can deliver to the boilers, the reserve feed tank or overboard. On account of the number of leads to and from this pump great care should be taken that fresh water is not pumped overboard, salt or bilge water pumped into the boilers, unless it is an emergency and so intended, or that the pump is used at all for boiler feed after pumping the bilge unless it has been thoroughly washed by a salt water circulation.

Pump, Ballast. A pump used for filling and emptying the ballast tanks. It has by-passes so that it can work the bilges and fire system either alone or in conjunction with the other pumps.

Pages 391, 393, 399, 401, 1038. Plates XII, XIV, XLVII, XLVIII.

Pump, Bilge. A pump used aboard ship to remove accumulations of water in the vessel's bottom tanks, hold and other compartments and discharge it overboard.

Pages 865, 1038, 1048.

Pump, Bilge and Fire. See PUMP, FIRE AND BILGE.

Pump Booster. See PUMP, TRANSFER.

Pump Bucket. This term is sometimes used synonymously with the plunger. More correctly it is the cylindrical piston in vertical single acting pumps where the water is lifted from the bottom to the top of the cylinder. The term bucket should be used only when both top and bottom sides of piston come into operation in the performance of the function of the pump. Where one side of the piston only comes into operation, the term plunger should be used.

Pump Bucket Valve. A non-return valve placed in the moving bucket of a pump. See AIR PUMP BUCKET VALVE.

Pump, Centrifugal. This pump consists of a shaft to which vanes are attached and which rotates in a circular shape casing. Water enters the casing near the center or rotating shaft and moves outward along the vanes by centrifugal force. There is a discharge pipe at the circumference of the casing through which the water escapes. The pump may require priming to start it and is more efficient with low heads.

Pages 885, 921, 970, 1012, 1024, 1040, 1041, 1044.

Pump, Condensate. The function of this pump is to deliver condensate to the hot well or feed tank.

Pages 425, 934, 1041, 1044. Plates XIV, XLVII, XLVIII.

Pump, Direct Acting. A pump in which the piston and plunger are on the same rod but that does not require a fly wheel to carry it over the dead points.

Pump, Direct Driven. A pump whose plunger is actuated from the main engine.

Pump Discharge Head. The distance from the pump up to the point of delivery including frictional resistance.

Pump, Distiller. A pump used for transferring the distillate to the culinary and supply tanks.

Pump, Distiller Circulating. A pump for forcing circulating water through the distiller tubes to condense the vapor into water. It should have a by-pass to the flushing system.

Pump, Donkey. This pump has the same suction and discharge leads that the bilge pump has, and in addition is usually connected to the donkey boiler. Thus it can work when the main boilers are cold.
Page 425.

Pump, Double Acting. A pump that delivers on each stroke and from both ends of the cylinder.

Pump, Downton. A hand pump that is also a force pump. It is worked by cranks on each side of the pump chamber or if placed on a lower deck the cranks may work through shafting and gears. It is arranged to draw from all compartments and from the sea and discharges overboard and to the fire main.

Pump, Dredging. A heavily built pump of the centrifugal type used on dredges and sand suckers for removing sand, gravel, etc., from the bottom of rivers and harbors when building or deepening channels.
Page 1045.

Pump, Duplex. A pair of pumps so placed that the piston rod of one pump actuates the valve of the other.
Page 885.

Pump, Evaporator Feed. This pump supplies the evaporator with salt water for vaporization.
Page 425, 885. Plates XIV, XLVII, XLVIII.

Pump, Fire and Bilge. A pump used for keeping the bilges free of water, washing decks and for putting out fires. It has a sea suction and an overboard delivery of its own. It is more or less constantly in operation, keeping the bilges free of water and when used for washing decks should be cleaned by pumping salt water overboard. This pump has a suction to the bilge, drains, and inner bottom.
Pages 391, 393, 399, 400, 401, 656 to 659, 425, 1038. Plates XII, XIV, XLVII, XLVIII.

Pump, Flushing. See PUMP, SANITARY.

Pump, Force. One that in addition to lifting the water also forces it out through piping to a point of delivery.

Pump Foundation. A term applied to a foundation supporting a pump and given the name of the pump as Ballast Pump Foundation, Feed Pump Foundation, etc.

Pump, Fresh Water. This pump delivers fresh water from the culinary or supply tanks to a gravity tank, which is also called the daily supply tank. The gravity tank feeds the fresh water supply lines to the quarters, galleys, pantries, lavatories, etc.
Page 425. Plate XIV, XLVII, XLVIII.

Pump, Fuel Oil Service. A pump for feeding the oil burner in a boiler.
Page 991. Plate XIV.

Pump, General Service. A term applied to the main fire and bilge pump.
Pages 885, 1040, 1049.

Pump Governor. See GOVERNOR, PUMP.

Pump, Hand. A pump worked by hand. They are located in the upper decks and consequently have a high suction and are difficult to operate by hand. The amount of water that they will handle is so small that these pumps are not of much use in ships of any size.
Page 1048.

Pump, Handy Billy. A portable hand pump.

Pump, Hydraulic Pressure. A pump designed to deliver against a heavy pressure. The pump and its parts must be extra heavy and strong.
Page 749.

Pump, Independent. A pump with its own engine. The piston and plunger are usually on the same rod, the valve gear being actuated from the crosshead.

Pump, Lift. A pump that lifts only and does not discharge against a head.

Pump, Lubricating Oil. The function of this pump is to force lubricating oil to the shaft and engine bearings and crossheads.
Pages 442, 443, 964, 965. Plate XIV.

Pump, Main Circulating. The function of this pump is to take water in large quantities from the sea, force it through the main condenser tubes and then overboard. On account of the low head to be overcome and the large capacity required, it is usually of the centrifugal type. In addition to a suction line, sea injection valve, delivery line, and overboard discharge valve, it has a by-pass to the bilge which may at any time be used in pumping water overboard either directly or through the condenser. As a centrifugal pump will handle ashes and such refuse as are liable to collect in the bottom of a ship, it becomes of great value when a large quantity of water is admitted to the ship through the hatches or by accident.
Pages 442, 443, 656 to 659, 885, 921, 1012, 1024, 1041, 1044. Plate XIV.

Pump, Main Feed. The function of this pump is to keep the water at the proper level in the boilers. It takes fresh water either from the main or reserve feed tanks. Some types are driven from a connection to the main engine and others have independent engines. The number and location of these pumps depends on the size of the ship and the design.
Pages 391, 399, 401, 425, 656 to 659, 1038, 1040. Plates XII, XIV, XLVII, XLVIII.

Pump, Oil. Oil pumps on shipboard are used for feeding the lubricating system, feeding oil burners on boilers, transferring fuel oil from one tank to another and to the settling tanks, and for handling cargo oil. These pumps are specially designed for oil service.
Pages 443, 624, 625, 656 to 659, 1037, 1046, 1047.

Pump, Oil Service. A pump for the circulation of lubricating oil.

Pump, Plunger. A solid or hollow cylindrical piston that moves back and forth or up and down in the water cylinder of a pump. The plunger retains its full diameter when it passes through a stuffing box.

Pump, Reciprocating. A pump composed of one or more cylinders in which a piston or bucket moves back and forth or up and down. The power is obtained from steam cylinders and depends on the area of the piston and the steam pressure.
Page 1040.

Pump Rose Box. See PUMP STRAINER.

Pump, Rotary. This pump discharges through the action of a rotating cam or plunger and does not rely on centrifugal force.

Pump, Rotary Air. One form of rotary pump consists of a water wheel which throws thin films of spray into a discharge pipe in which a stream ejector is installed. It removes air and vapor only while a condensate pump handles the condensed steam.

Pump, Sanitary. The function of this pump is to supply salt water to the flushing system and for baths. It may deliver directly but commonly discharges into a

gravity tank, the overflow of which is carried to the water closets and troughs. It also supplies a tank in which a steam coil is installed for the purpose of providing for hot sea water baths.

Pages 391, 399, 401, 425, 442, 444, 656 to 659. Plates XII, XIV, XLVII, XLVIII.

Pump, Single Acting. A pump that delivers from one end of the cylinder only and on alternate strokes.

Pump Strainer. A galvanized iron box with the sides perforated by small holes, the combined area of which equals at least twice the area of the suction pipe. The object is to prevent refuse from clogging the pumps.

Page 606, 962.

Pump Strum. See PUMP STRAINER.

Pump Suctions. In the midship and dead flat sections of a ship and where there is not a sharp rise in the floor or bottom three suctions are required, one at the keel and one on each side to make sure of clearing the ship when she has taken a heavy list. In the ends of the ship and where there is a sharp deadrise only one suction need be installed near the keel.

Pump, Transfer. An oil pump used for transferring oil from one tank to another and from the oil tanks to the settling tanks.

Page 885, 1046. Plates XIV, XLVII, XLVIII.

Pump, Water Service. A pump for circulating cooling water through shaft bearings, crosshead, slides, etc. The delivery should also by-pass to the fire main and to the distiller.

Pump Wells. A tank formed either independently or by the structural members of the ship in which the pump strainer on the end of a suction line is installed. The hot well may be an independent tank and is used to collect the condensate water. Other wells are usual depressions in the inner bottom and into which the bilge water drains.

Pumping. The American Bureau of Shipping requires that all Steamers are to be provided with efficient steam pumping plant, having the suctions and means for drainage so arranged that any water which may enter any compartment of the Ship and any watertight section of a compartment can be pumped through at least one suction when the Vessel is on even keel and upright, or has a list of five degrees. Satisfactory means are to be provided for draining the tops of tanks in order to comply with this requirement.

All pipes from the pumps which are required for draining cargo or machinery spaces should be entirely distinct from pipes which may be used for filling or emptying spaces where water is carried; the arrangement of valves, etc., should be such as to prevent water passing from the sea and from such water spaces into the cargo and machinery spaces, or from one compartment to another. If a suction pipe from the engine room is led to the fore peak, a screw-down stop-valve capable of being operated from above the bulkhead deck, is to be fitted on the suction inside the forepeak.

Bilge Suctions.—The diameter of bilge suction pipes in inches should not be less than

$$\sqrt{\frac{L\times(B+D)}{2{,}500}}+1$$ for main line suctions to the pumps;

$$\sqrt{\frac{l\times(B+D)}{1{,}500}}+1$$ for branch suctions to cargo and machinery spaces,

Where L = Length of Vessel in feet.
B = Breadth of Vessel in feet.
D = Molded depth to bulkhead deck, and
l = length of compartment in feet.

Main suction pipes should not be less than 2½" bore and branch suction pipes should not be less than 2" bore, and need not be more than 4" bore.

Ballast Suctions are to be of the sizes given in the following table:

INSIDE DIAMETERS OF SUCTION PIPES

CAPACITY OF TANK.	Diameter of Suction. Inches.
Under 20 tons	2½
20 tons and under 40 tons	2¾
40 tons and under 60 tons	3
60 tons and under 85 tons	3¼
85 tons and under 120 tons	3½
120 tons and under 190 tons	4
190 tons and under 270 tons	4½
270 tons and under 365 tons	5
365 tons and under 480 tons	5½
480 tons and under 625 tons	6
625 tons and under 800 tons	6½
800 tons and under 1,000 tons	7
1,000 tons and under 1,300 tons	7½

The main suction line to the pumps is not to be of less diameter than is required for the largest tank; where it is necessary to fit branches in tanks in order to comply with par. 1, the total area of the suctions should be increased.

The Main and Donkey Pumps are to draw from all compartments, and in addition, the donkey is to have a separate bilge suction in the engine room. The pumps are to be of sufficient capacity to give a speed of water through the pipes of not less than 400 feet per minute, under ordinary working.

Main circulating pumps should have direct suction connections to the lowest drainage level in the machinery space. The diameter of these connections should be at least twice the diameter of the engine room main suction line.

Distribution Boxes, cocks, and valves are to be in positions which are accessible at all times under ordinary circumstances.

Bilge and Ballast Suction Pipes are to be efficiently secured, and straps are to be fitted at the middle of the length of each range of pipes to prevent fore and aft movement. Efficient expansion joints are to be fitted, and where the connections at the ends of each range of pipes are made with lead bends, the radii of the bends and the distance between the centers of the radii should each be equal to 3 diameters, and the length of the bend to 8 diameters of the pipe.

Roses and Boxes are to be easily accessible for examination and cleaning. The bilge suctions in machinery spaces and tunnel wells should be led from easily accessible mud boxes placed wherever practicable above the level of the working floor, and should have straight tail pipes to the bilges. The suction ends in other spaces should be enclosed in strum boxes having perforations whose combined area is not less than three times that of the suction pipe, and so constructed that they can be cleared without breaking the joints of the suction pipe.

Sounding Pipes are to be fitted to each compart-

ment and ballast tank, with a thick doubling plate securely fixed under each pipe, for the rod to strike upon. These pipes are to be fitted, without bends, directly into the compartment intended to be sounded, and are to extend to the Bulkhead Deck or to a position which is always accessible; if in accessible positions below the Bulkhead Deck they are to be fitted with non-detachable screw caps.

Air Pipes, not less than 2 inches in diameter, are to be fitted at each corner of each ballast tank; this requirement may be modified in the case of small tanks and increased for large tanks; the total area of the pipes should always be greater than that of the supply pipes and in the case of deep tanks should be at least twice that of the supply pipes. Efficient arrangements must be made to permit of the air getting freely to the pipes while the tanks are being filled. Where the tank top is peaked, cambered, or has sheer, air pipes are to be fitted at the highest position.

Air, sounding and suction pipes are to be effectively protected against the risk of damage from cargo, coal, etc.

Pumping

The American Bureau of Shipping requires that Vessels are to be provided with efficient hand pumps or power pumps, operated from the Bulkhead Deck or the highest convenient level which is always accessible. The pumps are to be arranged to drain each cargo compartment and the fore peak; the position of the suctions should be such that each compartment can be properly drained when the Vessel is on even keel and upright, or has a list of 5 degrees.

Hand pumps to the fore peak may be of the lever type, with pump chambers which need not exceed 4″ diameter; other spaces are to be drained by pumps of the rotary type; in small Vessels lever pumps may be adopted in cases where the diameter of suction pipes by the following formula is less than 2.″

The diameter of suction pipes should not be less than

$$\sqrt{\frac{l \times (B+D)}{1{,}500}} + 1.$$

Where l = length of compartment.
B = the molded breadth.
D = the depth.

No suction pipe should be less than 2″ nor need it be more than 4″ bore.

The chambers of plunger pumps should be copper, and the distance from the suction to the pump bucket when at the top of the stroke is not to exceed 26 feet. The efficiency of the pumps is to be tested upon the completion of the Vessel.

Pumps to peak ballast tank tops are to draw from suitable drain boxes or "hats" in the top plating.

All service pumps are to have efficient sea cocks on the side of the Vessel, worked from the Freeboard Deck or Bulkhead Deck if that be higher.

Sounding pipes are to be fitted to each compartment; the pipes are to be straight and are to have a direct lead; they are to extend to the Bulkhead Deck or to a position which is always accessible; if in accessible positions below the Bulkhead Deck they are to be provided with non-detachable screw caps. A thick steel plate is to be securely fixed below each sounding pipe for the rod to strike upon.

All pump chambers, tail pipes, sounding pipes, and rods are to be protected by substantial casings, so fitted that they can be conveniently removed when necessary for purposes of examination.

Sufficient limber holes are to be cut to permit a free flow of water to the suctions without unduly weakening the plates.

Punch. See Punching Machine.

Punch and Shear, Combination. A double ended machine designed for punching at one end and shearing at the other. Each end is controlled independently and may be operated simultaneously on two pieces of work.

Pages 736, 743.

Punch, Double End. A double ended punching machine, designed for punching holes in metal plates or shapes at both ends. The punches at each end are controlled independently and may be operated simultaneously on two pieces of work.

Punch, Horizontal. A punching machine in which the punch moves in a horizontal direction. This type is generally used for punching holes in shapes such as angles, zee bars, etc.

Pages 741, 745.

Punch, Multiple. A punching machine designed for punching more than one hole in a single operation. See Punching Machine.

Pages 742, 743, 745.

Punch, Vertical. A punching machine in which the punch moves in a vertical direction. This type of punch is generally used for punching holes in plates.

Pages 740, 743, 744, 745, 746.

Punching Machine. A machine used for punching rivet and bolt holes in metal plates, angles, I-beams, channels, etc. Some punching machines are designed to punch holes exclusively; whereas other machines are adapted to either punching or shearing by simply attaching suitable tools.

Some types of punching machines are designed to be power driven while others are hand operated. These machines are also designed for punching one or more holes in a single operation, according to the type.

Pages 736, 740, 741, 742, 743, 744, 745.

Punt. A heavily built boat of rectangular shape used by workmen employed in painting, cleaning or repairing a ship's topsides when in sheltered waters.

Purchase. Any mechanical advantage which increases the power applied.

Purser. A ship's officer who has charge of provision accounts, is head of the steward's department, handles mail, etc.

Putty, Rust. A putty made from the cast iron filings or borings and sal ammoniac, used as a luting between the flanges of iron pipe, etc.

Pyrometer. An instrument for measuring the temperatures of the hot gases and steam in a boiler.

Q

Quadrant. A casting, forging or built up frame in the shape of a sector of a circle attached to the rudder stock and through which the steering gear leads turn the rudder.

The hub of the quadrant is bored and keyed to fit the rudder stock. It may be in two pieces clamped together by bolts or in one piece, in which case it must be slipped down over the end of the stock.

The rim of the quadrant is provided with two

grooves to take the steering chains or ropes and it should be designed with sufficient length of arc so that the leads are tangential to the rim at all angles of the rudder.

Quadrant. A reflecting hand navigating instrument constructed on the same principle as the sextant, but with a shorter limb, measuring angles up to 90 degrees only.

If named on the same principle as the sextant, it would be called an octant, and this name has been given to the metal-framed instruments manufactured in recent years. Quadrants have, generally, a wooden frame with an inlaid ivory limb and were formerly very much larger than the present quadrants or octants.

A part of the reversing gear on a reciprocating marine engine.

A fourth part of a circle or its circumference.

Quadruple Riveting. See RIVETING, QUADRUPLE.

Quarter. The part of a yard just outside the slings; the upper part of a vessel's sides near the stern; portions of a vessel's sides about midway between the stem and the middle and between the middle and the stern.

Quarters. Living spaces for passengers or personnel. It includes state rooms, dining saloons, mess rooms, lounging places, passages connected with the foregoing, etc.; individual stations for personnel for fire or boat drill, etc.

Quarter Deck. See DECK, QUARTER.

Quarter Deck Sheerstrake. The strake of outside plating adjacent to the quarter deck.

Quarter Deck Stringer. See STRENGER, QUARTER DECK.

Quarter Deck Stringer Bar. See STRINGER, BAR.

Quarter Iron. A metal ring or hoop fitted on the yard arm at the quarter through which a studding sail traverses and is held down at its inner end when rigged out.

Quarter Master. An under officer of a ship's crew who steers the ship and has charge of the navigating instruments.

Quarter Pillar. See PILLAR, QUARTER.

Quarterman. An under foreman. A term generally restricted to the navy yards.

Quay. An artificial wall or bank usually of stone, made toward the sea at the side of a harbor or river for convenience in loading and unloading vessels.

Quicken. To lessen the radius of a curve or make it sharper; to snub; e. g. to quicken a waterline is to make its curvature more pronounced.

R

Rabbet. A groove in the stem, keel or stern frame into which the edges of planking or plating are fitted.

Racing. See PROPELLER RACING.

Racking. Spun yarn or other small stuff used to bind two ropes together.

Racking. The tendency to deformation in built up structures or shapes which results from the action of racking stresses. In a ship the transverse racking tendencies are of more importance than the longitudinal. This is due both to the character of the structure and to the nature of the stresses to which the structure is usually exposed.

The line of demarcation between racking and shearing is somewhat indefinite. As ordinarily used, however, racking implies the deformation of a section or structure as a whole, so that one set of diagonals in the plane of action is shortened, while those at right angles thereto are elongated. Shearing, on the other hand, implies the sliding of one part of a section or structure past or relative to the adjacent part.

Racking Stresses. Stresses which tend to produce racking strains. See RACKING.

Racks, Rifle or Pistol. See RIFLE AND PISTOL RACKS.

Radial Countersinking Machine. See DRILLING MACHINE, RADIAL.

Radial Drill. See DRILLING MACHINE.

Radial Wood Boring Machine. See DRILLING MACHINE.

Radiator. A pipe coil or casting designed to radiate heat from a steam or hot water pipe line.

Pages 612, 613.

Radio. All radio stations are required to have a license and can be used only by licensed operators.

The Department of Commerce, Bureau of Navigation, Radio Service, Washington, D. C., has jurisdiction over Radio Communication and "Regulations Governing Radio Operators and the Use of Radio Apparatus on Ships and on Land," may be obtained on application to the department.

Certain vessels are required by law to be equipped with radio apparatus, and there are three classifications for ship stations. Ship owners or naval architects should consult the regulations to ascertain the requirements for any particular vessel.

Radio is the transmission of intelligence by means of electromagnetic waves. Briefly, the apparatus consists of a transmitter, receiver and antenna ("aerial" consisting of an elevated system of wires). The same antenna is usually used for both sending and receiving. The transmitter is a device for causing high frequency alternating currents (oscillations) to flow up and down the antenna. These oscillations cause a disturbance in the surrounding ether somewhat similar to those caused on the surface of a sheet of still water into which a stone is dropped. When these waves impinge on an antenna which is being used for reception, it is set into oscillation (as a cork would bob, floating on the surface of the sheet of water). The receiver translates these oscillations into an audible sound in a pair of head telephone receivers.

Pages 1076, 1077.

Wave Length. The wave length depends on the frequency of these antenna oscillations (in radio from 10,000 to 1,000,000 per second). The fewer oscillations per second, the longer the wave. This may again be compared to water waves. A great many ripples two feet from crest to crest will break on the beach in the same interval in which two combers 100 feet from crest to crest will break. Wave length is usually measured in meters, 600 meters being at present the standard merchant ship wave length.

Tuning. Tuning consists of adjusting a transmitter to emit a desired wave length, or a receiver to respond best to a desired wave length.

Interference. When two or more stations are sending on the same or nearly the same wave length, in a receiver "tuned" for one, the operator will hear the several simultaneously, making the desired station difficult to pick out.

Static. Atmospheric disturbances sometimes directly traceable to thunderstorms, which produce loud crackling and hissing noises in the receiver, sometimes loud enough to prohibit communication by "drowning out" the desired signal. Static occurs more frequently in summer than in winter and is usually more intense in the tropics than in the temperate zones.

Transmitters. There are two major types of radio transmitters—Group and Continuous Wave.

The Group transmitters include all the various types of spark set (500 cycle, Quenched, Impact, Impulse, Shock, Rotary-synchronous, Rotary-non-synchronous, Plain Spark and Buzzer Sets).

The Continuous Wave apparatus (Undamped Wave) includes the Arc, Tube (Pliotron and other bulbs) and High-frequency Alternator.

The fundamental difference between these two types of apparatus is that the Group transmitter sends out energy in groups of waves—the groups occurring at a frequency of, say, 1,000 a second, so as to produce an audible note. This frequency is often that of the alternator used to generate the alternating current, which is stepped up to a higher potential by a transformer and is used to produce the spark. Hence the terms "500 cycle quenched set," "240 cycle synchronous set," etc.

The Continuous Wave Set, throughout the time that the key is depressed, sends out its energy in an uninterrupted train of waves which has no note of its own. In this case the note is usually produced at the receiver, either by "chopping" the waves into audible groups by making and breaking some part of the circuit periodically, or by combining a local vibration of slightly different frequency with the incoming wave so as to produce "beats" at an audible rate.

The various types of Group transmitter or Spark set have almost invariably a common feature; namely, two circuits—one in which the spark takes place, and the other the antenna circuit, from which the waves are radiated. Alternating current is used (hence the necessity of a motor generator on shipboard where direct current only is supplied), and, through a transformer which raises the potential, it charges a condenser in the spark gap circuit or "Primary" to a sufficiently high value to cause a spark to jump across the gap. The primary circuit during the sparking in the gap transfers its energy to the "secondary" or antenna circuit. The method in which this transfer occurs differentiates the spark transmitter into various types. In the plain open spark gap and its variations, the rotary-non-synchronous and the rotary-synchronous, the current of the spark consist of a long series of alternately increasing and diminishing oscillations.

This gap circuit is electromagnetically coupled to the antenna circuit. The energy is first increasing in the antenna circuit and decreasing in the gap circuit, then vice versa. The two are coupled together and oscillate together. This has the disadvantage that there is a great deal of energy used up in the resistance of the spark gap and its circuit. It is as if two pendulums, A (the Primary or gap circuit) and B (the Secondary or antenna circuit) were connected together by a string. We make B swing by swinging A. We are only interested in making B swing as long and hard as possible with the least possible application of energy to A. It stands to reason that if they are tied together, B has to overcome both its friction and the friction of A.

The "Quenched Spark" to a great extent overcomes this difficulty. Owing to the design of the gap (a series of slightly separated flat plates) the spark is cooled rapidly, and after a few oscillations ceases, leaving the secondary circuit to oscillate freely by itself. It is as if in our pendulum experiment we give A two or three vigorous swings and then cut the string connecting it with B, leaving B to swing alone.

The "Impact" ("Impulse" or "Shock") transmitter carries this one step further—to the limit, in fact. The spark is not an oscillation at all, but a one-directional discharge, during which most of the energy in the gap circuit is transferred to the antenna. It is almost as if the A pendulum was removed and the B pendulum struck a blow with a hammer.

There is, in practice, little difference in the efficiency of the last two methods. The advantage claimed for the Impact type is that the two circuits do not at any time oscillate together and therefore do not have to be carefully tuned together, thus simplifying the adjustment of the apparatus. Certain transmitters of this type use a great many small sparks to produce each group of waves, instead of one large discharge. This may, in a sense, be likened to a 12-cylinder engine compared to a single cylinder of the same power. The maximum strain on any part is less.

The various types of continuous wave apparatus may be described briefly as follows:

Page 1076.

The Arc consists of a large electric arc supplied by a 500 volt DC generator. Its poles are also connected to the antenna and ground. The current instead of flowing across the arc in the usual manner alternately flows up into the antenna and then down through the arc, keeping the antenna in a constant state of oscillation. To function properly the arc must be water-cooled and one of the poles rotated. It must be in an airtight chamber into which alcohol is dripped and in a strong magnetic field. The arc is at present only used in the larger powers of 15 KW or more, principally on naval ship and shore stations.

The Tube Set which still might be said to be in the experimental stage consists of one or more exhausted glass bulbs, resembling incandescent lights, but containing two elements in addition to the filament called the plate and grid. When connected in one of several ways, continuous oscillations are produced.

The High Frequency Alternator is now used only in the largest powers. It consists of a special design of alternator with such a large number of poles, and run at such high speed that continuous oscillations are generated at a high enough frequency (30,000 cycles per second, or more) to use directly in the antenna. The "Frequency Changer" is a variation of this latter method in which a fairly high frequency is generated (say, 10,000 cycles), and doubled or quadrupled by means of a special series of transformers having a direct current winding in addition to the usual windings.

At present only "group transmitters" are used to any extent on merchant ships; and most merchant ships are not provided with any means of "chopping" or producing local oscillations for beats, so are not in any way equipped for reception of continuous waves. It is thought by many that continuous waves eventually will be universally used, but there are many problems in this connection still unsolved.

For instance, if "chopping" is used (which is an extremely inefficient method, as half the time when the circuit is open no energy is being received), all signals will have exactly the same frequency and quality of note, so that an interfering signal will sound exactly like the desired signal.

If beat reception is used, the notes may be different, but the quality is always the same. Two "spark" sets may have exactly the same number of groups per second; i. e., the same tone—but may differ enough in

quality so that the desired one may be picked out in the same manner that a given note on a violin may be told from the same note on a flute; so that the spark set may be said to have three variables which may be used in eliminating interference, namely, note, quality of note and wave length, while the continuous wave set has but note and wave length.

Radio Compass. See COMPASS, RADIO.

Radio Room. A room used for sending and receiving wireless messages. It should be as sound-proof as possible, with a closely-fitted door, so that noises will not confuse the operator.

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Radio Telephone. The radio telephone is yet in its infancy. At present it has in general a short range and is somewhat complicated. It consists briefly of a continuous wave set, in which the strength of the oscillations is modified by the voice in a manner similar to that in which the direct current is modified in an ordinary telephone line. It would seem on first thought that the telephone would possess the marked advantage of not requiring the services of a skilled telegrapher. It must be remembered, however, that unless all ship and shore stations with which it is desired to hold communication are likewise equipped they will answer by telegraph in the International Morse, which will require a telegrapher to translate. The telephone is also somewhat more subject to interference if several stations are working simultaneously in one wave length. It is a well-known fact that a telegrapher can pick out his sounder and copy it through the noise of a dozen others, but it would be more than difficult to understand a telephone conversation with one person if a dozen others were talking on the same line. This fault will undoubtedly be eliminated eventually by further progress in the art.

Receivers. The receiver consists of an antenna circuit capable of being tuned to any desired wave length within certain limits, called in this case the Primary; and an electromagnetically coupled circuit, the Secondary, containing one of the various forms of Detector, a device whose purpose is to convert the high frequency oscillations induced in it from the antenna into a form of current which will cause a sound in the telephone receivers worn by the operator. The oscillating currents in this circuit reverse direction so rapidly that they cannot affect the diaphragm of the telephone receiver—it cannot follow sufficiently fast, and even if it could, the sound produced would be of a pitch far too high to affect the human ear. This difficulty is overcome by the Detector, which is invariably some form of rectifier—a device which allows current to flow easily through it in one direction, but offers a high resistance in the other, causing the current to flow through the telephones instead. This results in a quantity of small impulses being given the diaphragm in one direction which is in effect one large impulse, so that each group of oscillations produces one pulse in the telephones. If there are 1,000 groups per second, a 500 cycle note is heard.

There are only two forms of detector in common use today; the Crystal Detector, consisting of one of several crystalline materials having the property of conducting practically in one direction only, held in some kind of clamp; and the Audion ("Three Element Vacuum Tube"), consisting of an exhausted glass bulb containing a hot filament and two other electrodes. The current is carried in minute charges thrown off from the incandescent filament, and they flow in one direction only. The Crystal Detector is exceedingly simple, requiring no auxiliary apparatus. The Audion is somewhat more sensitive, but requires a rheostat to control the filament current, and two storage batteries. The Audion may be made to oscillate in a manner similar to the Tube Transmitter, so as to receive continuous waves by the production of beats. With a Crystal it is necessary to use some form of Chopper (or "Tikker").

The Wave Meter is simply a circuit capable of being tuned to any wave length within a certain range, and its adjusting handle and scale calibrated to read directly in wave length. Some indicating device is usually included, so that if placed near a transmitter that is in operation and adjusted to maximum response, the wave length of the transmitter may be read from the scale directly, or by means of a curve.

Radius of Gyration. If M be the mass of a system, such as a ship, and K be such a quantity that MK^2 is the moment of inertia about a given straight line; K is called the "Radius of Gyration" of the system about that line.

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Raft. A quantity of timber, lumber, etc., secured together by means of ropes, chains or rods in order to permit of its being floated by water to its destination.

Raft Body. That horizontal slice or zone of the hull of a first-class naval vessel which is located at and immediately above the vessel's designed load waterline. In United States Naval practice the top of this zone or slice is formed by the protective deck and its bottom by the splinter deck. Its sides and ends are protected by means of the main side and transverse arm or belt, respectively. The space within that portion is closely subdivided by heavy watertight bulkheads. The principal object in the above construction is the maintenance of the ship's stability and floatability even when damaged.

Raft, Life. See LIFE RAFT.

Raft Port. See PORT, BOW OR STERN.

Rail. Channel bars, shapes or flat pieces of wood fitted at the top of bulwark plating or at the top of rail stanchions. Also applied to the tiers of guard rods running between the top rail and the deck.

Rail, Brest. The top rail running athwartship on a bridge, the after end of a forecastle deck or the fore end of the poop deck.

Rail, Hand. A term applied to a rail fitted along the side of a ladder or a companionway.

Rail, Main. The top rail running along the top of the bulwark or rail stanchions on the upper or weather deck.

Rail, Poop. A term applied to the rail around the top of the bulwark or rail stanchions on the poop deck.

Rail Stanchions. Steel or wood stanchions that serve as fence posts for the guard railing or ropes enclosing the decks, bridge, forecastle, etc., of a vessel. They are spaced at approximately equal distances and are fitted permanently or removable as the requirements demand.

Rail, Topgallant or Monkey. The rail running along the top of a topgallant or upper extension of the bulwark.

Railway, Marine. See DRY DOCK, RAILWAY.

Raised Quarter Deck. See DECK, RAISED QUARTER.

Raising Iron. A tool used by calkers to remove dirt from a seam preparatory to calking.

Rake. A term applied to the inclination from the vertical of a mast, smoke stack, stem post, etc. For example, in a vessel with two masts and a smoke stack lying between them, the foremast may be given a rake of one-half of an inch to the foot aft; the smoke stack five-eighths of an inch to the foot aft, and the main mast a rake of three-quarters of an inch to the foot aft. It is claimed that by giving the stack and main mast the increased rake, mentioned above, that the masts and stack will appear parallel at a distance. If the stem is not given a rake forward it will appear to the eye to slant backward.

Rally. Men uniting in driving wedges when launching a vessel.

Ram. A forward, strongly constructed, underwater projection of the stem post. They were until recently fitted on most warships. On account of the severity of the stresses set up by the shocks of a collision and also on account of the fact that action between warships is generally conducted at long range, the ram as a means of offence is becoming less used.

The bulbous shape, although not projecting forward, is still retained at the bottom of the stern post on American warships.

A name given to a vessel that is designed for the purpose of sinking vessels by head on collision or for ice breaking.

Range, Galley. The stove, situated in the galley, which is used to cook the meals. The heat may be generated by coal, fuel oil or electricity.

Pages 1095, 1096, 1098.

Range Lights. See LIGHTS, RANGE.

Ratchet Drill. A hand tool in which a drill is rotated by a lever and ratchet.

Page 772.

Ratchet Socket Wrench. See WRENCH, RATCHET SOCKET.

Ratchet Stud Driver. A hand tool by which studs may be set or removed by a lever and ratchet.

Page 772.

Ratchet Wheel. A term applied to a wheel fitted to a revolving mechanism, having sharp angular teeth for the purpose of engaging a pawl and thus preventing recoil.

They are usually fitted on capstans, winches, and windlasses.

Rate. The class in which a vessel is placed. In the merchant service rating is based upon the character of material and the construction. In the naval service the displacement, number of guns, protection, speed, etc., are the determining factors.

The process of determining the error of a ship's chronometer relative to true time.

Ratline Stuff. A right handed, three stranded small stuff of usually four to eight threads to the strand making "12-thread," "15-thread," etc., ratline stuff.

Ratlines. Short lengths of ratline stuff secured to the shrouds parallel to the waterline. These serve the purpose of latter rungs for the crew in ascending or descending.

Pages 825, 826.

Rave Hook. A thin hood shaped tool used by calkers to remove old oakum threads from seams.

Reamer. A term applied to a rotary cutter used in enlarging punched and drilled holes.

Reamers. Workmen who operate a tool, usually power driven, so shaped as to enlarge holes already punched or drilled. Where the holes are unfair they cut away the overlapping material so bolts or rivets may be inserted.

Reaming. A term applied to the operation of enlarging a punched or drilled hole by a rotary cutter called a reamer. This operation is particularly necessary where the corresponding rivet holes in parts of the structure to be connected are not fair. Due to the curvature of a ship and the stretching necessary in bringing the plates and shapes into position many of the rivet holes overlap each other.

Recess Bulkhead. See BULKHEAD, RECESS.

Recess, Tunnel. See TUNNEL RECESS.

Reciprocating Engine. See ENGINE, RECIPROCATING.

Reciprocating Pump. See PUMP, RECIPROCATING.

Reclosing Battery Charging Switch. See SWITCH, AUTOMATIC RECLOSING BATTERY CHARGING.

Reclosing Circuit Breaker. See CIRCUIT BREAKER, AUTOMATIC RECLOSING.

Rectifier, Mercury Vapor. An electrical device for changing alternating current to direct current.

Red Lead. See PAINT.

Red Leaders. Painters who paint faying surfaces with red lead paint before they are placed together. Also painters who apply the coats of red lead paint to the structure while it is being erected in order to protect it from the weather.

Reducer. A pipe coupling having one end larger in diameter than the other. They are either fitted with inside threads or with flanges.

Reducing Valve. See VALVE, REDUCING.

Reduction Gearing. Generally applied to gearing designed for use with marine steam turbines. When so fitted its purpose is to step down from the turbine speed to a speed suitable for the ship's propellers.

In order to develop proper efficiency the rotor of the steam turbine must turn at a high number of revolutions. On the other hand, the screw propeller driving a vessel develops reasonable efficiency only when operating at a relatively low number of revolutions per minute.

The above conditions for efficiency can be realized only by the introduction of some form of reduction gearing.

The principal forms of reduction gearing are: Hydraulic, Electrical, and Mechanical.

As commonly used, the term reduction gearing more often designates the mechanical type than either of the other two.

In this type one or more pinions on the turbine shafting engage a gear wheel or wheels on the propeller shafting, thereby transmitting the power of the turbines to the propeller shafting.

Very high efficiency may be expected from this type, provided care is exercised in the design and cutting of the pinion and gear teeth and in proper alignment and lubrication.

Pages 921, 931, 932, 960, 961. Plate XIV.

Reef. To reduce sail spread or area by rolling or folding that portion adjacent to a yard or boom and making it fast thereto In square sails this reduction is made in the head, while in fore-and-aft sails it is done in the foot.

Reef Points. Short lengths of cordage fitted at equal distances apart on the reef bands of sails for tying up the sail in reefing.

Sometimes referred to as nettles.

Reef Tackles. Tackles used for hauling the leeches of square sails up to the yards and out in reefing. The

upper blocks are secured under the ends of the yard-arms, the lower blocks to the reef tackle cringles on the leech ropes of the sails at the upper ends of the reef tackle patches. The falls are led to the deck and when hauled on, the upper part of the leeches are slacked for passing the earrings and rousing the cringles to the yards.

Reel, Hawser. See HAWSER REEL.

Reeled Riveting. See RIVETING, STAGGERED.

Reem. To open the seams of the planking by means of a reaming iron that the oakum may be more readily driven in.

Reeming Iron. A chisel shaped tool used by calkers to open up seams so that threads of oakum may be driven into them.

Reeving. The act of passing a rope or chain through an aperture as a rope through a block, dead-eye, bull's eye, etc., or a lacing through an eyelet.

Refined Bar Iron. Described under STEEL AND IRON.

Reflector, Cargo. A reflector for electric lights suitable for illuminating cargo holds.

Pages 947, 1074.

Refrigerating Machine Foundation. A term applied to a seating prepared for a refrigerating machine. This seating may be built up from the deck or the deck may be reinforced by thicker or extra plates and shapes.

Refrigeration. **The American Bureau of Shipping** requires that the machine room is to be efficiently ventilated and drained; it is to be effectively separated from the insulated spaces by watertight plating.

The insulation of the containing walls and floors and all metal which might otherwise come in contact with the cargo is to be complete and the insulating material in thoroughly efficient condition. Full particulars of the nature and construction of the insulation are to be reported to the Bureau's Committee and approved.

All pipes, trunks, etc., in insulated spaces are to be well placed, secured and protected from risk of damage from cargo. All bilge suction, sounding and air pipes which pass through insulated spaces are to be properly insulated, and bilge suctions from the engine room are to be fitted with non-return valves.

All thermometer tube flanges and covers are to be of brass and arranged so that water cannot enter and freeze in the tubes.

Sluice valves should not be fitted in bulkheads of insulated spaces, and if fitted are to have brass non-return valves and are to be accessible at all times.

Provision is to be made for the ready examination of the bilges, rose boxes, etc., and it is recommended that the bottoms, sides and coamings of all hatches and limbers be varnished.

Cargo battens are to be fastened to the sides and bottom of all insulated cargo spaces before shipping the cargo to be refrigerated. The battens on the bottom are to be at least 2″ by 2″, and those on the sides by 2″ by 1½″, while their spacing is to be about 12″.

The refrigerating machinery is to be of approved construction and of sufficient power to maintain the required temperature in the cargo spaces when in tropical climates and with the machines running 18 hours per day. Duplex or duplicate machines are to be fitted where the refrigerated spaces have a greater capacity than 70,000 cubic feet. Upon completion the machinery is to be tested under working conditions, the time and fall of temperature being noted. After the spaces are considered to be properly refrigerated the machinery should be stopped for at least two hours, or two and a half hours with a brine installation, and a note taken of the rise in temperature at the end of the period of stoppage.

Spare gear is to be supplied in accordance with the following list, and is to be stowed where readily accessible. Where two sections or compartments are each cooled by machines of the same pattern only one set of spare gear will be required. Where two machines are fitted, each being capable of keeping the whole of the refrigerated spaces at the required temperature in tropical climates, when running 18 hours per day, no spare parts will be required, provided all similar parts are interchangeable.

Pages 684, 685, 686, 687, 1026, 1027, 1028, 1029. Plate XIV.

(a) **Where one Single Dry Air Machine is fitted:**

1 Crank-shaft, complete, with eccentric sheaves, or 1 half shaft where interchangeable.
1 Cover of each pattern for steam and air cylinders.
1 Piston, complete, of each pattern for steam and air cylinders.
1 Piston rod of each pattern, with nuts, for steam and air cylinders.
1 Eccentric strap and rod, complete, of each pattern.
1 Slide valve spindle and nuts of each pattern.
Main and cut-off valves for each steam cylinder.
Valve face, with pins, of each pattern, for steam and air cylinders.
1 Air pump bucket and rod, complete.
1 Circulating pump bucket and rod, complete.
1 Pair main-bearing bushes, complete.
2 Main-bearing bolts.
1 Set of piston rod and connecting rod bolts and bushes.
1 Full set of valves and seats for air compressor.
1 Set inlet and outlet valves for air expansion cylinder.
1 Set of valves for air, circulating, and feed pumps.
1 Set of escape valve springs.
40 of each—Suction, delivery, and buffer springs.
6 Tubes and 24 ferrules for condenser.
6 Tubes for cooler.
1 of each kind of pressure gage.
A supply of assorted bolts, nuts, studs, packings, joint rings, compressor rings, and leathers.

(b) **Where one Duplex or two Single Dry Air Machines are fitted:**

1 Cover of each pattern for air compression and expansion cylinders.
1 Piston, complete, of each pattern for air compression and expansion cylinders.
1 Piston rod of each pattern, with nuts, for steam and air cylinders.
1 Slide valve and valve face, with pins, for H.P. steam cylinder.
1 Set of piston rings, etc., for each steam cylinder.
1 Slide valve spindle and nuts of each pattern.
½ Set inlet and outlet valves and seats for air compressors.
½ Set inlet and outlet valves for air expansion cylinder.
1 Valve face, with pins, for air expansion cylinder.
1 Eccentric strap of each pattern.
1 Air pump bucket and rod, complete.
1 Circulating pump bucket and rod, complete.
1 Set of piston rod and connecting rod bolts and bushes.

2 Main-bearing bolts.
1 Set of valves for air, circulating, and feed pumps.
1 Set of escape valve springs.
30 of each—Suction, delivery, and buffer springs.
6 Tubes and 24 ferrules for condenser.
6 Tubes for cooler.
1 of each kind of pressure gage.
A supply of assorted bolts, nuts, studs, packings, joint rings, compressor rings, and leathers.

(c) **Where one Single Ammonia or Carbonic-Anhydride Compression Machine is fitted:**

1 Crank shaft, complete, with eccentric sheaves, or 1 half shaft where interchangeable.
1 Cover of each pattern for compressors.
1 Piston and rod with nuts, complete, of each pattern, for steam cylinders and compressors.
1 Slide valve spindle and nuts of each pattern.
1 Pair main-bearing bushes, complete.
2 Main-bearing bolts.
1 Set of piston rod and connecting rod bolts and bushes.
1 Eccentric strap and rod, complete, of each pattern.
Main and cut-off valves and valve face, with pins, for steam cylinder.
1 Brine pump bucket and rod.
1 Air pump bucket and rod.
1 Circulating pump bucket and rod.
1 Compressor gland and packing, complete.
1 Set compressor suction and delivery valves, with springs and boxes, complete.
1 Set of valves for air, circulating, and feed pumps.
1 Set of valves and springs for brine pump.
1 Crank shaft for fan engine.
1 Piston rod, complete, for fan engine.
1 Set of top and bottom end bushes and bolts for fan engine.
1 Set piston rings for fan engine.
1 of each pattern of Ammonia or CO_2 valve and cock flange and fittings.
Blocks for making all leather packing.
6 Tubes and 24 ferrules for condenser.
1 of each kind of pressure gauge.
Assorted lengths and bends of piping, together with flanges, couplings, and screwing appliances.
A supply of assorted bolts, nuts, studs, packings, joint rings, compressor rings, and leathers.

(d) **Where one Duplex or two Single Ammonia or Carbonic-Anhydride Compression Machines are fitted:**

1 Piston rod with nuts, complete, of each pattern, for steam cylinders and compressors.
1 Slide valve and valve face, with pins, for H.P. steam cylinder.
1 Slide valve spindle and nuts of each pattern.
2 Main-bearing bolts.
1 Set of piston rod and connecting rod bolts and bushes.
1 Set of piston rings, etc., for each steam cylinder and for fan engine.
1 Set of piston rings or packing for each size of compressor.
1 Eccentric strap of each pattern.
1 Air pump bucket and rod.
1 Circulating pump bucket and rod.
1 Brine pump bucket and rod.
1. Compressor gland and packing, complete.
1 Compressor suction and 1 delivery valve with springs and box, complete.
1 Set of valves for air, circulating, and feed pumps.
1 Set of valves and springs for brine pumps.
1 Crank shaft for fan engine.
1 Piston rod, complete, for fan engine.
1 Set of top and bottom end bolts and bushes for fan engine.
1 of each pattern of Ammonia or CO_2 valve and cock, flange, and fittings.
Blocks for making all leather packing.
6 Tubes and 24 ferrules for condenser.
1 of each kind of pressure gage.
Assorted lengths and bends of piping, together with flanges, couplings, and screwing appliances.
A supply of assorted bolts, nuts, studs, packings, joint rings, compressor rings, and leathers.
Brine and water circulating pumps should be in duplicate, or there should be independent connections to auxiliary pumps. Spare piston rings, pump valves and rods, for independent pumps, should be carried.

When the air, circulating, and feed pumps are all worked by one independent engine and there are no independent connections to the main engine pumps, the following additional spare gear is to be carried.

1 Piston rod, complete, of each pattern.
1 Set piston rings of each pattern for steam cylinders.
1 Eccentric strap and rod of each pattern.
1 Slide valve spindle, complete, of each pattern.
1 Set connecting rod and crosshead bolts and nuts.

A sufficient supply of spare liquid and calcium chloride is to be carried to ensure an ample margin for any leakage in the refrigerating plant during the voyage.

All brine regulating valves are to be fitted outside the insulated spaces so as to be accessible without entering these spaces.

Before the Certificate of Survey is issued all the insulation is to be carefully examined and tested for dryness and fullness and all test holes subsequently closed. All limbers and hatches are to be removed, the limbers cleared, and the suctions, sluices and sounding pipes examined. All hatches, trunks, thermometer tubes, ventilator coamings, and deck connections are to be examined, and water-tight doors to be worked. Where brine may escape to the bilges, the cement is to be examined at each survey.

It is recommended that the machinery be examined and tested at a home port, before the cargo is fully discharged, but in all cases all parts of the refrigerating machinery, pumps, steam and water pipes, condensers, coolers, coils and connections, brine pipes and tanks are to be opened out and examined, and the condensers, coolers, coils and brine pipes tested if considered necessary; in the case of condensers containing iron or steel coils, the coils are to be withdrawn from the casing and tested at intervals of not more than four years; corroded parts should be tinned or otherwise made good; the coils are to be scraped, cleaned and painted with good anti-corrosive paint. The machinery is to be afterwards tested under working conditions.

A further survey is to be made at the port of shipment of the cargo to be refrigerated, in order to ascertain that the dunnage battens are in good order, that the insulation has not sustained damage since the home port survey, and also to test the refrigerating machinery under working conditions, the temperature in the holds being noted.

At ports where the services of a Surveyor to the

Society are not available, a report of survey by a reliable, practical Surveyor will be accepted by the Committee, or if such a Surveyor is not available, they will accept a report of survey made by two competent Engineers of the Vessel.

Refrigerator Coils. A series of pipes surrounding the sides of a refrigerating box for maintaining a low temperature.

Pages 686, 687.

Register Breadth. See BREADTH, REGISTER.

Register Depth. See DEPTH, REGISTER.

Register Length. See LENGTH, REGISTER.

Regulator Valve. See VALVE, REGULATOR.

Relay. An electrical device which will perform a certain operation in one electric circuit when a certain predetermined condition exists in another.

Releasing Gear. This gear is composed of specially constructed hooks attached to the davit heads and rods, chains or fittings installed in lifeboats. By the use of this gear both ends of a lifeboat may be released or picked up quickly and simultaneously.

Page 820.

Relief Valve. See VALVE, RELIEF.

Relieving Tackles. Tackles used for emergency steering in case of accident to the steering gear or to assist the gear in heavy weather. The tackles are secured to the head of the tiller or to the cross head, the opposite ends being made fast to any convenient structure as a bulkhead or deck.

Render. To pass through an aperture freely, as a rope through the swallow or mortise of a block.

Reserve Buoyancy. The difference between the amount a vessel would displace if she were watertight and totally submerged, and the amount she actually does displace at her designed draft.

Resistance, Air. That part of a ship's total resistance to motion which is due to the above water portion of the vessel moving through the air.

Resistance, Bare Hull. The sum of the frictional and residual resistances of a vessel's hull to which no appendages such as bilge or docking keels, struts, spectacle frames, rudders, etc., have been fitted.

Resistance, Center of Lateral. That point through which a signal force could act producing an effect equal to the total lateral resistance of the vessel. The center of lateral resistance is ordinarily assumed to be coincident with the center of gravity of the central immersed longitudinal plane.

Resistance, Eddy-Making. Resistance due to the formation of eddies at the stern, usually resulting from the abrupt termination of the after ends of waterlines, from the action of propellers and rudder, and from the addition to the hull of projections such as struts, docking keels, etc.

Resistance, Electrical. A property of materials which opposes the free flow of an electric current through them, but does in no way tend to cause a current in the opposite direction to that in which the electric current actually moves.

Resistance, Frictional. The resistance due to the friction of the water upon the surface of the ship and the ship's appendages.

Resistance, Hollows of. Portions of the curves of resistance, plotted on a speed base, which show a sagging tendency as compared with the other portions of the curves.

For the sake of economy in power and fuel it is desirable that the designed speed of a ship be such as to correspond to the hollows rather than the humps of the resistance curves.

Resistance, Lateral. The resistance which a vessel offers to a lateral motion of translation through the water. The lateral resistance of a vessel is of especial moment in sailing ships, and it is for the purpose of increasing the lateral resistance that keels and centerboards are sometimes fitted.

Resistance, Residuary. The total resistance less the resistance due to skin friction, is termed the residuary resistance.

Resistance, Skin. The frictional resistance existing between the shell or skin of a ship and the water through which she is progressing.

Resistance, Tow Rope. The total resistance overcome in towing a ship or model. It equals the sum of the frictional resistance, eddy making and wave making.

Retaining Strip, Stern Tube. See STERN TUBE RETAINING STRIP.

Reverse Frame. See FRAME REVERSE.

Reversing. The act of turning completely about. Used with reference to either motion or position.

Reversing Shaft. A threaded shaft actuated by the reversing wheel and forming part of the reversing gear.

Reversing Wheel. A hand operated wheel by means of which the reverse gear is controlled. It is located in front of an engine and easily reached from the starting platform.

Revolution Counter. A device arranged to register automatically and sum up engine revolutions. In principle, this is accomplished by the transmission at each revolution of the movement of a suitable engine part to an ordinary counter built up of a series of numbered and properly engaging discs.

Pages 1005, 1083, 1086. Plate LXI.

Rheostat. An electrical device consisting of several resistances of different values arranged so that they may be cut in or out of an electric circuit.

Ribband. A painted stripe or molding around a vessel's side. Applied for decorative purposes.

Ribbands, Fore-and-Aft. Pieces of timber arranged longitudinally around the building site outlining the form of the ship at different levels and having the frame stations marked on them. When a frame is erected it bears against the ribbands which hold it in its correct athwartship position and by setting it to the ribband frame station marks it assumes its proper fore and aft position.

Ribs. A term applied to the transverse frames of a boat or the skeleton.

Ride. To float in a bouyant manner while being towed or lying at anchor.

Rider. A plate or girder fixed to the inner side of the framing at the center line for extra strength.

Rider Keelson. See KEELSON, RIDER.

Rider Plate. A continuous flat plate attached to the top of the vertical center keelson, to the top of the floors, or both.

Ridge Rope. See ROPE, RIDGE.

Rifle and Pistol Racks. A wood or metal case with racks for holding rifles and pistols.

Rig. As applied to a vessel, the method according to which spars and sails are designed and fitted. Rigs of all kinds fall into one of two classes, viz.: square or fore-and-aft.

Rigger. A workman who makes up the standing and running rigging from cordage and fittings and fits

same on shipboard. During the construction of a ship riggers have charge of the hoisting in place of such heavy parts as the stem stern post, boilers, engines, masts and spars.

Rigging. A term used collectively for all the ropes and chains employed to support and work the masts, yards, booms and sails of a vessel.

Pages 317 to 352, 597, 598.

Rigging Screws. See SCREWS, RIGGING.

Rigging, Steel Wire. The standing rigging in practically its entirety as well as a large part of the running rigging on modern vessels. The use of hemp cordage for rigging purposes is now nearly obsolete.

Right Rudder. A term recently adopted in the Navy which is applied to the operation of moving the rudder to starboard and consequently turning the bow of the ship to the right.

Righting Arm, Maximum. The maximum length of the righting arm attained by any given vessel with a given loading when heeled from the upright throughout her entire range of stability.

Righting Lever or Arm. The perpendicular distance between two vertical lines, one through the center of gravity and one through the center of buoyancy, the ship being inclined from the vertical. If the relative positions of the center of gravity and center of buoyancy are such as to produce a righting couple, the lever is positive and is a true righting lever. If, however, the couple produced tends to overturn the vessel, this righting lever becomes negative and is then more properly termed an upsetting lever. The displacement of the vessel multiplied by the righting lever equals the righting moment. At small angles of inclination, the righting arm is equal to the metacentric height multiplied by the sine of the angle of inclination.

Righting Moment. The product of the displacement and length of the righting arm. The displacement being expressed in tons, and the righting arm in feet, the righting moment is therefore given in foot-tons.

Right-laid Rope. See ROPE, RIGHT-LAID.

Rimer. See REAMER.

Riming. See REAMING.

Ring Bolt. See BOLT, RING.

Rip Saw. See SAW, RIP.

Rise of Floor. See DEADRISE.

Riser. The upright board of a stair.

River Steamer. A steam driven vessel designed for service on inland waters. Vessels of this type usually carry both passengers and cargo.

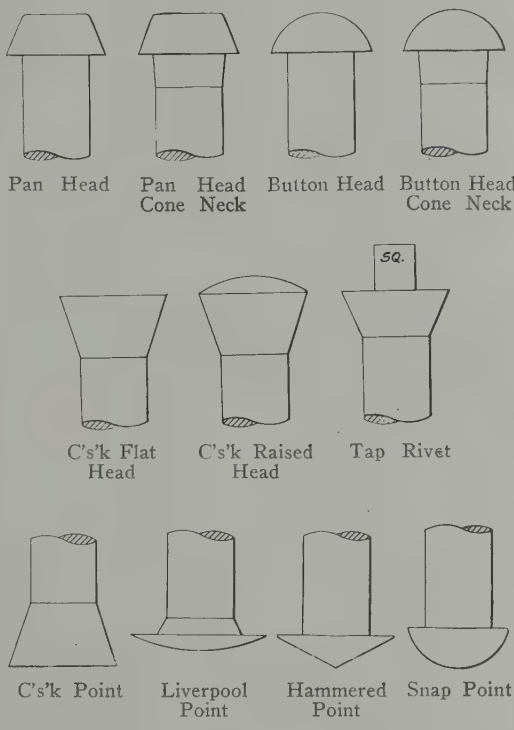
For use on deep rivers, sounds, etc., large vessels of moderate draft, good hull free board, lofty superstructures, and either paddle or screw propulsion are present practice.

River Steamer, Shallow Draft. For shallow rivers the shallow draft type with small hull freeboard, lofty superstructures, and either stern wheel or tunnel screw is used.

Pages 458, 459, 460, 461, 462, 969. Plates XXVII, XXVIII.

Rivet. A pin used for connecting two or more pieces of material by the means of passing it through a hole drilled or punched for the purpose and hammering down one or both ends. Rivets should be made from high grade iron or mild steel, except that in cases where high tensile steel parts are to be connected high tensile steel rivets are generally used. Copper rivets are used for various minor purposes. In the shell plating, decking, bulkheads and the framing of a ship, as well as in the boilers, the joints must be very firm and in most cases watertight; therefore, for this reason, and because of the fact that rivets ⅜" diameter or over can be more efficiently worked while hot, it is the practice to heat rivets before passing them through the holes and to hammer the points down before the rivet cools. The contraction of the rivet due to cooling will aid very materially in producing the firm joint desired.

(Types of rivets in general use)



Countersunk heads should be used where flush surfaces are required and where rivet head calking may be necessary. Countersunk raised heads may be used where a flush surface is not required, but where calking may be necessary.

Pan and button heads may be used in all other cases. The button head is considered better appearing where finish is required.

Straight necked rivets should be used where the holes are drilled and cone neck rivets where the holes are punched.

Countersunk points should be used for flush surfaces and for rivet point calking. Care should be taken that the points are not hammered down below the surface of the bar or plate. The points should have a very slight convex surface. Snap points and button or pan heads may be used where it is not necessary to have a flush surface. They are sometimes used in strength members to avoid loss of material in the rivet holes due to countersinking.

Hammered points are used largely on internal work where it is not necessary to have a flush surface. For hand riveting they are the easiest to clinch, and when of the proper length their points require no chipping.

Liverpool points are used in light plating which is not subject to a high head of water where a connection stronger than the countersunk point is desired.

Tap or screwed rivets are used to connect plates to the stern post boss and in general either plates of shapes to heavy forgings or castings where a through rivet is either impossible or not practical. As shown in the sketch, the tap rivet has a square pin on the countersunk head which is used for screwing up and is cut or burned off when the rivet is in place. They should be avoided as a connection to a thin steel plate because of the small grip obtainable in the thread.

In ordering rivets the length given should be exclusive of the heads in all cases except countersunk rivets and taps, in which case the length given should be to the top of the countersink. Allow the thickness of the plates to be connected and where there are more than two thicknesses allow $\frac{1}{8}$" extra for each additional thickness. With countersunk rivets allow the diameter of the rivet for the point; for hammered points allow $\frac{1}{2}$" to $\frac{5}{8}$", for snap points allow $\frac{3}{8}$" more than the diameter of the rivet, and for Liverpool points about $\frac{7}{8}$".

Pages 778, 798.

The size and spacing from center to center of rivets as required by the **American Bureau of Shipping** are given in the following tables; the sizes given are the diameters of the finished rivet as it leaves the manufacturer.

The riveting of butts and seams need not exceed that required for the table thickness of plate, in cases where thickness has been increased solely on account of the frame spacing being greater than the table spacing. Where adjoining plates differ in thickness, the riveting of end connections is governed by the larger thickness; in seams it may be governed by the smaller thickness; in boundary angles it should be governed by the lesser thickness, whether in plate or bar.

Holes in two-ply work are to be punched from the faying surfaces; "burr" and other projections are to be carefully removed from all faying surfaces; the holes in three-ply and four-ply work are to be fair; any unfair holes are to be reamed out after the work is screwed up; they are to be re-countersunk and the size of the rivets suitably increased.

Countersinks are to have the face diameter given in the following tables; the countersink is to extend through the plate where the thickness is under .60" and through at least 90 per cent. of the thickness where it is .60" or more.

Holes in liners are not to be larger than those in the plates or bars. Lining pieces under outside strakes of plating are to be of iron or steel in one length, and are to have breadths not less than $3\frac{1}{2}$ times the diameter of the connecting rivets. Tapered liners in watertight landings, in way of end laps, are to be long enough to take three holes (or pairs of holes) beyond the plate end.

Work is to be thoroughly screwed up before riveting is commenced, with a sufficient number of service bolts to ensure close fitting; unfair holes are to be reamed fair, not cut; riveted work must be so closely plied up that an ordinary testing knife cannot be inserted between surfaces; rivet points are to be full in the finish.

Calking in watertight work must be thorough—light or superficial calking will not be accepted; the score or crease in butts is to be of ample width and well set in.

Bar Keels, Stems and Stern Posts are to have rivets of sufficient diameter to ensure sound workmanship; $\frac{3}{4}$" rivets may be used where the total rivet length is under $3\frac{1}{2}$ inches, $\frac{7}{8}$" where under 5 inches, 1" where under 6 inches, $1\frac{1}{8}$" where under 8 inches, and $1\frac{1}{4}$" where under 10 inches; rivets of such proportions are to be turned and fitted; where the length is too great to permit of sound work, efficient tap rivets are to be used. The spacing of rivets at the calking edge is not to exceed $4\frac{1}{2}$ diameters with rivets $\frac{1}{8}$" larger, nor 4 diameters with rivets $\frac{1}{4}$" larger than is required by the following tables for the thickness of plating attached to them; the spacing of the inner line of rivets in stems, stern posts, and propeller posts above the boss may be $5\frac{1}{2}$ diameters in the first and 6 diameters in the second case. The spacing of the inner line of rivets in propeller posts below the boss is not to exceed $4\frac{1}{2}$ diameters; in vessels above 300 feet additional rivets are to be fitted around the heel of the post; in vessels above 350 feet length three rows of rivets are to be fitted up to the boss. Care is to be taken to space the rivets to suit the position of shell seam riveting. Holes for tacking rivets and in thin ends of scarphs are to be drilled after forgings are faired in position; the scarphs are to be plained and calked. Holes in forgings are to be drilled with twist drills.

Rudder Arms are to have rivets of not less size than required for the rudder plate; they are to be reeled at the inner end and spaced 6 diameters in each row; they are to be gradually closed up until the spacing at the outer end does not exceed 4 diameters in each row. The rivets are to have large, carefully fitted countersink heads and large hammered points.

Plate Keels are recommended to be fitted as outside strakes and made flush all fore and aft by fitting the end-laps so that they do not come below the underside of the plate, or by fitting inside butt straps. End connections on plates under .60" thickness may be double riveted; on plates .60" and under .80" they are to be treble riveted, and on plates .80" in thickness and above they are to be quadruple riveted; the spacing of rivets in each row is to be $3\frac{1}{2}$ diameters in each case. In cases where straps are used and there is insufficient space between the frames to take a quadruple riveted strap, doubling plates of the thickness of the shell plate are to be fitted for the whole length of the frame space between seam and bottom angle, and a treble riveted strap fitted on top; the top strap may be fitted in two pieces from outer edge of seam to bosom of center girder bottom angle. No rivets are to be put in until every hole in the connection has been reamed or drilled fair.

Center Girder Plates are to have overlapped end connections with the riveting required for midship plates but the spacing permitted for girder butts. The bottom angles are to have rivets 5 diameters apart; the top angles may have rivets spaced 7 diameters, except under engines, where they are to be $5\frac{1}{2}$ diameters apart. Where single angles are fitted in place of double angles, the above spacing is to apply to each row in the top flange, but the spacing in each row in the vertical flange may be 8 and 6 diameters respectively. Single riveted angles connecting floor

TABLE 16
See Continuation

RIVETING

BREADTHS OF SEAMS, END-LAPS AND BUTT STRAPS

BREADTHS AND SIZES ARE GIVEN IN INCHES

THICKNESS OF PLATE	·18–·34	·36–·48	·50–·68	·70–·88	·90–1·12	1·14–1·26	1·28–1·38
SIZE OF RIVET	5/8	3/4	7/8	1	1 1/8	1 1/4	1 3/8
Breadths of—							
Single-riveted Seams	2 1/2	2 1/2	3	3 1/2	4		
Zig-zag-riveted Seams	3 1/2	3 1/2	4 1/2	5	5 1/2	6 1/2	
Double-riveted Seams	3 1/2	4 1/2	5 1/2	6	6 1/2	7 1/2	8 1/2
Double-riveted End-laps	4 1/2	5 1/2	6 1/2	7			
Treble-riveted End-laps	6 1/2	7 1/2	8 1/2	10	11 1/2	12 1/2	14
Quadruple-riveted End-laps		9 1/2	11 1/2	13	14 1/2	16 1/2	18
Quintuple-riveted End-laps				16 1/2	18 1/2	20 1/2	23
Double-riveted Butt Straps	8	9 1/2	11 1/2	13			
Treble-riveted Butt Straps		14 1/2	16 1/2	19	21 1/2		
Quadruple-riveted Butt Straps		18 1/2	22	25	28	31 1/2	34 1/2
Quintuple-riveted Butt Straps				31	35	39	43

TABLE 16
See Continuation

BUTT STRAPS

SIZES ARE GIVEN IN INCHES

Thicknesses				Thicknesses				Thicknesses			
Plate	Single Strap	Double Straps		Plate	Single Strap	Double Straps		Plate	Single Strap	Double Straps	
		Not Countersunk	Countersunk			Not Countersunk	Countersunk			Not Countersunk	Countersunk
·18	·18			·58	·72	·34	·40	·98	1·22	·58	·64
·20	·20			·60	·74	·36	·42	1·00	1·26	·60	·66
·22	·22			·62	·76	·36	·42	1·02	1·28	·60	·66
·24	·24			·64	·80	·38	·44	1·04	1·30	·62	·68
·26	·26			·66	·82	·40	·46	1·06	1·32	·64	·70
·28	·28			·68	·86	·40	·46	1·08	1·36	·64	·70
·30	·30			·70	·88	·42	·48	1·10	1·38	·66	·72
·32	·34			·72	·90	·42	·48	1·12	1·40	·66	·72
·34	·38			·74	·92	·44	·50	1·14	1·42	·68	·74
·36	·40			·76	·96	·46	·52	1·16	1·46	·70	·76
·38	·44			·78	·98	·46	·52	1·18	1·48	·70	·76
·40	·46			·80	1·00	·48	·54	1·20	1·50	·72	·78
·42	·48			·82	1·02	·48	·54	1·22	1·52	·72	·78
·44	·52			·84	1·06	·50	·56	1·24	1·56	·74	·80
·46	·54			·86	1·08	·52	·58	1·26	1·58	·76	·82
·48	·58			·88	1·10	·52	·58	1·28	1·60	·76	·82
·50	·60	·30	·36	·90	1·12	·54	·60	1·30	1·62	78	·84
·52	·62	·30	·36	·92	1·16	·54	·60	1·32	1·66	·78	·84
·54	·66	·32	·38	·94	1·18	·56	·62	1·34	1·68	·80	·86
·56	·68	·32	·38	·96	1·20	·58	·64	1·36	1·70	·82	·88

TABLE 16

See Continuation

RIVETING

SPACING AND SIZES ARE GIVEN IN INCHES

THICKNESS OF PLATE	*18–20	*22–24	26–30	32–34	36–38	40–42	44–48	50–52	54–58	60–64	66–68
SIZE OF RIVET	5/8	5/8	5/8	5/8	3/4	3/4	3/4	7/8	7/8	7/8	7/8
Diameter of Countersink Face	1	1	1	1	1 3/16	1 3/16	1 3/16	1 5/16	1 5/16	1 5/16	1 5/16
Oiltight Seams and Butts; Spacing	2	2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	3 1/4	3 1/2	3 1/2	3 1/2
Tank and Girder Butts; Watertight Seams; Engine and Thrust Seat Plates; Spacing	2 1/2	2 1/2	2 1/2	2 1/2	3 1/2	3 1/2	3 1/2	4	4	4	4
Sheerstrake, Topside Strake and Strength Deck; Riveting in Butts	Single	Double	Double	Double	Double	Treble	Treble	Treble	Treble	Quad'le	Quad'le
Sheerstrake, Topside Strake and Strength Deck Amidships; Spacing in Butts	2 1/2	2 1/2	2 1/2	2 1/2	3	3	3	4	4 and 3	4	4 and 3
Shell and Other Plates Amidships; Riveting in Butts	Single	Double	Double	Double	Double	Double	Treble	Treble	Treble	Treble	Quad'le
Shell and Other Plates Amidships; Spacing in Butts	2 1/2	2 1/2	2 1/2	2 1/2	3	3	3	4	4	4 and 3	4
Butts at Ends, and Seams at Breaks of Superstructure; Riveting	Single	Single	Single	Double	Double	Double	Double	Treble	Treble	Treble	Treble
Butts at Ends, and Seams at Breaks of Superstructure; Spacing	2 1/2	2 1/2	2 1/2	2 1/2	3	3	3	4	4	4	4
Masts, Keel Angles; Floor Connecting Angles; Edges of Doubling Plates; Brackets; Shell Clips in Peaks; Spacing in Zig-zag Seams and in Butts and Seams	3 1/2	3 1/2	3 1/2	3 1/2	3 1/2	3 1/2	3 1/2	4 1/2	4 1/2	4 1/2	4 1/2
Frames to Shell in After Peak; on Flat of Floor Forward in Deep Tanks; and for ·15 L at Fore End; Tank Stiffeners to Plating; Auxiliary Seating, etc.; Spacing	3 1/2	3 1/2	3 1/2	3 1/2	4 1/2	4 1/2	4 1/2	4 1/2	4 1/2	4 1/2	4 1/2
Shell Clips; Beams on Alternate Frames; Frames to Shell Where Spacing Exceeds 27 Inches; Spacing	3 1/2	3 1/2	3 1/2	3 1/2	4 1/2	4 1/2	4 1/2	5 1/2	5 1/2	5 1/2	5 1/2
Frames; Beams, Keelsons, Bulkhead, Stiffeners, and Girder Work Generally; Spacing	4 1/2	4 1/2	4 1/2	4 1/2	5 1/2	5 1/2	5 1/2	6 1/2	6 1/2	6 1/2	6 1/2
Casing Stiffeners, etc.; Spacing	5	5	5	5	6	6	6	7	7	7	7

Increases in thickness on account of frame spacing need not be considered in connection with butt riveting requirements. For detailed requirements as to riveting of butts and seams of plating, etc., see Section 23. Where two spacings are given for butt riveting, the wider applies to the edge riveting and the narrower to other rows. Rivets in butts of plates of different thicknesses are to be of the diameter required for the thicker plate; in seams they may be as required for the thinner plate; in boundary angles they should be as required for the thinner material, whether in plate or bar.

* 1/2-inch rivets may be used in plates of these thicknesses in association with suitable modifications in spacing.

TABLE 16

Concluded

RIVETING

SPACING AND SIZES ARE GIVEN IN INCHES

THICKNESS OF PLATE	·70–·74	·76–·80	·82–·84	·86–·88	·90–·98	1·00–1·06	1·08–1·12	1·14–1·26	1·28–1·38
SIZE OF RIVET	1	1	1	1	1 1/8	1 1/8	1 1/8	1 1/4	1 3/8
Diameter of Countersink Face	1 5/16	1 5/16	1 5/16	1 5/16	1 5/16	1 5/16	1 5/16	1 5/16	2 5/16
Oiltight Seams and Butts; Spacing	3 1/2	3 1/2	3 1/2	3 1/2	4 1/2	4 1/2	4 1/2	4 1/2	5 1/2
Tank and Girder Butts; Watertight Seams; Engine and Thrust Seat Plates; Spacing	4 1/2	4 1/2	4 1/2	4 1/2	5 1/2	5 1/2	5 1/2	6	6 1/2
Sheerstrake, Topside Strake and Strength Deck; Riveting in Butts	Quad'le	Quad'le	Quin'ple	Quin'ple	Quin'ple	Quin'ple	Quin'ple	Quin'ple	Quin'ple
Sheerstrake, Topside Strake and Strength Deck Amidships; Spacing in Butts	4 1/2	4 1/2 and 3 1/2	4 1/2	4 1/2 and 3 1/2	5 1/2	5 1/2 and 4 1/2	5 1/2 and 4 1/2	6 and 5	6 1/2 and 5 1/2
Shell and Other Plates Amidships; Riveting in Butts	Quad'le	Quad'le	Quad'le	Quad'le	Quad'le	Quad'le	Quad'le	Quad'le	Quad'le
Shell and Other Plates Amidships; Spacing in Butts	4 1/2	4 1/2	4 1/2 and 3 1/2	4 1/2 and 3 1/2	5 1/2	5 1/2 and 4 1/2	5 1/2 and 4 1/2	6 and 5	6 1/2 and 5 1/2
Butts at Ends, and Seams at Breaks of Superstructure; Riveting	Treble	Treble	Treble	Treble	Treble	Treble	Treble	Treble	Treble
Butts at Ends, and Seams at Breaks of Superstructure; Spacing	4	4	4	4	4 1/2	4 1/2	4 1/2	4 1/2	5 1/2
Masts, Keel Angles; Floor Connecting Angles; Edges of Doubling Plates; Brackets; Shell Clips in Peaks; Spacing in Zig-zag Seams and in Butts and Seams	5	5	5	5	5 1/2	5 1/2	5 1/2	6 1/2	7
Frames to Shell in After Peak; on Flat of Floor Forward in Deep Tanks; and for ·15 L at Fore End; Tank Stiffeners to Plating; Auxiliary Seating, etc.; Spacing	5 1/2	5 1/2	5 1/2	5 1/2	6 1/2				
Shell Clips; Beams on Alternate Frames; Frames to Shell Where Spacing Exceeds 27 Inches; Spacing	6	6	6	6	6 1/2				
Frames; Beams, Keelsons, Bulkhead, Stiffeners, and Girder Work Generally; Spacing	7	7	7	7	8				
Casing Stiffeners, etc.; Spacing	8								

Increases in thickness on account of frame spacing need not be considered in connection with butt riveting requirements. For detailed requirements as to riveting of butts and seams of plating, etc., see Section 23. Where two spacings are given for butt riveting, the wider applies to the edge riveting and the narrower to other rows. Rivets in butts of plates of different thicknesses are to be of the diameter required for the thicker plate; in seams they may be as required for the thinner plate; in boundary angles they should be as required for the thinner material, whether in plate or bar

plates are to have rivets spaced 5 diameters; double riveted angles are to have rivets spaced 7 diameters in each row in Vessels under 55 feet breadth; they are to be 5 diameters in Vessels of 55 feet breadth and above.

Keelsons.—Center keelson horizontal plates are to be riveted as required for their thickness and for girder butts; the spacing of rivets in the top angles is not to exceed 7 diameters; the spacing of rivets in the reverse angle and clip forming the floor connection with continuous center girder plates is not to exceed 5 diameters. In keelson angles the spacing of rivets is not to exceed 7 diameters. Keelson and side stringer angles are to be attached to reverse angles or clips by two rivets in each flange; side stringer intercostals are to be attached to the face angle by rivets spaced not more than 6 diameters. The spacing of rivets in shell clips is not to exceed 6 diameters, and where double riveting is required this spacing applies to each row.

Frames and Reverse Angles.—Rivets connecting frames to shell plating are not to be spaced more than 7 diameters; where the frame spacing exceeds 27 inches they are not to be spaced more than 6 diameters; where double riveting is required these spacings apply to each row; they are not to be spaced more than 5½ diameters in the after peak, in deep tanks, and from the keel to well above the load line for .15 of length at fore end. Rivets connecting reverse angles to frames, frames and reverse angles to floors, and plating to reverse angles are not to be spaced more than 7 diameters; in way of the thrust block and engine seating of high powered reciprocating machinery, the spacing is to be 5½ diameters. Rivet holes in frames, in way of shell seams, are to be drilled or "beared" after the frames are faired in position. The rivet holes at the round of bilge are not to be punched until after the frames are turned.

Floors with single bottoms, which are not attached to center girders, are to have butt riveting as required for midship plates with rivets spaced as required for girder butts.

Double Bottoms.—End-laps of center strakes may be single riveted in Vessels under 200 feet length; in Vessels of 200 feet length and above the end-laps within the midship half lengths are to be riveted as required for midship plates, and those at ends as permitted for plates at extreme ends; end-laps of margin plates may be single riveted in Vessels under 250 feet length; they are to be double riveted in Vessels 250 feet and under 350 feet length; in Vessels of 350 feet length and above the end-laps within the midship half length are to be riveted as required for midship plates, and those at ends as permitted for plates at extreme ends; end-laps of plating between center strake and margin plate may be single riveted in Vessels under 300 feet length; in Vessels 300 feet and under 350 feet length the end-laps within the midship half length are to be double riveted, and those at ends may be single riveted; in Vessels 350 feet length and above the end-laps within the midship half length are to be riveted as required for midship plates; those at ends may be double riveted where treble riveting is required amidships; they may be treble to double where quadruple riveting is required amidships. The spacing of rivets in all end connections in tank top plating may be as required for watertight seams. The seams of center strakes are to be double riveted within the midship half length in Vessels of 300 feet length and above; they are to be double riveted forward of the half length, where the breadth at the outside of frame at the level of the tank top exceeds 45 feet. The riveting requirements for end connections are not affected by additions to the table thicknesses on account of frame spacing. The rivets in angle connections to margin plate are not to be spaced more than 5 diameters, nor than required by Table 8 of the **American Bureau of Shipping** rules; those in the vertical connections of intercostal girders are to be spaced not more than 7 diameters, and those in horizontal connections are to be spaced 6 diameters. The attachment of tank top plating to reverse angles and intercostals is not to exceed 5½ diameters in the engine space; the attachment of engine and thrust seat plates is not to exceed 4½ diameters; the attachment to reverse angles elsewhere is not to exceed 7 diameters.

Attachments.—The rivets in beam knees, brackets and overlaps on brackets are not to be spaced more than 5 diameters with single and chain riveting, nor more than 7 diameters in each row with zig-zag riveting.

Panting Arrangements.—In the after peak and for .15 of length at the fore end from the keel to well above the load line, the spacing of rivets in connections of shell plating to frames and stringers is not to exceed 5½ diameters; shell clips in peaks are to have rivets spaced not more than 5 diameters.

Shell Plating.—Seams of shell plating may be single riveted in Vessels under 225 feet length; seams at ends may be single riveted in Vessels under 300 feet length; the foregoing is subject to the requirement that the seams on the flat of floor forward of the midship half length are to be double riveted in Vessels above 150 feet length and in all sea-going Vessels which have the machinery at the after end. Seams of superstructures may be single riveted, except at breaks, and within the midship half length of Vessels over 450 feet length; the seams of superstructures at breaks are to be riveted as required by the following tables; shell plating in other cases than specified above, is to have double riveted seams. The spacing of rivets in seams is to be as required for watertight seams, except in the neighborhood of the quarter length, at about the neutral axis of the section, in Vessels of 450 feet length and above, where the spacing is to be as required for oiltight seams. Two rivets are to be fitted in the frame at the seams in way of propeller bossing, joggled shell plates, and joggled frames; two rivets are to be fitted in all shell seams in Vessels over 450 feet length. End connections in sheerstrakes and topside strakes within the midship half length, are to be as specified in the following tables; from the midship half length to the three-quarters length they may be as specified for other midship plates; beyond the midship three-quarters length they may be as permitted at ends. End connections of the remaining shell plates within the midship two-thirds length and at the fore end up to the light load line, are to be as required for plates amidships; beyond these limits they may be as permitted for connections at ends; these arrangements are subject to such local additions at breaks, heel of stern frame, openings, etc., as may be required.

Machinery Space, Tunnels, Etc.—The rivets connecting the seat plates for engines and thrust bearings to the substructure, is not to exceed 4½ diameters;

the spacing used throughout the substructure of engine and auxiliary seating should not exceed 5½ diameters. The riveting of tunnel plating and bars is to be in accordance with the requirements for watertight bulkheads. Machinery casings which are not exposed to weather, and are not intended to be watertight, may have 6 diameters spacing for rivets in seams and end connections, except in the butts of coaming and other plating essential to girder efficiency; in these cases the riveting is to be as required for midship girder plates; the spacing of rivets connecting stiffeners to plating is not to exceed 8 diameters; the spacing of rivets connecting coaming angles to deck plating is not to exceed 5 diameters. Machinery casings which are exposed to weather are to be riveted in accordance with the requirements for watertight bulkheads. The spacing of rivets in connections of bunker plating should not exceed 6 diameters, nor should it exceed 8 diameters in stiffeners.

Masts and Spars.—Masts and bowsprits in Sailing Vessels may have single riveted seams where angle stiffeners are fitted throughout their length; they are to be double riveted where no stiffeners are fitted; masts in Steamers, topmasts and yards in Sailing Vessels, may have single riveted seams. End connections in masts from below the wedging up to the cap are to be treble riveted; those in topmasts for Sailing Vessels are to be treble riveted; in yards they may be double riveted. Straps are to be fitted outside where plates are butted.

Doubling Plates are to be single riveted at edges with rivets spaced not more than 5 diameters; the rivets in the body of the plate are to be sufficiently close to bring the plate surfaces well home to their work and should be put in before the edge rivets. The edge rivets in long overlaps at corners of openings are to be spaced as required for watertight seams; the rivets in the body of the overlap are to be spaced from 7 to 9 diameters.

Rivet Cutter. A tool similar to a pneumatic riveting hammer used for cutting and punching out rivets.

Page 790.

Rivet Forge. See FURNACE, RIVET.

Rivet, Furnace. See FURNACE, RIVET.

Rivet Heading Machine. See BOLT HEADING MACHINE.

Rivet Heater. One who heats the rivets. This work is generally done by one or two boys with a portable forge. They should be careful to place the rivets in the fire shank down so that the heads will not become too plastic when thrown or passed to the holder on. Care should also be taken not to burn the rivets or to leave them in the fire too long. See FURNACE RIVET.

Rivet Holes. A term applied to the holes that are punched or drilled in plates, shapes, forgings and castings for rivet connections.

Rivet, Keel. A term applied to a rivet used in attaching the keel to the garboard strake.

Rivet Set. A calking tool for use around a rivet.

Rivet Spacing. A term applied to the distance between the centers in a row of rivets. This distance usually consists of a multiple of the rivet diameter and it depends on whether oil tightness, water tightness or strength is to be the governing requirement.

Rivet Squad. A squad for hand riveting consists of two riveters, one holder on and one or more rivet heaters. For pneumatic riveting it consists of one riveter, one holder on and generally two rivet heaters.

Riveter, Hydraulic. Usually a large C-shaped cast steel frame with a hydraulic ram fitted at the open end which carries the rivet set. See Riveting Machine.

Page 751.

Riveters. Workmen who drive rivets by hammering the points into the required shape either by means of hand or power tools.

Riveters usually work in gangs, a gang including one or two riveters, a holder on, a heater, and perhaps one or more passers.

Riveters should be responsible for the fairness of the surfaces riveted and should see that there are no lateral bends, bumps or irregularities in the plating, because when once riveted the structure is permanent. They should also see that the surfaces are rigidly and firmly united when they perform the operation of swaging down the points of the rivets. A sufficient number of hand riveters have always been hard to obtain and as hand riveters generally work in pairs, each striking alternate blows, it has become the general practice in America to use the pneumatic rivet hammer as much as possible, for this tool requires but one man to operate.

Riveting. The art of fastening two pieces of material together by rivets.

Riveting, Bull. A term applied where rivets are driven by power machines, usually air or hydraulic.

Riveting, Chain. A term applied to two or more rows of rivets that have their centers opposite each other. A line drawn perpendicular to the edge of the plate through the center of a rivet in one row will also pass through the centers of the corresponding rivets in the other rows.

Riveting, Double. A term applied when a connection is made with two rows of rivets. In butt joints there are two rows in each piece connected.

Riveting Hammer, Hand. Either a long double headed hammer of medium diameter with flat faces or having a long head and a narrow peen.

Riveting Hammer, Pneumatic. A light machine operated by compressed air, in which a rivet set with its shank having a sliding fit in the bore is given very rapid, short and powerful strokes. This type of hammer has had the antagonism and opposition of the hand riveters to contend against, but as its use in America has become very general in spite of this, there can be no question of its economic advantage. One man operates this tool in place of two with hand hammers and it has the further advantage of handling rivets better in places that are not easily accessible. See HAMMER, PNEUMATIC.

Pages 780, 781, 782, 784, 788, 790.

Riveting, Hydraulic. A term applied where the rivets are driven by a machine actuated by hydraulic pressure.

Riveting Machine. A machine designed for upsetting and forming rivet points. This may be done by compression, by a succession of rapid blows, by rapid blows accompanied by rotary motion of the rivet set or by combined compressive and rolling or spinning action. Riveting machines used in a shipyard are usually of the pneumatic or hydraulic type.

Riveting, Quadruple. A term applied when a connection is made with four rows of rivets. In quadruple riveted butt joints there are four rows in each piece connected.

Riveting, Reeled. See RIVETING, STAGGERED.

Riveting, Single. A term applied where a connection is made with one row of rivets. In butt joints there is one row in each piece connected.

Riveting, Staggered. A term applied to two or more rows of rivets where the centers of the rivets in one row are one-half the pitch or spacing ahead of the other row.

Riveting, Three-ply. A term applied where three thicknesses of material are connected by one rivet.

Riveting, Treble. A term applied when a connection is made with three rows of rivets. In treble riveted butt joints there are three rows in each piece connected.

Riveting, Zig Zag. See RIVETING, STAGGERED.

Rivets, Row of. A term applied to a continuous line of rivets whether vertical, diagonal or horizontal. The spacing of the rivets from center to center depends upon the nature of the connection.

Roasting Ovens. The heated chambers constituting the interior portion of a ship's range.

Rock Shaft. See SHAFT, WEIGH.

Roller Bearings. The inherent principle of the roller bearing is the substitution of a true rolling motion for the sliding friction of plain bearings. The low coefficient of friction for rolling contact as compared with sliding contact is utilized in such a practical way that the power consumed in overcoming friction is reduced by from 60% to 75%.

Flexible roller bearings are wound helically from flat strip steel into a hollow, cylindrical roller, which, because of its flexible construction, can adapt itself to slight irregularities in either the journal or the housing without causing excessive pressure or permanent deformation. The hollow center of the roller serves as a reservoir for the lubricant which is distributed through the helical slots over all the bearing surfaces.

Roller bearings are extensively used on all type of machinery and can be applied in practically every place where a wheel or shaft turns. They minimize friction, give a smoother and easier operating machine, eliminate sticking bearings, hot boxes and bearing replacements, insure positive and care free operation, greatly reduce maintenance costs, and are capable of years of satisfactory service with no appreciable wear. They are the logical bearing for cranes, hoists, plate castors, and all shipbuilding equipment where a durable, dependable, easy running bearing should be used.

Page 792.

Rolling. The oscillating motion of a vessel from side to side due to ground swell, heavy sea, or other causes.

Rolling Chock. A term applied to a bilge keel.

Rolls, Bending. A machine in which power driven steel rolls are used to give curvature to plates. Three rolls are provided and two are adjustable allowing the arc to which a plate may be rolled to be varied within wide limits. A slot is usually cut in the forward roll to allow the rolls being used for flanging plate brackets, etc.

Pages 736, 744.

Rolls, Hand Power. A small machine designed to give curvature to light metal plates. This type is operated by hand, a large wheel with wood spokes being usually provided for this purpose.

Rolls, Mangle. A machine in which power driven steel rolls are used to straighten plates. In this machine there is an upper and lower series of rolls. The upper rolls are adjustable to allow for straightening plates of varying thicknesses. The adjusting mechanism of the upper rolls is arranged so that a plane tangent to the upper rolls is at all times parallel to a plane tangent to the lower rolls.

Roofing. A term applied to waterproof materials used in covering roofs.

Page 807.

Rope. The product resulting from twisting a fibrous material, such as manila, hemp, flax, cotton, coir, etc., into yarns or threads, which in turn are twisted into strands and several of these laid up together. Fiber rope is designated as to size by its circumference. Wire rope is made of iron, steel, or bronze wires twisted together like yarns to form strands, which in turn are laid up to form a rope. Wire rope is designated as to size both by its diameter and its circumference.

Pages 323 to 333, 824, 825, 826, 829, 830, 831, 832, 833, 836, 838, 839, 840, 841, 870.

Rope, Back Hand. A rope in which the fibers are twisted up left handed, the yarn right handed, and the strands left handed.

Rope, Bolt. A rope used around the boundaries of sails, awnings, canvas, tarpaulins, etc. It is made from selected yarns of the best quality of hemp cordage, which are rather loosely laid up and tarred.

Page 824.

Rope, Buoy. The rope by which a buoy is attached to its anchor. It should be of sufficient strength to lift the anchor should a vessel be obliged to slip her cable or the cable part.

Rope, Cable-Laid. A term that was formerly exclusively applied to a rope consisting of nine strands, being made by laying three plain ropes together left-handed; but now used to denote three, sometimes four, plain laid three-stranded ropes twisted together in the opposite direction to the twists in the several ropes. Also known as *hawser laid* and *water laid* rope.

Rope, Cast Steel Wire. A rope made from cast steel wires. It is used for standing rigging and derrick guys and when so used should be galvanized.

Pages 323, 326, 327, 328, 829, 831, 838, 841, 870.

Rope, Check. A term applied to a rope used in checking the way of vessel when docking or warping. A hawser having one end fastened to a dock and the other end turned around a bitt so that it may be slackened or held taut.

Rope, Coir. Rope made from the fibrous husks of the cocoanut having about one-fourth the strength of manila rope. It is sufficiently buoyant to float upon the surface of the water, but is disagreeable to handle.

Rope, Cotton. A rope of small diameter made from cotton fibers and used for sheets and halyards on yachts and sail boats.

Rope, Flat. A rope having its strands braided instead of twisted up.

Rope, Hawser. A term applied to warping and towing lines.

Pages 825, 836.

Rope Heart. When a fiber rope has a heart it consists of a small pliable rope whose diameter is about one-third that of the strands. In a wire rope the heart may consist of a tarred hemp rope where pliability is the chief consideration and a wire heart where strength is more important.

Rope, Hemp. A rope made from fibers of the hemp plant. As in manila rope the fibers are made into yarn, the yarn into strands, and three or more strands twisted up to form a rope.

Hemp rope where exposed to the weather requires tarring as it otherwise decays rapidly. Hemp rope is used principally for bolt ropes and standing rigging.

Page 824.

Rope, Hide. A rope made from strips of uncured hide and principally used as wheel rope.

Rope, Iron Wire. A rope made of iron wires. It has less strength but is more pliable than steel rope of the same make up.

Pages 323, 329, 838, 841, 870.

Rope Knots. See KNOTS.

Rope Lay. The direction in which it is twisted up.

Rope, Left-Laid. Rope in which the strands are twisted together in the same direction as that of the hands of a clock.

Rope, Manila. A rope made from fibers of manila which are obtained from the wild banana plant growing in the Philippines. The fibers are made into yarn, the yarn into strands and three or more strands twisted up to form a rope. Manila rope is usually made up of three strands up to 3" circumference and above that diameter four strands with a heart center. This rope is more desirable than hemp for hawsers and running gear because it is lighter and more pliable and does not require tarring for preservation. Manila rope is stronger than tarred hemp rope but a little weaker than white rope.

Pages 323, 331, 824, 826, 839.

Rope Marline. See ROPE SPUN YARN.

Rope, Mast. A heavy rope used in hoisting or striking down a topmast, topgallant mast, etc.

Rope, Parcelling. This operation consists of wrapping straps of canvas around the rope with the upper edges overlapping similar to shingles. For wire rope the strips should be coated with red lead and linseed oil and for fiber rope they should be tarred. The rope is usually wormed if parcelled.

Rope, Plain-Laid. A term that was formerly exclusively applied to the three-stranded right-handed rope, but is now applied commercially to three, four or six stranded rope laid up in the contrary direction to the twist in the strands.

Rope, Plow Steel. A rope made from plow steel wires. It is very strong and durable, and is used for running gear. When working over sheaves it should not be galvanized.

Pages 323, 324, 325, 326, 829, 838, 841.

Rope, Ridge. A rope running through the eyes at the heads of the awning stanchions to which the edge of an awning is hauled out and stopped. The term is sometimes applied to the center rope of an awning, but "backbone" seems to be a more satisfactory term for it.

Rope, Right-Laid. Rope in which the strands are twisted together in the opposite direction to the motion of the hands of a clock.

Rope Seizing. A method of making a joint between two ropes by binding with marline or spun yarn. There are three kinds of seizing, viz.: Round seizing where two layers of marline are used; flat seizing where one layer of marline is used; throat seizing where the parts of the rope or ropes cross.

Page 825.

Rope Serving. Consists of wrapping a complete layer of marline or cord around a rope to protect it against chafing. The rope is usually wormed or wormed and parcelled before serving.

Rope, Shroud-laid. A rope made by laying up four strands around a core or heart in a right handed direction.

Rope, Sisal (a substitute for manila). The fiber for Sisal rope is procured from a plant grown in Yucatan, Mexico and Key West, Fla. Its tensile strength is not more than three-quarters that of Manila fiber. Unlike Manila, Sisal is stiff and harsh, and deteriorates rapidly when exposed to the elements.

Rope Splicing. A method of making a rope joint which is accomplished by braiding the strands. A splice in wire rope is from 10 to 15 per cent. weaker than the rope.

Page 828.

Rope, Spun Yarn. Hemp fiber loosely twisted and tarred. Also called Marline and Hambroline.

Page 825.

Rope, Stern. A rope leading from the stern of a vessel to a wharf or buoy for mooring. Also known as "stern line" or "stern fast."

Rope Strand. This is composed of rope yarns twisted up and usually in a left handed direction.

Rope, Tapered. A rope having a relatively large diameter where strength is required and tapering down to a smaller diameter where more pliability is desirable.

Rope, Tiller. A term applied to the ropes actuating a tiller. A very desirable type is made up of small bronze wires which is quite pliable.

Pages 832, 833, 836.

Rope, Tow. A hawser of either fiber or wire by which a vessel is towed or tows another.

Rope, Twice-Laid. Rope made from old yarns laid up a second time.

Rope Walk. A place where rope is manufactured by the less modern machine methods. A long walking space is required for the workmen in their back and forth motion in the operation of spinning, hence the name.

Rope, White. A term applied to untarred hemp rope. It is used for log and lead lines. The white rope is stronger than manila.

Rope, Wire. A rope made up of wires twisted up into strands and strands twisted up into rope. The strands are usually twisted up around a heart of hemp or wire. Particular care should be taken with wire rope to prevent kinking. It should never be pulled out from a coil as fiber rope but should be unwound from an axis or the coil should be rolled along like a wheel. The larger the number of wires per strand or the larger the number of strands per rope, the greater the flexibility obtained. In ordering wire rope care should be taken to give the largest diameter or that of the circumscribing circle.

Pages 323 to 330, 828, 829, 830, 831, 832, 833, 836, 838, 839, 840, 841, 870.

Rope Wire Fittings. See the respective headings for clips, clamps, sockets, thimbles, etc.

Pages 834, 835, 837, 870.

Rope, Wire, Marline Clad. A wire rope in which each strand is served with tarred marline before being twisted about the core.

Pages 832, 839, 840.

Rope, Wire, Steel Clad. A wire rope in which each strand is served with flat steel wire before being twisted about the core.

Page 832.

Rope Worming. Filling in the valleys between the strands of a rope with marline. The marline should run with the lay of the rope.

Rope Yarn. This consists of fibers of manila or hemp which are usually twisted up in a right handed direction.

Rose Box. See PUMP STRAINER.

Rose Box, Strum or Strainer. See STRUM BOX.

Rose Lashing. A lashing made by alternately passing the parts over and under the object lashed, then finishing by turning the end around the crossing point. Also known as Rose Seizing.

Rose Seizing. See ROSE LASHING.

Roses. Perforated metal plates, fitted over the outside of injection sea cocks in order to prevent the entrance of weeds or other foreign substances to the ship's piping system or pumps.

A perforated nozzle for delivering water in a fine jet.

Rosin, Wood. A solid substance exuded from various trees, or left as a residue from the distillation of turpentine.

Rot. A term applied to wood that has become soft or discolored.

Rotary Air Pump. See PUMP, ROTARY.

Rotary Converter. A rotary electrical machine for transforming alternating current to direct current or vice versa. Also called Synchronous Converter.

Rotary Pump. See PUMP, ROTARY.

Rotary Shear. See SHEAR, ROTARY.

Rotor, Turbine. See TURBINE ROTOR.

Round In. To haul in a rope rapidly.

Round Stern. The Stern of a ship whose decks terminate aft in semi-circular or elliptical shape.

Rounded Gunwale. See GUNWALE, ROUNDED.

Roundline. A three-stranded, right-handed, tarred hemp, small stuff used for seizings, service, etc.

Rouse. To overhaul rapidly as a rope or cable. To "rouse out" the crew to get them on deck quickly.

Row Locks. U-shaped fittings with shank or socket attachments to the gunwale of a boat. They are used as a fulcrum for oars in rowing, sculling and steering. Page 823.

Royal. A light square sail set next above a topgallant sail.

Rubbing Strip. A plate riveted to the bottom of a keel, to afford protection in docking and grounding. Also a strip fastened to the outside of a fender or to the shell plating where contact is likely to occur.

Rudder. A device used in steering or maneuvring a vessel. The most common type consists of a flat slab of metal or wood, hinged at the forward end to the stern or rudder post and rounded at the after end to make a fair ending to the lines of the vessel.

When made of metal it may either be built up from plates, shapes and castings, with or without wood filling or it may be a casting.

The rudder is attached to a vertical shaft called the rudder stock, by which it is actuated or turned. Pages 231, 577, 899.

The American Bureau of Shipping requires that rudder stocks above the top pintle are to be as short as possible and are to have diameters not less than given by the formula:

$$S = .26 \sqrt[4]{R.A.V.^2}$$

Where S = diameter of upper stock in inches.
R = distance in feet from center line of pintles to center of gravity of immersed rudder area; the area to be measured between center line of pintles and back edge of rudder.
A = rudder area below the load line in square feet, measured between center line of pintles and back edge of rudder.
V = maximum sea speed of vessel in knots per hour.

The least speed to be used with the formula is 8 knots in vessels of 100 feet length; 9 knots at 150 feet; 10 knots at 200 feet; 11 knots at lengths of 250 feet length and above; in vessels of intermediate lengths, intermediate minima are to be taken. The formula may be modified to $.25\sqrt[4]{R.A.V.^2}$ where the sea speeds of steamers are two or more knots greater than the above minima; intermediate co-efficients may be used for smaller additions to the minima. Where the center of the lower stock is abaft that of the upper stock, the latter is to be suitably increased in area where the material passes from one center to the other. The lower stock is to be of the full diameter at the top arm, but the diameter may be gradually reduced below the top arm until it is .75S at the heel. The stock is to be swelled in way of each rudder arm to such a diameter as will permit the arm keyways to be cut clear of the stock, but the increase in diameter is not to be less than .5"; the swells are to extend at least 1.5 inches above and below each arm (except on the lower side of bottom arm) and are to be gradually tapered from thence to the stock.

Rudder Arms are to be shrunk and keyed on to the lower stock; those for 5-inch rudder stocks are to be spaced not more than 50 inches, center to center; those on 15-inch stocks may be spaced 75 inches; intermediate spacings are to be used for stocks having intermediate diameters. The arms are not to be less in size in way of the rivet hole nearest the stock than is given by the following formulæ:

$$M = .001\ a.r.V^2$$

$$\text{Breadth in inches} = 1.5\sqrt[4]{M.} + C.$$

$$\text{Thickness in inches} = .9\sqrt[4]{M.}$$

Where a = mean breadth in feet of segment supported by arm (measured from back of stock to back edge of rudder) multiplied by spacing of arms in feet.
r = distance in inches of center of gravity of a. abaft first rivet hole in arm.
V = speed as specified above.
C = 1 with ¾" rivets, 1.1 with ⅞", 1.2 with 1", 1.3 with 1⅛", and 1.4 with 1¼" rivets.

The depth of the pintle boss is not to be less than .7S., the breadth of the outer end of the arm is to be sufficient to take chain riveting where practicable; the rivet holes at the inner end of the arm are to be reeled and spaced six diameters in each row; the pitch is to be gradually reduced until the holes at the outer end are spaced four diameters in each row.

Pintles are to be fitted in each rudder arm, and in cases where the arm spacing accords with the preceding paragraph, their diameter is to equal .5S, they are to extend for the full depth of the gudgeons, except in the bottom gudgeon, where the length may equal .5S if bearing rings are fitted under the bottom arm; the top pintle is to be placed as high as possible. Pintles are to be fitted as taper bolts in the pintle boss; there is to be no shoulder on the pin; the

taper should not be greater than 1 in 12, and the nuts are to be fitted with efficient locking pins. Where pintles of 3½ inches diameter and upwards are required and are protected by gun metal sheathing shrunk on to the pintle, the diameter .5S may be measured over the sheathing.

Rudder Couplings between upper and lower stocks are to be supported by an ample body of metal worked out from the rudder stock, and are to have flanges of not less thickness than .25S; if keyways are cut in couplings the thickness is to be increased by the depth of the keyway; the material outside the bolt holes is not to be less than two-thirds of the diameter of the bolt; there should be at least six bolts in each coupling, and the united area in square inches of the bolts should not be less than given in the following formulæ:

Horizontal Couplings.

$.3S^3 \div r =$ Bolt area.

r = mean distance in inches of the bolt centers from the center of the system of bolts.

Vertical Couplings.

$.33S^2$ = Bolt area at bottom of thread.

Scarphed Couplings.

$.4S^2$ = Bolt area at bottom of thread.

2.5S = Length of scarph.

1.75S = Width of scarph at top where there are two bolts in end.

2.5S = Width of scarph at bottom.

.13S = Thickness of scarph tips.

The nuts on coupling bolts are to be of standard proportions, and are to be efficiently locked in position after having been screwed up.

Rudder plates are recommended to be fitted clear of the rudder stock so that all surfaces may be kept clean and painted; the thickness of the plate, in association with the spacing of arms required above, is not to be less than given in the following table:

Stock	3	4	5	6	7	8	9	10	11	12	13	14	15
Plate	.68	.72	.76	.8	.84	.88	.92	.96	1.00	1.04	1.08	1.12	1.16

(Sizes are given in Inches.)

Intermediate thicknesses may be obtained by interpolation; where the sea speed exceeds 15 knots the thickness is to be increased; the rate of increase is to be .04″ per knot.

Rudder Stops. Strong and efficient stops are to be fitted on deck; steam steering engines are to be provided with satisfactory arrangements for stopping the engine before the stops are reached.

Bearing Rings are to be fitted under the rudder arms, or carriers, as may be required to distribute the rudder weight.

Balanced Rudders. The size above the neck bearing of stocks for balanced rudders is not to be less than obtained from the formula for unbalanced rudders where R and A are measured between the center line of stock and back edge of rudder. The limitations and modifications in terms of sea speed specified under rudder stocks will apply to upper and lower stocks of balanced rudders.

The size of the lower stock for balanced rudders which have efficient neck and bottom bearings is to be obtained from the formula:

$$S_1 = .26 \sqrt[4]{R.A.V.^2}$$

Where S_1 = diameter of lower stock in inches.

$R = .25 (a + \sqrt{a^2 + b^2})$.

A = area in square feet of the rudder surface below the load line.

a = vertical distance in feet from the neck bearing to the center of gravity of the immersed rudder surface.

b = horizontal distance in feet from center of lower stock to the center of gravity of the immersed rudder surface.

V = maximum sea speed of vessel in knots per hour.

The lower stock is to be the full diameter for at least two-thirds of the distance from the neck to the bottom bearing; the diameter may be gradually reduced below this point until it is $.75S_1$ in the bottom bearing; the stock is to extend into the bottom bearing for a distance not less than $.7S_1$. One-half of the neck bearing is to be a solid part of the stern post and the length of the bearing is not to be less than $1.5S_1$; the area at the bottom of the thread of the bolts for the cover is not to be less than $.33S_1$. The bearings are to be bushed with metal and satisfactory arrangements are to be made at each bearing to take the weight of the rudder.

The size of the lower stock for balanced rudders which have no bottom bearing is to be obtained from the formula:

$$S_1 = .26 \sqrt[4]{R.A.V.^2}$$

Where $R = a + \sqrt{a^2 + b^2}$

and S_1, A, V, a and b have the values given in the preceding paragraph.

The lower stock is to be of the full diameter to the underside of the top rudder arm; the diameter may be gradually reduced below this point until it is $.33S_1$ at the heel. The length of the neck bearing is to be at least $1.5S_1$, the bearing is to be bushed with metal and satisfactory arrangements are to be made to take the weight of the rudder.

Rudder Area. The area of the effective rudder blade. Usually referred to as a percentage of the area of the immersed middle line or lateral plane of the ship.

Rudder Arms. A term applied to the frames or arms projecting or radiating from the vertical main piece for the purpose of supporting and stiffening the rudder plating.

Page 577.

Rudder, Auxiliary. A term applied to bow rudders. They are fitted to ferry and sometimes paddle-wheel boats.

Rudder, Balanced. A rudder having the forward or leading edge of the whole or a portion of the rudder far enough forward of the center line of the rudder stock to bring the center of pressure of the water on the rudder at the maximum helm angle on or near the centerline of the rudder stock.

With a balanced rudder the torque is reduced to a minimum so that the power of the steering engine may be reduced. The size of the stock, however, will depend largely on the bending stresses.

Rudder, Bearing. A fitting usually constructed in two parts which are bolted together around the rudder stock. The upper portion of the bearing is usually fitted with an annular groove and a flat ring floating in oil upon which the rudder carrier turns.

The middle portion, which is usually lined with white metal, forms a side bearing for the rudder stock and the bottom portion, which is composed of

a wide flange, provides for attachment to the top of the rudder trunk or a deck.

Page 578.

Rudder, Bow Piece. A term applied to the curved frame forming the after edge of a rudder.

Rudder Brace. See GUDGEONS.

Rudder Bushings. A term applied to brass or metal sleeves fitted around the pintles.

Pages 577, 891.

Rudder Carrier. A fitting usually constructed in two parts which are bolted together around the rudder stock and which forms a means of transferring the weight of the rudder to the rudder bearing.

The upper portion of the carrier consists of a sleeve that forms a close fit around the stock which is usually turned to a larger diameter at the top and bottom of the carrier sleeve to form shoulders.

The upper shoulder aids in transferring the weight of the rudder through the carrier to the bearing and the lower shoulder prevents the stock from slipping up through the carrier. Set screws or a key and keyway are usually fitted to insure that the carrier turns with the stock.

The lower portion of the carrier consists of a flange having a flat bearing surface that works on an annular ring floating in oil in a groove on the top of the rudder bearing.

Page 578.

Rudder, Cast Steel. A term applied to a rudder having the plate and framework of cast steel. It may be made in one piece or in two or more pieces bolted together.

Rudder Coupling. A term applied to the flanges or palms fitted to the lower end of the rudder stock and to the top of the main piece to provide a means of efficient connection.

Pages 577, 578.

Rudder, Double Plate. A rudder constructed by two planes of plating tapering in section from the width of the main piece in the way of the rudder stock down to the width of a bar at the edges. The space between the two plates is usually filled with wood.

Rudder, Flat Plate. A term applied to a rudder constructed by one plane of steel plating. The plating is supported and stiffened by arms projecting from a vertical main piece. The rudder arms may all be on the same side of the plate or alternating on one side and then on the other.

Page 577.

Rudder Frame. A term applied to a vertical or main piece and the arms that project from it, forming the frame work of a rudder.

Rudder Gudgeons. See GUDGEONS, RUDDER.

Rudder Head. The upper end of the main piece to which the rudder stock is attached. The head consists of a flange or thick palm to which a flange or palm on the lower end of the rudder stock is bolted.

Page 577.

Rudder Heel. A term applied to the lowermost portion of the main piece of a rudder.

Page 577.

Rudder, Jury. See JURY RUDDER.

Rudder Keeper. A term applied to wedge shaped pieces of metal that are fitted between and prevent the nuts on the coupling bolts from working loose.

Page 578.

Rudder Lugs. A term applied to the projection, cast or fitted to the forward edge of the rudder frame for the purpose of taking the pintles.

Rudder, Main Piece. The vertical or main frame of the rudder to which the rudder arms are attached.

Page 577.

Rudder Pendants. A term applied to a pair of chains or ropes attached by a shackle to a hole bored through the upper after end of a rudder frame or to a monkey tail for the purpose of providing a temporary steering gear. The upper ends of the pendants are usually attached to pads fitted to the shell.

Rudder Pintles. See PINTLES, RUDDER.

Rudder Scores. A term applied to the portions of the forward edge of a rudder that are cut out between pintles. This scoring allows the rudder to be unshipped readily.

Rudder, Side Plate. See RUDDER, DOUBLE PLATE.

Rudder Stays. See RUDDER ARMS.

Rudder Stock. A vertical shaft having a rudder attached to its lower end and having a yoke, quadrant or tiller fitted to its upper portion by which it may be turned.

In addition to the function of turning, the stock should take the weight of the rudder through a carrier attached to the stock which works on a bearing fitted at the top of the rudder trunk or on a platform or deck.

The rudder stock should be designed to withstand the torque, and bending stress coming on the rudder at the maximum helm angle and the maximum speed of the ship.

Pages 578, 893, 896, 898.

Rudder Stock Stuffing Box. See STUFFING BOX, RUDDER STOCK.

Rudder Stops. A term applied to fittings attached to the structure of the ship or to shoulders on the stern post which have the function of limiting the swing of the rudder to an angle of about 35 degrees.

Rudder, Telltale. See TELLTALE RUDDER.

Rudder Trunk or Tube. A term applied to a casing fitted around the rudder stock and extending from the counter to a platform or deck. Its purpose is to prevent water from entering the hull, and for this reason a stuffing box is fitted at its upper end.

Rudder, Underhung. A rudder that is not hinged or stepped on the stern post but supported entirely by the rudder stock.

In this form of rudder the bending stress on the stock at maximum speed is generally quite large and becomes the most important factor in calculating the size of the stock.

Rules of the Road. Regulations for preventing collisions and for promoting safety to navigation.

These include the following:

1. The International Rules established by agreement between maritime nations governing navigation on the high seas and in all waters connected therewith navigable by sea-going vessels.

2. The Inland Rules enacted by Congress governing the navigation of the inland waters of the United States.

3. The Pilot Rules for United States Inland Waters, supplementing the Inland Rules.

These Rules are established by the Board of Supervising Inspectors of Steam Vessels under authority of the United States Inland Rules.

4. Local Regulations for the navigation of various harbors, rivers, and other inland waters, of countries

other than the United States. These Rules are generally made locally for each port.

In general, the local rules do not modify the International Rules in the more important particulars, but frequently emphasize many minor requirements.

Run. The under water portion of a vessel aft of the midship section or dead flat.

Runner. A length of rope made fast at one end and rove through a single movable block, i. e. a single whip reversed.

Running Rigging. Ropes which are hauled upon at times in order to handle and adjust sails, yards, etc., such as sheets, clewlines, halyards, downhauls, outhauls, reef-tackles, etc.

S

Saddle. A block of wood, hollowed out to receive the inner end of a jib-boom.

Safety Goggles. Spectacles specially designed to protect the eyes of workmen against dust, flying pieces of metal or excessive light.

Chippers, calkers, riveters and welders should be required to wear them.

Pages 762, 763.

Safety Keel. See KEEL, SAFETY.

Safety Rules. An innovation which has met with considerable favor in a number of shipyards during the past two or three years is the adoption and enforcement of fixed rules relative to safety and sanitation. Precautions and measures have been taken for safeguarding the workers, and responsible persons charged with the administration of this work.

The principal idea embodied in this work is that by a proper system of education regarding the dangers of their work and the advantages of modern sanitary methods, the co-operation of the personnel will be readily forthcoming, with the result that a higher state of efficiency will prevail throughout the plant which will be of mutual benefit to the employes and the company, the employes benefiting by the precautions taken to safeguard their health and eliminate avoidable accidents and the company by the increased production and reduction in accident compensation costs.

During the war the Newark Bay Shipyard of the Submarine Boat Corporation made a notable record, not only for the tremendous amount of work turned out but also for the extremely low percentage of accidents per number of men employed. The following Rules and Regulations in force at the Newark Bay Shipyard are therefore published through the kind permission of the Submarine Boat Corporation.

Organization of Safety, Sanitation and Service Board

The Submarine Boat Corporation desires to make the work of every employe as safe and healthful as possible, and to bring this about the Safety Organization has been created to co-operate with its employes in the advancement and in the improvement of sanitary and working conditions. To assist in accident prevention and to secure the ideas and co-operation of all employes safety committees are to be formed.

Until such time as additional departments are created there will be eleven departmental committees, comprised of the following departments:

PLANT CONSTRUCTION
MECHANICAL AND ELECTRICAL INSTALLATION AND MAINTENANCE
HULL CONSTRUCTION
TRANSPORTATION
YARD SUPERINTENDENCE
FABRICATING DEPARTMENT
PASSENGER TRANSPORTATION
COMMISSARY DEPARTMENT
FIRE DEPARTMENT
MILITARY DEPARTMENT
POLICE DEPARTMENT
PURCHASING DEPARTMENT
TIMEKEEPER'S DEPARTMENT

The superintendent of each of these departments will quarterly appoint a committee, for the ensuing quarter, consisting of three or more, the total number to be an odd number, which departmental committee shall include at least one foreman. The majority of such committee shall choose its own chairman and the chairmen of all the departmental committees shall quarterly choose four of their number to serve on the Safety, Sanitation and Service Board for the ensuing quarter. Each department committee may at its discretion and with the approval of its superintendent organize such sub-committees as its work may make desirable.

The Safety, Sanitation and Service Board shall consist of the—

CHIEF PHYSICIAN
COMMISSIONER OF LABOR
SAFETY ENGINEER
CHIEF ENGINEER
GENERAL MANAGER'S ASSISTANT
SUPERVISOR OF WELFARE (HONORARY MEMBER)
FOUR ELECTED MEMBERS

It shall quarterly choose one of its members to act as chairman for the ensuing quarter.

The Safety, Sanitation and Service Board will have general charge of and supervision over safety work. It will receive and pass upon all safety recommendations received from the departmental superintendents.

It will devise and promulgate standards for safeguarding, sanitation, working conditions and such other matters as may be referred to it.

It will formulate rules for safe operation of machinery and will promulgate same through the Safety Organization.

Periodic inspection of the plant and of working and sanitary conditions will be made and written reports of such inspections submitted to department superintendents, who will, after review, or action on any or all items, cause reports to be delivered to the Safety, Sanitation and Service Board.

It will arrange for investigators to determine immediately the causes of accidents. These investigators must be rendered every assistance by all employes to the end that the facts may be developed in each case and any attempt on the part of any employe to mislead the investigators will result in his dismissal.

Regular meetings will be held. The date of such meetings will be determined.

Safety bulletin boards will be erected in all departments and employes are instructed to read the bulletins and notices placed thereon. The subject is to be changed at frequent intervals and departmental safety committee men will find much material in these bulletins for discussion at their meetings.

The Safety, Sanitation and Service Board will at once proceed to formulate and adopt rules for its procedure which will insure the placing of definite responsibility for

activities of its own initiative directly on one of its members or upon a person or persons selected by it. It will also arrange to have reports of accidents investigated and inspection reports received from Safety Engineers inspecting the plant passed directly to the superintendent of the department concerned so as to avoid delaying of the transmission of the facts until after the meeting of the Safety, Sanitation and Service Board.

It is to be the duty of every employe to report to a member of the Safety Committee of his department or to any Safety Engineer all unsanitary and unsafe conditions or practices. Such reports will be investigated by the Departmental Safety Committee and if substantiated the Departmental Committee will submit their recommendations to the superintendent of the department affected, who will either issue the necessary safety requisitions to correct such conditions or refer the matter to the Safety, Sanitation and Service Board. All recommendations shall be submitted in writing and filed with the record of action taken.

Instructions to Superintendents to Be Carefully Read by Every Superintendent

The Submarine Boat Corporation desires to make the work of every one of its employes as safe as possible. To achieve this object, the management will hold each superintendent responsible for every preventable accident occurring in his department, and expects each superintendent to likewise hold responsible his foremen. The failure of a foreman to take necessary steps to prevent an accident will not relieve a superintendent, or vice versa.

To prevent accidents it is therefore the duty of each superintendent to exact from his foremen a strict compliance with the rules and instructions formulated for their guidance. By personal investigation he should assure himself that this is being done. Accident reports should prove a great help in determining whether any particular foreman is doing his part or not. These reports must be returned to the Safety, Sanitation and Service Board as soon as possible, and must have noted thereon the remedial or disciplinary action which was taken.

Superintendents must report all fires on proper form to the Safety, Sanitation and Service Board as soon after a fire as possible.

Success or lack of success in prosecuting our work safely depends largely upon close attention to every safety rule and co-operation between superintendents, foremen and the employes in their respective departments, and accident records will bear an important place in the annual review of our work.

Instructions to Foremen

The Submarine Boat Corporation desires to make the work of every one of its employes as safe as possible. To achieve this object the management has created a Safety, Sanitation and Service Board. This board will be given every possible assistance to the end that each employe may go safely about his work. Each superintendent will be held strictly accountable for every preventable accident occurring to employes in his department, and the superintendent shall hold each foreman likewise responsible, nor will the negligence of one excuse the other. The following instructions have been prepared so that each foreman may know exactly what the management expects of him. To the degree that a foreman complies with the spirit of these instructions, to that degree will he enter into the spirit of the organization, and to that degree he will become a valuable man to the company.

The first duty of the foreman in the prevention of accidents is to inspect his department for the purpose of locating and eliminating dangerous conditions. A daily inspection must be made with four objects mainly in view:

1. To see that all workmen in this department are complying with these rules.
2. That they are not doing their work in an awkward or unsafe way.
3. That only tools and machinery in good condition are being used.
4. That no guards or safety signs have been removed without having been replaced. That passages and aisles are free from materials; that proper clearances have been maintained, and that clean and neat conditions prevail.

Next in importance is the proper instruction and handling of the men. A new man should be carefully sized up and if he seems to be a slow-thinking, heavy-footed man, he should not be placed on work requiring a quick-thinking, nimble man. If no one in the department can talk with the new man, he should be transferred to a department where some one can talk his language or an interpreter called. If there is work which it is reasonable to suppose he can be taught to do, the foreman must personally instruct the man in his duties and in the dangers of the work and before leaving the new man to do his work unassisted he must make sure that the work is understood.

Such thorough instruction not only has the effect of lessening the chance of injury, which is much greater for an inexperienced man, but it also makes the new man more efficient from the beginning, and where the new man uses machinery, proper instruction avoids a great deal of wear and tear. If the new man is to work with other and more experienced men, one of these men should be appointed to act as monitor to the new man until such a time as he becomes thoroughly experienced. At this time he must be given a rule book, and he must be familiar with rules pertaining to his work within seven days, to be determined by an examination given by the foreman.

If his work is of a nature that requires the use of goggles, he must be given them as soon as he commences work. Adjustable goggles are kept in stock, which can easily be fitted to any man. Foremen are held strictly responsible for the enforcement of the rule that all men in their charge who should wear goggles are provided with the right style, properly adjusted. The new man should be made to understand that he must wear them if he expects to continue in the employ of the company. By insisting on this at the start, when the man is anxious to comply with instructions, a great deal of friction is avoided. He should also be impressed at this time with the extreme necessity of reporting to the Emergency Hospital to have even the slightest injury properly cared for.

Where an employe is found disobeying rules or taking chances which endanger him or other workmen, he must be so dealt with as to make certain that the offense will not be repeated. Employes who unwittingly are doing their work in an awkward or unsafe way should be instructed until they do it in the right way. Tools with broken handles, mushroom heads, etc., must not be allowed to remain in use, but must be replaced. Guards, railings, safety signs, etc., removed by others and not replaced must be put in their proper place, and the fact they were not properly replaced, with the names of the offenders, if it is possible to secure them, reported to the superintendent at once. Floors that are clean, with material orderly piled and aisles kept clean speak loudly of an efficient foreman,

and are as important in the prevention of accidents as proper covering for gears. Night foremen should look out for places that are poorly lighted and attend to their proper lighting, as conditions which may be safe in daylight may be dangerous at night, especially for new men. Night foremen should also keep a close watch on all their men, as it frequently happens that men go to sleep in extremely dangerous out-of-the-way places so they will not be caught.

As time goes by and it is possible to fairly judge the man, foremen should ask themselves whether a man is really doing the kind of work that he should. If not, try to place him at work where he will be able to do better. If he has been injured frequently, put him on the least dangerous work possible, and if on this work he still meets with accidents return him to the employment office. Return slip must give full information both as to the man's qualifications and deficiencies. This, however, should never be done until every effort has been made to develop him into an efficient and safe workman. Some foremen, the poorest ones as a rule, return men for little or no reason. If a new man does not perform his duties correctly he should not be returned but should be very carefully instructed again and given a chance to adjust himself to his work. Summary dismissal will not be tolerated by this company.

Each foreman is expected to use patience and care in instructing new men; a well-trained man is what the management looks to the foreman for. Cursing, striking, abuse or mistreatment of employes, new or old, will be most severely dealt with. While the company expects an honest day's work from each man, it does not expect this to be secured by means of bullying. An employe who will not willingly do his work should be cautioned in a firm, honest way that loafing or disobedience can only result in dismissal, and then if he is indifferent he should be returned to the employment office with full information as above outlined. In case of serious infraction of the rules he may be discharged.

A careful watch should be kept to see that no man starts to work if intoxicated, or if he becomes intoxicated while at work he should be sent home. Efforts shall be made to ascertain the reason why men are off. This will be undertaken by a designated person or persons. If it develops that a man frequently lays off as the result of a debauch on the previous night, such a man should be warned that he will be the first to go in case work becomes slack, and even when workmen are scarce, such a man should not be retained, as he cannot be an efficient or safe man excepting for part of the time. Another man to avoid is one who in his personal habits is slovenly, for he will also be slovenly in his work. Employes who are subject to epilepsy or fainting spells, which render them more or less unconscious, must not be retained in any department, but must be sent to the Chief Physician for examination and taken back only on his recomendation. Employes who come to work ill, or are taken ill while at work, should be sent to the hospital for treatment. If the Chief Physician discovers no sign of illness and it is evident that the man is shamming he will be discharged. They must, however, never be allowed to continue working contrary to Chief Physician's recommendation, as lowered vitality with a constant lowering of mental and physical efficiency tends to the hazard of serious or fatal accidents. Of equal importance is the laying out of work so that it will not be necessary for a man to work more than a single shift or at the most a double shift. Triple shifts should never be worked, as this is not only deleterious to the employe's health, but is a fruitful source of accidents and a cause for lowered efficiency for several days following until the system has recuperated.

Foremen must never allow personal feelings to enter into their work. Work must be apportioned without favoritism, excepting such as is fully merited for faithful service. If an employe makes a complaint, the foreman must see that the grievance, if justified, is adjudicated; if the grievance is imaginary, he must explain to the man just why his complaint is unfounded. Foremen must never argue with their men. If trouble develops, a policeman must be called to remove from the plant the obnoxious person, and his superintendent notified of the fact.

Foremen who demand, borrow, or accept money or presents from men in their charge will be dismissed from the service.

In dealing with men of his own or other departments, or the heads of other departments, a foreman must studiously avoid friction. If impossible to adjust differences, recourse must be had to his superintendent, who will see that the affair is properly taken care of. The spirit of co-operation, the esprit-de-corps, is so vital to the success of the organization that foremen found guilty of unjustly criticizing other employes, and particularly other foremen, will be discharged. This does not mean that well-founded, honest criticisms cannot be made, but it does mean that they must be made to the proper authority, and in the proper spirit only.

If workmen from another department are doing repair or other work in your department, see that it is done safely and right, for you are responsible for conditions in your department. Be sure in doing work of any kind that guards that have been removed are replaced, and that pits, etc., are properly guarded. Note the operation of steam cranes and engines in your department, and if they are not being operated safely, notify your superior.

Should one of your men be injured, see that he goes to the hospital for treatment, and that you get back a properly made out hospital slip. If necessary, send a man along to accompany him, or have the ambulance come for him. To avoid unnecessary delay, foremen must familiarize themselves with the location of stretchers and ambulance stations in their vicinity.

Foremen must never permit an employe who has been injured to return to work unless he has a release slip properly signed by the Chief Physician and Claim Agent.

Release slips are in two different colors, blue and white. White slips are given to employes when they are able to do their regular work. Blue slips are given to employes who are not as yet able to perform their regular work, but who are able to do light work. Foremen must pay especial attention to employes who have blue slips and must place them on some suitable light work until such a time as they are given a white check.

If the foreman is of the opinion that an employe who has been released for light work is again able to do his regular work, he should send him to the Chief Physician, who will have him examined, and if the employe is found able to do his regular work, he will be given a white slip, and can then be put on his regular work by the foreman.

All release slips, either blue or white, must be returned to the Claim Agent as soon as the employe is placed at work.

Make it your business to discuss the accident with other foremen and see if you cannot think out some way of preventing a similar accident from occurring.

The management in conclusion desires to impress on all

foremen the necessity of complying as fully as possible with these instructions, and that the measure of success achieved will be given the consideration its importance deserves in making the annual review of a foreman's work.

General Rules

These instructions and rules apply to and govern all departments of Submarine Boat Corporation, at its Newark Branch Shipyard:

Rule 1. Superintendents and foremen must be conversant with all rules applicable to the work under their control. It is their duty to see that all employes in their charge are instructed regarding same and that the INSTRUCTIONS ARE THOROUGHLY UNDERSTOOD. Foremen must see that the rules are strictly complied with.

Rule 2. Heads of departments and employes must be courteous to each other at all times. Co-operation between departments is absolutely essential.

Rule 3. This company will not tolerate on the part of its foremen, or others in authority, the demanding, borrowing or acceptance of money or presents from men in their charge.

Rule 4. Printed or written regulations will, from time to time, be posted in various parts of the works, and all employes must read and abide by these notices.

Rule 5. Employes are warned not to look around or engage in conversation while at work, as this is the cause of many injuries. "Keep your eyes on your work, and your fingers on your hand."

Rule 6. Employes who feel ill before coming to work should remain at home, and on the first day of absence have some one notify the service department. Employes taken ill at work should report to their foreman, who will send them to the Chief Physician. Anyone shamming illness will be discharged.

Rule 7. Employes must report at the hospital immediately after sustaining injury, even though the injury be slight, as neglect to do this may result in death from infection. Workmen must not remove foreign bodies from their own eyes, nor permit anyone else to do so except the nurses or doctors at the hospital.

Rule 8. Employes are required to preserve and mark for identification any material, tools or pieces of machinery involved in an accident.

Rule 9. Employes must not disregard warning signs, as to do so is to deliberately invite injury.

Rule 10. Employes are forbidden to take short cuts over dangerous places.

Rule 11. Employes whose work requires them to enter other departments must familiarize themselves with the rules and dangers of those departments. Foremen will be held responsible for compliance with this rule.

Rule 12. Employes are warned not to deface, mark, mar or destroy any buildings, machinery, bulletin boards or other equipment, under penalty of dismissal and prosecution.

Rule 13. Employes found fighting or fooling will be disciplined. Employes injured while so engaged will be refused free medical or surgical aid.

Rule 14. In construction or repairs, the surrounding premises shall be kept clean and orderly. Boards with nails sticking up in them must not be left lying around and all material of whatever nature and wherever located must be piled safely and orderly in places designated by foremen.

Rule 15. Whenever employes see a nail protruding upward, they should bend the nail down flat and not merely turn the board or timber so the nail point will be point down.

Rule 16. Employes are forbidden to rest or lean against any railings.

Rule 17. All employes are directed to report to Department of Safety Commission or to Safety Engineer the negligence or failure to properly furnish, maintain, construct, guard, repair, inspect, or protect any of the ways, works, plants, machinery, appliances, tools, or area-ways in any way connected with or in any way used in the business of this company.

Rule 18. Tools or material must not be left on or between tracks.

Rule 19. Do not violate rules regarding smoking.

Rule 20. Employes must never fool with compressed air. Never turn compressed air on anyone, nor on yourself. It may enter the body and cause serious injury or death. Even though it does not enter the body, the sudden cooling caused by the air coming in contact with the body may result fatally.

Rule 21. Employes engaged in grinding, chipping, "busting" rivets or bolts, or other work where there is danger of chips entering the eye must wear goggles. Failure to do so will result in suspension or dismissal. Screens must be used to protect others from flying chips, etc.

Rule 22. Employes engaged in babbitting or pouring lead must wear goggles or babbitting masks.

Rule 23. Employes should never stand on the head of a barrel to reach a higher object. If a barrel must be used, place a board across the top.

Rule 24. Employes when using a jack must remove the handle if the work is suspended or discontinued, as there is danger of something slipping and causing the handle to fly out and injure someone.

Rule 25. All persons not authorized by the Chief Electrician are forbidden to work on any electrical apparatus, because of the danger of injury and the fire hazard. All employes whose duty does not require them to do so are warned against touching wires of any kind, as it may result in death. Before doing any work where there is danger of coming in contact with any electric wires, notify your foreman, who will call the electrician, who will send an experienced man to advise concerning the work. Do not try to fix electric lights, but call your foreman, as sometimes lamp globes explode, causing serious accidents.

Rule 26. If loose or hanging wires are found, notify your foreman, who will call the electrician.

Rule 27. When it is necessary for employes to work above other employes, those working underneath must be notified. When it is necessary for employes to work underneath other employes those overhead must be notified. Whenever employes are working overhead, they must place a sign on the ground reading "Caution—workmen above."

Rule 28. Exercise care in placing ladders. There is danger of all, except fixed ladders, slipping; have someone hold them for you. All portable ladders must be provided with safety shoes or spiked ends.

Rule 29. Do not go up or down a ladder without the free use of both hands. If material has to be handled, use a rope.

Rule 30. When working on high elevations from which they are liable to fall, or when working on smokestacks or scaffolding supported by tackle, employes shall, when practicable, wear safety lines and belts.

Rule 31. Material must never be piled within four feet eight inches (4′ 8″) from the outside of standard gage rails.

RULE 32. Employes are forbidden to go into other departments than their own except on company business, and when it is necessary to do so in going to and from work.

RULE 33. Employes are forbidden to walk upon or along the various railroads or gantry tracks or trestles, unless having work to do thereon. Employes are forbidden to cross tracks except at regular crossings, and must first look and listen for approaching cars or other moving machinery. Where a full view cannot be had of tracks in both directions, employes must always act on the assumption that nearby cars, engines or machinery are apt to be suddenly moved, and they should not cross any tracks within sixteen (16) feet from the end of an engine, cars or machinery.

RULE 34. Employes are warned of the danger from the arc used in electric welding. This work will be done inside of screens and employes are positively prohibited entering same or even looking in, as a short exposure of the eyes to the arc may cause total blindness.

RULE 35. Employes are forbidden to go into engine, power or pump houses, or electric motor rooms unless their duties take them there.

RULE 36. Workmen must not carry a burning match, torch or lantern when entering or working in an oil house, or any pit which might be oily or covered with grease.

RULE 37. No employe is permitted to enter a sewer, duct or pit for cleaning or repairing purposes, without first notifying the foreman in charge of his intentions to do so. An employe must be stationed at the opening through which he enters, and must not leave until the employe returns to the outside.

RULE 38. Garbage cans are provided and must be used for scraps of lunch, waste material, etc.

RULE 39. Employes must not loaf in toilets, wash or locker rooms.

RULE 40. Employes found wasting the supplies furnished in toilet, wash or other rooms, or who are found in the act of defacing or destroying equipment, will be discharged.

RULE 41. Employes must not spit on the floors of workshops, as this is a menace to health.

RULE 42. In case of fire, until the fire alarm system is installed, call work's central, and tell her where the fire is located, and notify the nearest fire company. When the new fire system is installed, go to the nearest fire alarm box and turn in an alarm.

RULE 43. Order and cleanliness are important from a fire prevention standpoint. Many fires are caused by untidy conditions. Foremen must inspect the premises of the department under their charge daily to see that empty boxes, barrels, trash, litter, garbage, waste and scrap materials of all kinds have not accumulated, but have been properly disposed of. Watch the corners and dark out-of-the-way places and keep them clean.

RULE 44. EMPLOYES ARE FORBIDDEN TO USE ANY OF THE FIRE FIGHTING APPARATUS OR EQUIPMENT OF THIS COMPANY FOR ANY OTHER PURPOSE THAN THAT OF FIGHTING FIRE, WITHOUT THE CONSENT OF THE FIRE CHIEF.

RULE 45. When it is necessary to use a fire extinguisher of any design, direct the stream at the face of the flame, where it will do most good.

RULE 46. Employes are strictly forbidden to place any obstruction within fifteen (15) feet of fire plugs, hose houses or hose boxes, or enter any hose or exit house except on business.

RULE 47. Crane operators and foremen of the various departments wherein pyrene or soda and acid extinguishers are located, shall be held responsible for the preservation and recharging of the same. When recharging is necessary, arrange with your foreman with the Fire Department to have it attended to immediately.

RULE 48. Sand boxes and scoops are provided in oil houses, paint storage, and other places where they are needed. Employes are warned that such sand is to be used for fire fighting only.

RULE 49. Chief of the Fire Department will be held responsible for the working condition of the various hydrants and fire fighting equipment within the plant.

RULE 50. The Fire Chief must be notified at once of any condition that constitutes a fire hazard, or that would interfere with fire fighting.

RULE 51. Employes are cautioned not to use celluloid eye shield cap visors, collars, etc. This material is very inflammable and is likely to ignite from sparks or intense heat, and cause serious injury.

RULE 52. Do not allow waste, rags, old clothes, etc., to accumulate in corners or lockers. Spontaneous combustion often results from such a condition.

RULE 53. Stove pipes must not run through floors or partitions, unless protected so they will not touch wood.

RULE 54. Ashes must never be dumped into any but a metal receptacle. Do not dump ashes against frame buildings or near any wooden construction, and see that receptacles do not stand closer than three feet to any inflammable material.

RULE 55. Only metal lamp shades are permitted to be used. Paper or cardboard shades are a dangerous fire hazard. Flexible cords for lamps must not be tied to iron rods or nails, nor allowed to come into contact with water or oil.

RULE 56. Whenever an employe is directed to work in close or dangerous proximity to any track used for the passage of cars, engines, locomotives, cranes, or other moving machinery, the employe in charge of such work must, before the work is commenced, TAKE ALL NECESSARY PRECAUTIONS for the safety of the men under him. When possible he shall notify the operators of such machinery, and it shall be the duty of the operator to exercise due care in the handling of the machinery under his control. This, however, does not relieve any workman from exercising the utmost vigilance to prevent injury to himself or others. If it is absolutely necessary for the safe conduct of the work, the man in charge of the work being done shall see to it that such machinery is not operated, or shall place one or more men to act as watchmen, whose duty it shall be to warn of approaching danger.

RULE 57. Cranemen are positively prohibited from moving cranes with chains swinging full length, or while hookmen or others are in a position which leaves them open to injury.

RULE 58. All employes are positively prohibited from riding on any lift being handled by a crane, excepting for inspection purposes.

RULE 59. Do not take hold of crane cable above sheave block, as your fingers may be drawn into the block. Watch hooks as they are being hoisted so they may not catch on anything.

RULE 60. All chains and cables must be regularly inspected, and records kept of such inspection (and annealing) as there is always danger of the metal in chains crystallizing and strands in cable becoming frayed, causing serious accidents. Where chains or cables are found defective, they must be replaced.

RULE 61. Tying knots in chains is positively prohibited.

Rule 62. Whenever possible chainmen or hookers must walk ahead of load carried by crane, and see that employes on the floor get out of the way before load passes over them. Never walk under a load.

Rule 63. If employes engaged in making a lift notice a kink in chain, lift must be lowered and chain straightened.

Rule 64. Cranemen must before starting sound a warning and employes must keep from under loads being carried by electric or other cranes.

Rule 65. In using hoisting apparatus employes are forbidden to make a hoist before the load is securely made fast and properly balanced.

Rule 66. Tag lines must be used where unwieldy loads are lifted with a crane.

Rule 67. Employes are positively forbidden to do any work on machinery, pipe lines of any description, wires or electrical apparatus before opening switch and attaching safety lock and chain where power is turned on.

Rule 68. Operators of cranes must obey signals from one person only. If signals are given by more than one person, disregard all signals and wait until proper signal is given by person in charge or the one designated to give signals.

Rule 69. At all shears where short pieces of material have to be cut, tongs must be provided and used to hold short length pieces in cutting.

Rule 70. Because of the danger incident to hoisting material by means of line shafting, it is forbidden that any hoisting be done in this manner. All hoisting must be done with block and tackle, chain blocks, or with regular hoisting machinery.

Rule 71. Millwrights, sailors and riggers will be held responsible for all loose material overhead, such as boards, bolts, nuts, tools, etc.

Rule 72. Operators of cranes or machinery are warned not to attempt to make repairs to the machinery. Call your foreman or crane repairman, who will instruct you what to do.

Rule 73. All employes must know that all tools, material, etc., which they are to use in their work, are in proper condition; if not, repair them or report to the proper person and have them repaired before using. Do not use unsafe tools as they are dangerous both to yourself and fellow workers.

Rule 74. Before lighting furnaces heated by oil, see that the draft dampers are open and the oil valves closed tight, so that there will be no accumulation of gas in the furnace. Then place lighted material in the furnace and turn on the oil. Never turn on the oil until lighted material has been placed in the furnace.

Rule 75. Employes are forbidden to load or unload cars on any truck until they protect either or both ends, as the circumstances require, with blue flags or lanterns. No one, excepting the foreman or someone authorized by him, shall remove the blue flags or lanterns, nor shall train crews place cars in such a way as to obstruct blue flags or light. If necessary to do so, the foreman must be notified so that he can change the position of the flags or light.

Rule 76. Blue flags or lights must be removed after they have served their purpose, so as not to unnecessarily delay trainmen.

Rule 77. Before a switch is made, the foreman ordering the switch must assure himself that all men on the cars ordered switched are warned. This warning is in addition to the warning usually given by the train crews.

Rule 78. When an employe is required to do work of any description on a power line, pipe line or machinery, and finds a safety chain and lock on the control apparatus, he shall place his own safety lock and chain on the control apparatus also, and in the event of his completing his own work first, must not disturb the other safety lock and chain.

Rule 79. Employes are positively prohibited from removing a safety lock and chain other than their own, from a valve, switch, or other appliance that governs light, power, gas, oil, water, steam or pipe lines of any description.

Rule 80. Employes are forbidden to remove or disturb any covering or guard except for purpose of oiling, inspecting or repairing machinery, and if removed, must be replaced and securely fastened as soon as work has been completed. Any employe violating this rule will be subject to dismissal.

Rule 81. All gears, bolts, shafting and machinery must be properly protected at all times. When necessary to remove safeguards for any purpose, those who do so must see that they are replaced and properly fastened before leaving the job. Foremen will be held personally responsible for this.

Rule 82. Millwrights are responsible that all safety guards are maintained and kept in their proper places.

Rule 83. Employes are forbidden to set in motion any machinery without first assuring themselves by personal investigation that there are no employes in a position to be injured. Employes must not operate valves or close switches controlling electric current without first assuring themselves that there are no employes in a position to be injured. Any employe violating this rule is subject to discharge.

Rule 84. When an employe removes the cover from any opening in the floor, ground, valve pit or sewer, he must take such steps as are necessary to guard that opening so that no one will be endangered thereby.

Rule 85. Employes working around machinery should avoid wearing ragged sleeves, loose coats, flowing ties or loose jumpers, as they may get caught in the machinery. Many fatal accidents have been caused in this way.

Rule 86. Employes are strictly forbidden to ride on any part of a steam crane unless engaged in operating same. Employes are especially warned of the danger of riding on the car body of the steam crane, as this has resulted in many fatal accidents. Riggers are permitted to do so when especially authorized by their foreman. Any others found doing so will be discharged.

Rule 87. Employes other than those whose work requires them to do so are strictly forbidden to ride on cars or engines.

Rule 88. Cars standing on inclined tracks must have their brakes tightly set, and a chuck block must also be placed on the track to keep the cars from running away.

Rule 89. Employes who have occasion to move cars with pinch bars, must be instructed by their foreman in the safe and right way, and provided with the proper tools.

Employes must not block any crossing or roadway when moving cars by means of bars, cranes, or by any other method.

Employes are forbidden to drop cars against standing cars, unless they have previously made investigation to see that this will not endanger some one working in, on, under or behind the standing cars.

Rule 90. Never crawl under a car to get in the shade or out of the rain, or for any other purpose, unless your duties require you to do so, and do not do so then unless

you know the car is properly protected by flags, a flagman or lanterns.

Rule 91. Employes are strictly forbidden to climb over or crawl under cars.

Rule 92. Employes engaged in loading must not allow material to project over the sides of the car, nor must it be so piled that there is a possibility of its falling off in transit. The weight of the load must be properly distributed, and large pieces braced to prevent shifting.

Rule 93. If in doubt as to the meaning of any rule, apply to Safety, Sanitation and Service Board or to your foreman for an explanation.

Rule 94. Vigilance and watchfulness insure safety. Employes must not trust to the care exercised by another where their own safety is involved. When in doubt, take the safe course, always.

Rules and Regulations for the Operation of Electric Cranes

Rule 1. The purpose of these rules is the prevention of accidents. If the enforcement of a rule appears to be impractical or fails to provide proper protection, bring the subject immediately to the attention of some one in authority. The paramount duty of every employe is to avoid and prevent accidents.

Rule 2. Cranes must not be operated except by regularly authorized operators and only men who are sober, trustworthy and careful will be retained as crane operators.

Rule 3. Each man authorized to operate cranes must have been instructed and must be of proven ability, and must, of course, be able to read and write the English language.

Rule 4. Each operator must handle loads as directed by the signal man, but if the signal man's directions are such, in your opinion, as will cause an accident, make sure before carrying out instructions that an accident will not occur.

Rule 5. Recognize signals only from the regular signal man, or his designated substitute. Do not recognize signals from any other person, and do not move a load without receiving the proper signal, and if you are in doubt, stop and make sure as to what should be done.

Rule 6. Do not move your crane if any one is trying to ride on the hook or on the load.

Rule 7. Do not move your crane when repairmen or inspectors are on it, unless they signal you to do so and you are sure they are in safe places.

Rule 8. After repairs have been made, make sure before moving your crane that all safety guards have been replaced and that no tools, bolts or other materials have been left on the crane.

Rule 9. Ring your gong frequently when carrying loads to or beyond a point where men are working, being especially careful before swinging a load to see that no person is in danger.

Rule 10. When hooking onto a load, place the hook directly over it so that it will not swing or drag. Do not make side pulls.

Rule 11. Do not drag sling chains. After the load has been taken off lower the hook so that the sling can be hooked up. Long slings are the cause of many accidents, and foremen should see that the hookers use short slings only and that these are properly hooked up.

Rule 12. When lowering a load be sure no one is under it or in a position to get hurt. Lower slowly and keep the load under control.

Rule 13. Overhoisting will result in either your discharge or suspension. The excuse that your controller stuck will not be accepted. Keep your controllers in good condition and they will not stick. Pull the main switch if anything goes wrong. Do not lower the boom into a load block. It is as dangerous as overhoisting.

Rule 14. The operator should not reverse a motor until it has come to a full stop, except to avoid accidents.

Rule 15. When handling a heavy load, test your brakes by throwing the controller to the "off" position, after having hoisted a few inches. If the brakes do not hold, get rid of the load by checking the lowering speed with the controller, using only the first or second notch. Do not use the controller to hold the load. Send for your foreman and do not make another lift until the trouble is corrected.

Rule 16. Do not bump another crane with your crane. If you must move another crane do not do so until you have made sure that no one is on it and then move it very slowly.

Rule 17. Do not shift cars or drag material with your crane, unless blocks are rigged up so that you can do it with your hoist. Exceptions to this rule will be made if ordered by the Superintendent. In turning crane, see that other cranes are in the clear.

Rule 18. Loose material must not be left on your crane.

Rule 19. Allow no person in your cage, unless he be authorized to visit the same. Any violator of this rule will be discharged.

Rule 20. Remain in your cage for duty until your relief appears or you are excused by your foreman. Do not read or become otherwise distracted while on duty.

Rule 21. Never leave your cage without opening the main switch. When you go out of your cage open also the safety switch and make sure controllers are in the "off" position before closing main switch.

Rule 22. If you cannot come out to work at the regular time, send word to your foreman.

Rule 23. If you are taken sick or get hurt while on duty, send word to your foreman, who will send you relief.

Rule 24. Never remove a safety flag from an open switch unless you have placed it there yourself. Report to your foreman for instructions.

Rule 25. Report to your foreman any repairs which are needed. Help the repair men on all repair work on your crane unless ordered to operate another crane by your foreman.

Rule 26. It is your duty to inspect your crane every turn and keep it in good condition, clean and well oiled. Keep all bolts tight and keep controller fingers and segments and brakes in adjustment. Use enough oil, but do not waste it.

Rule 27. Open the main switch when repairing or adjusting controller.

Rule 28. Put controllers to the "off" position and open the main switch if power goes off.

Rule 29. Do not "plug," as this will burn out the controller or motor or otherwise damage the crane. Start your motors slowly by moving the controller handle a notch at a time. Take up slack hoist rope or chains slowly.

Rule 30. Do not use switches for cigar lighters.

Rule 31. Inflammable material of every description, such as rags, waste, oil, papers and clothes, must be kept out of cages.

Rule 32. Fire extinguishers are to be kept in each crane cage. Report when they have been used so that they will be refilled.

Rule 33. Do not throw anything at men on the floor. Report any one who throws anything at you.

Rule 34. When going onto or off your crane, use the ladder or stairway which has been provided.

Rule 35. Articles too large to go into your pockets should be lifted to or lowered from your crane by a hand line.

Safety Steps. Special non-slipping arrangements for the steps of ladders or stairs. When in the form of a surface attachment to existing steps, they are called safety treads. The most modern practice, however, incorporates the non-slipping feature in the step itself.

One form of safety step consists of grating, set on edge and solidly riveted together so that it is ready to be attached to the frame of the ladder or stair.

Page 977.

Safety Treads. See Treads, Safety.

Safety Valve Box. The protective casing sometimes used to cover the safety valve and to prevent its being injured.

Safety Valves. See Valves, Safety.

Sag, Sagging. The drooping or tendency to droop of the midship portion of a vessel relative to the ends.

Sagged. Permanently deformed by the action of sagging forces.

Sail. An article made of canvas and rope designed to be spread on spars in such a manner as to utilize the power of the wind in driving a vessel.

Sails are of two general classes: square and fore-and-aft.

Square sails are suspended from yards. Fore-and-aft sails are spread on booms and gaffs or bent to stays.

Page 1102.

Plates XXIV, XXVI.

Sail Needle. A strong needle with a large eye used by sailmakers.

Sail Plan. A plan drawn to show the number, arrangement and dimensions of the sails for a sailing vessel.

Plate XXVI.

Sailing Vessel. See Vessel, Sailing.

Sailmakers. Workmen who work the canvas, rope and fittings up into sails, awnings, tarpaulins, weather cloths, covers, etc.

Sampson Post, King Post. A strong vertical post used to support a derrick boom.

Pages 320, 342.

Sand Jack. See Jack, Sand.

Sand Sucker. A scow, or hull of other form, on which is installed a large, power operated pumping outfit of the centrifugal type, arranged to take water from the bottom of the channel or river bed by means of a long pipe or tube and to discharge either through a pipe line, generally carried on floats, to any convenient point in the vicinity or into holds provided in the vessel's own hull.

Up to 10 or 15% of the volume of liquid thus handled may be solid matter, sand, gravel, etc. An immense amount of material is thus handled.

Sometimes a rotary knife is fitted at the lower end of the intake pipe in order to accelerate the breaking down of the earth formations requiring removal.

Page 1045, 1104, 1105.

Sander. A machine designed to automatically sandpaper and finish the surface of woodwork.

These machines are built in a number of different designs but the general features of all consist in a power operated drum or a disc covered with sandpaper. Often for securing true plane surfaces a drum projects through a slot in the work table, the upper edge being about tangent to the top of the table.

Sanitary Fixtures. Plumbing installations such as toilets, bath tubs, showers, lavatories, toilet cases, waste jars, supply pitchers, carafe, water heaters, etc.

Pages 1054, 1055.

Sanitary Pump. See Pump, Sanitary.

Sanitary System. A system of piping supplying and draining the plumbing fixtures aboard a ship such as lavatories, showers, toilets, sinks, etc.

Page 610, 611.

Plate XLIV.

Sanitary Tank. See Tank, Sanitary.

Sash, Window. A frame for holding the glass. It is generally composed of a horizontal piece at the top, called the top rail, a horizontal piece at the bottom, called the bottom rail or, where beveled in an upper sash, a check rail, the sides called stiles, and pieces dividing the sash into separate lights called mullions or bars.

Saturated Steam. See Steam, Saturated.

Saw, Band. A machine designed for carrying an endless saw. It usually consists of a frame carrying two wheels upon which the band saw, or steel ribbon with teeth cut in one edge, is mounted. A small tension is put on the saw to hold it in place and make it function properly.

The saw passes through a slot in the table of the machine and is operated at high velocity by power applied to the shaft carrying the lower wheel.

Saw, Band, Setting and Filing Machine. A machine designed to sharpen the teeth of a band saw by filing and to give them the proper set, the operations usually being performed automatically.

Saw, Circular. A machine designed for sawing timber to dimensions. Usually consists of a circular saw mounted in a fixed table. The table is generally of steel and is slotted or grooved to take fences or metal upright pieces which are used to gage the work.

Saw, Cold. A cutting off machine which utilizes a revolving saw for severing the material.

Saw, Cross-Cut. A hand or power operated saw designed for cutting timber across the grain. The teeth of a cross-cut saw are designed to cut through the fibres on each side before they are removed from the body of the wood.

Saw Filers. Men who sharpen saws, of either the band or circular type, in a carpenter or joiner shop. They may also sharpen the hand saws of the carpenters or joiners.

Saw, Hand Hack. A close-toothed saw blade held in a light metal frame and used for cutting metal.

Saw, Jig. A machine designed for sawing fine wood work such as scroll, curved work, etc.

In these machines a very narrow steel saw blade is passed through the work table and is given a rapid up and down motion by being gripped in a crosshead at the lower end, the crosshead being attached by means of a connecting rod to a crank through which the power is furnished for operating the machine.

The upper end of the saw blade is gripped in a block which travels on a guide and to which a spring device is attached for maintaining the necessary tension in the saw blade.

Saw, Power Hack. A machine for driving a hack saw with power. The mechanism provides means for reciprocating the hack saw by power, for the cutting off of metal bar stock, pipe, etc. The type in general

use has a crank and connecting rod for operating the hack saw frame. Means are provided for holding the saw in contact with the work on the cutting stroke, and lifting it from the work, so as to prevent it from dragging in the cut, on the return stroke.

Saw, Rip. A hand or power operated saw designed for cutting timber parallel to the grains. The teeth of a rip saw are designed to cut through the fibres at their ends before they are removed from the body of the wood.

Saw, Scroll. A machine designed for sawing scroll or curved wood work. See SAW, JIG.

Saw, Swing. A machine for cutting timber usually consisting of a circular saw carried at the end of a frame, the frame being pivoted overhead. The power for operating the saw is furnished by a belt over pulleys. A bench or work table is located below the saw and work may be cut by swinging the saw past it.

Sawyers. Men who operate the power driven band, cross cut or circular saws in the wood working departments, or who operate the power driven circular saws that cut steel plates and shapes.

Scale. A more or less hard adherent crust which forms on boiler heating surfaces by the depositing of impurities from the feed water. The salts of lime and magnesia are usually responsible for such incrustation.

Scaling Hammer. A hammer used by cleaners to remove the rust scales from iron or steel plates and shapes.

Scantlings. A term applied to the dimensions of the frames, girders, plating, etc., that go into a ship's structure. The various classification societies publish rules from which these dimensions may be obtained and as these rules are the results of continued observation of ships' structures they give the most reliable information from a practical standpoint that can be obtained. The forces acting on a ship at sea cannot be accurately determined, hence calculations made to determine the size of a member of a ship's structure should be compared with similar calculations on existing practice where possible.

Page 229.

Scarph. A connection made between two pieces by tapering their ends so that they will mortise together in a joint of the same breadth and depth as the pieces connected. It is used on keels, stem and stern frames, etc. Also used to designate the tapering of the corner of a plate where a joint occurs.

Scavenging, Gas Engine. See GAS ENGINE SCAVENGING.

'Scending. The oscillations of a ship in the fore and aft direction. Synonymous with the term "pitching."

Schooner. A sailing vessel with two or more masts rigged fore and aft.

Pages 445, 446, 447.

Plates XXIV, XXV, XXVI.

Scotch Boiler. See BOILER, SCOTCH.

Scotchman. A piece of wood, hide or metal fitting seized to a shroud or other rigging to prevent chafing by the running gear, etc.

Scout. A war vessel of small size, displacing from three to five thousand tons, carrying a battery of from five to eight guns of moderate size and several torpedo tubes, having a large cruising radius and a maximum speed in excess of twenty-five knots. Such vessels may or may not carry light side armor, but they are designed for keeping the sea under all conditions of weather.

Scratch Awl or Scriber. A small rod of cast steel with hardened sharp points used for marking lines on the surface of metal.

Screen Bulkhead. See BULKHEAD, SCREEN.

Screen, Clear View. A mechanical means of keeping lookout windows clear and transparent and prevent them from becoming fogged in heavy weather.

Page 1084.

Screw. A cylinder surrounded by a spiral ridge or groove, every part of which forms an equal angle with the axis of the cylinder, so that if developed on a plane surface it would be an inclined plane. It is considered as one of the mechanical powers. When used alone the term commonly means a wood screw, having a slotted head and gimlet point, for driving in with a screwdriver. Machine screws are similar, except that they have no gimlet point and have a metal screw thread. They are used for uniting metallic parts. All ordinary forms of bolts have screw threads cut on them, but are not commonly called screws. A special form of wood screw is a lag screw, which is a large size screw with a head like a bolt, so that it may be inserted with a wrench instead of a screwdriver.

Pages 727, 778.

Screw, Cap. A metal screw with a machine thread having a bolt head or a head with a socket recess.

Page 727.

Screw Cutting Engine Lathe. See LATHE, SCREW CUTTING ENGINE.

Screw Jack. See JACK, SCREW.

Screw Machine. A turret lathe designed for turning Small screws, pins, etc., from steel rods or bar stock, commonly known as a screw machine or a turret screw machine. The term wire-fed is used to indicate a design for automatically feeding the stock through the spindle. A machine not having this stock feeding mechanism is designated as a plain screw machine.

Pages 700, 701, 702, 703, 716.

Screw Machine, Automatic. A machine which controls all the movements of the cutting tool and is equipped with work-feeding mechanisms so that, when one part is finished, other duplicate parts may be produced automatically. A machine designed to perform certain operations, but not equipped with duplicating mechanisms may be classed as semi-automatic.

Pages 700, 701, 702, 703, 716.

Screw, Packing. A tool designed for the removal of worn packing.

Screw Propeller. See PROPELLER.

Screw-Post. See PROPELLER-POST.

Screw-Race. See APERTURE.

Screw, Shaft. See PROPELLER SHAFT.

Screws, Rigging. Implements possessing the mechanical advantage of the screw used at the lower ends of shrouds and stays in lieu of dead eyes and lanyards.

Pages 334, 347.

Scrive Board. A portable platform made of soft, clear, planed lumber on which a full sized body plan of a ship is drawn, the lines being cut into the surface of the wood in small "U" shaped grooves by means of a scriving knife, to prevent them from being obliterated. The scrive board is set up in some convenient spot and used as a ready reference for the shapes of frames, floors, etc., or to take dimensions from.

Scroll Saw. See SAW, SCROLL.

Sculling. The propelling of a boat by means of a single oar over the stern.

Scupper Holes. Drain holes cut through the gunwale or deck stringer angle bar and adjoining shell plate to allow water to drain directly from the gutter or waterway overboard. Where from strength considerations the holes cannot be cut in angle bar and plating, the usual scupper pipe is fitted, leading down through decks and the ship's side.

Scupper pipes. The pipes leading from the scupper to the fitting in the ship's side, for carrying accumulations of water from the deck overboard.

Scuppers. Drains from decks to carry off accumulations of rain water or sea water. The scuppers are placed in the gutters or waterways on open decks and in corners of enclosed decks, and connect to pipes leading overboard.

The flap valve at the bottom of the scupper pipe is also often called a scupper.

Page 609.

The American Bureau of Shipping requires that scuppers of sufficient number and size are to be fitted in all watertight decks; they are to be so placed as to provide thoroughly effective drainage; those in freeboard decks and decks above are to lead overboard, except under fully enclosed superstructures, where they may be led to the bilges. Scuppers from partially enclosed superstructures are to be fitted with storm valves. Scuppers and sanitary discharges from fully enclosed superstructures, or from decks below the Freeboard Deck, which are led overboard, are to be fitted with efficient, accessible means for preventing water from passing inboard, in addition to a non-return valve at the ship's side.

Scuttle. A small opening, usually circular in shape, and generally fitted in decks to provide access as a manhole or for stowing fuel, water and small stores. A cover or lid is fitted so that the scuttle may be closed when not in use.

Also applied to the operation of opening a sea valve or otherwise allowing the sea to enter a ship for the purpose of sinking her.

Scuttle Butt. The designation for a container of the daily supply of drinking water for the use of the crew. The scuttle butt formerly consisted of a simple wood cask standing on end, having a hole in its upper head or bilge. The more modern one is constructed of metal, well insulated and fitted with a sanitary drinking fountain. On large vessels provided with a refrigerating plant the scuttle butt is usually fitted with cooling coils connected to the refrigerating system.

Sea Anchor. See Anchor, Sea.

Sea Chest. A term applied to a casting fitted to the shell of a vessel for the purpose of supplying water from the sea to the condenser and pumps, and also for discharging water from the ship to the sea. Chests on suction lines should be fitted with strainers or gratings and when these gratings cannot be removed while the ship is in the water, a steam pipe should be led to the chest for the purpose of blowing out refuse.

It is desirable to have as few sea chests as possible, and with the exception of the main injection and discharge to the condenser, two or more leads may operate from one chest.

Page 626.

Sea Cock, Sea Connection. A sea valve secured to the bottom of the vessel for use in flooding the ballast tanks, supplying water to the fire pumps and sanitary pumps and other purposes. While these sea valves are sometimes called sea cocks, the ordinary type of valve is always used.

Sea Injection Pipe. See Pipe, Sea Injection.

Sea Painter. A long line led from a point well forward on a vessel outboard of the rail and awning stanchions to a lifeboat and bent to the inboard side of the forward thwart in such a manner that it may be quickly cast off. Hauling on the painter or when a strain is otherwise brought on it sheers the bow of the lifeboat away from the vessel.

Sea Room. The distance separating a vessel from the nearest point at which she could take the ground or meet other obstruction to navigation.

Sea Valve. See Valve, Sea.

Seam. A term applied to an edge joint whether flush or lapped. Also applied to the slight crevice between the ends or edges of butt joints.

Seam Straps. A term applied to a narrow strip of plate serving as a connecting strap between the butted edges of plating. The strap connections at the ends are called butt straps.

Searchlight. A powerful electric lamp placed at the focus of a mirror, which projects the light in a beam of parallel rays. The apparatus consists essentially of a base and turntable fitted with arms carrying trunnion bearings, in which is mounted the barrel or drum containing the mirror and lamp with its operating mechanism. The drum may be elevated and depressed and turned in azimuth by means of handles at the back, or by either mechanical or electrical distant control gear.

Of the various types of searchlights now in use, the principal differences consists in the type of lamp used and in the lamp control mechanism.

The open carbon arc, or some modification of it, is used in all high-power searchlights, although the incandescent lamp may be used to advantage in smaller ones for signalling purposes.

Pages 946, 947, 1094.

Searchlight, High Intensity. A searchlight of great brilliance distinguished from the ordinary type in being provided with carbons and lamp mechanism of special design, the positive carbon being cored, said core material being comprised of metallic salts which volatilize, becoming highly luminous when subjected to the temperature of an electric arc. The incandescent gas produced is held within the arc crater by the impinging of a flame from the negative carbon. The intrinsic brilliancy of a high intensity arc is equal to that of the sun at its zenith on a clear day.

Page 1094.

Seating, Boiler. See Boiler Foundation.

Secret Blocks. See Blocks, Secret.

Section. A drawing showing the internal arrangement of a ship as it would appear if cut by a plane, usually longitudinally or transversely.

Section, Midship. See Midship Section.

Sectional Area, Curve of. A curve, plotted from a straight base line, representing the length of the ship, the ordinates of which represent to scale the areas of the vessel's immersed cross sections at corresponding points. The area under this curve represents to scale the volume of the displacement. The center of gravity of this area represents the longitudinal center of buoyancy of the displacement.

Pages 169, 170, 177, 178, 187, 188, 224.

Seize. To secure one rope to another, two or more parts of the same rope together, or a fitting of any kind to a rope or other object by binding with any small stuff.

Seizing. A binding made of seizing stuff securing two ropes or two parts of the same rope together. Seizings are named according to their location and use, as throat or eye seizings, round seizing, flat seizing, etc. Several different ways of passing the seizings and making the finish are in general use for each of the above kinds. Seizings are also used to secure scotchmen to rigging, cleats, davits, etc.

Seizing Stuff. A tarred hemp, right-handed, three-stranded small stuff of two, three or four threads to the strand. It is heavier and stronger than houseline or roundline, being made by machinery and finished similar to the larger sized ropes. Seizing stuff is also made in galvanized annealed steel wire, six wires around a wire center, varying from 1/16 inch to ¼ inch diameter.

Self Opening Die Heads. A die head used on automatic screw machines and twists.

Page 698.

Semi-Diesel Engine. A term sometimes applied to a Hot Bulb Engine.

Sennit. A braided cordage made from rope yarns, spun yarns, and untarred marline plaited by hand in a number of patterns. *Common* or *flat sennit* is a plain plaiting of five or seven strands; *French sennit* is more open than the flat sennit, but similarly made of a greater number of strands; *round sennit* and *square sennit* take their names from their form, both consisting of an even number of strands. The former is plaited around a center or heart, while the latter is without a heart.

Sensitive Drill. See Drill, Sensitive.

Sentinel Valve. See Valve, Alarm.

Separator. A device for removing water from steam.

There are many varieties. That based on the centrifugal action developed by whirling or repeatedly changing the direction of steam is typical of such devices when fitted outside the boiler.

In certain types of water tube boilers, perforated plates are fitted in the upper drum. The steam on its way to the steam pipe is subjected to a straining action by these plates.

Separator, Steam. A mechanism designed to extract the moisture and impurities from saturated steam. It is fitted on the steam line between the boiler and the engine.

Plate XII.

Series Motor. See Motor, Series.

Serve (to serve a rope). To wrap any small stuff tightly around a rope which has been previously wormed and parcelled. Very small ropes are not wormed.

Service. The covering of small stuff applied to a rope as a protection against the weather.

Serving Stuff. The various materials used in serving ropes, such as spun yarn, rope yarn, marline, house line, and round line. Where great neatness is not essential spun yarn is generally used, while marline, house line, and round line are used for neater work, they being laid up more smoothly and of a superior quality material.

Set. Metal mold or template for use on the bending slab.

Set. Sometimes designated as "permanent set." The permanent deformation resulting from the stressing of an elastic material beyond its elastic limit.

Set Iron. A flat bar of soft iron used in transferring the shape of the frame from the scrieve board to the bending slab.

Set Screws. A machine screw with either a slotted or square head used for the purpose of holding a part in place.

Page 727.

Set Up. To tighten the nut on a bolt or stud; to bring the shrouds of a mast to a uniform or proper tension by adjusting the rigging screws or lanyards through the dead eyes.

Settling Tanks. Oil tanks used for separating entrained water from the oil. The oil is allowed to stand for a time or until the water has settled at the bottom, when the latter is drained or pumped off.

Pages 666, 667.
Plates XIV, XLVII, XLVIII.

Sewing Machine. A machine designed to provide a mechanical means of sewing with a needle and thread. Used in a shipyard in canvas work, upholstery, etc.

Sextant. A hand navigating instrument for measuring, by reflection, the angle subtended at the eye by two distant objects by a single observation. It is the most convenient and accurate instrument yet devised for use where the observer has a very unstable support, as on board ship, and is very generally used by navigators and surveyors for determining the attitude of celestial bodies and the angular distance between them as well as the horizontal angular distance between terrestrial objects. It consists of a rigid frame having a handle, a horizon glass, silvered on its lower half, but clear on its upper half, and a telescope pointing into this mirror, all rigidly attached to the frame. Another mirror, known as the "index glass," is rigidly attached to a movable arm, which carries vernier reading on a graduated limb. A ray of light coming from a distant object strikes the index glass and is reflected to the mirrored part of the horizon glass and thence through the telescope, while a ray coming through the upper half of the horizon glass passes directly into the telescope, each of which set of rays forms a perfect image. The observation consists in bringing the two images into exact coincidence by means of the movable arm when the angle subtended by the two objects is then read off the limb.

The name is derived from the fact that the limb of the instrument includes but an arc of 60 degrees of a circle, but owing to double reflection, angles up to 120 degrees may be measured with it. The scale is graduated to 120 degrees in a length of 60 degrees. A different form of instrument, known as the prismatic sextant, measures angles up to 180 degrees.

Shackle. A U-shaped link whose end is closed by a removable pin or bolt. Shackles are used principally to connect the shots of chain cables, blocks to davit heads and other places where severe stress is brought on the block, rigging to mast bands and deck connections, etc.

Pages 334, 335, 348, 350, 870, 878.

Shackle Bolt. A bolt that passes through both eyes of a shackle and completes the link. The bolt may be secured by a pin through each end, or a pin through one end and through the eye, or by having one end and one eye threaded, or one end headed and a pin through the other.

Shackle Bolt Pin. A metal, or rarely, a wood pin, used

to secure a shackle bolt. The pin generally has a split end, the two parts being slightly separated to prevent its starting, and is frequently termed a split pin.

Shade Deck. See DECK, SHADE.

Shade Deck Stringer. See STRINGER, SHADE DECK.

Shade Deck Stringer Bar. See STRINGER BAR.

Shade-Deck Vessel. A vessel constructed with a continuous upper deck of light scantlings and fitted with openings in the sides between the main and upper decks.

Shaft Angle. The angle which a propeller shaft makes with the line of intersection between the designed water plane and the longitudinal center plane of the ship. In many cases the horizontal shaft angle is ignored and only the angle which the shaft makes with the designed water plane is considered. This may be slightly less than the true shaft angle.

Shaft, Crank. See CRANK SHAFT.

Shaft Horsepower. See HORSEPOWER, SHAFT.

Shaft, Propeller or Tail. See PROPELLER SHAFT.

Shaft Stools. A term applied to the seatings to which the plumber-blocks or line shaft bearings are attached. In addition to supporting the weight of the shafting they have to resist any side bending tendency due to the vibrations or thrust on the shaft. The overturning force is not nearly so serious as in the thrust block.

Page 548.

Shaft Straightener. See PRESS, BENDING.

Shaft Strut. A term applied to a bracket supporting the after end of the propeller shaft and the propeller in twin or multiple screwed vessels having propeller shafts fitted off from the center line. It usually consists of a boss, fitted with a bushing to form a bearing for the shaft, connected to the side of the ship by two arms of pear-shaped section. The inboard ends of the arms are fitted with palms for attachment to the shell.

In designing the arms of a shaft strut, care should be taken that their major axes are kept in the stream lines and that they are of sufficient cross section for strength. Shaft struts should be erected at a frame and the shell should be reinforced with thicker or doubling plates in the way of the palms.

Page 231.

Shaft, Thrust. See THRUST SHAFT.

Shaft Tunnel. See TUNNEL, SHAFT.

Shaft Tunnel, Shaft Alley. A watertight passage housing the propeller shafting from the engine room to the bulkhead at which the stern tube commences. It provides access to the shafting and its bearings and also prevents any damage to the same from the cargo in the spaces through which it passes.

Page 507.

Shaft, Weigh. A shaft running parallel to the crankshaft, used for the purpose of controlling the valve gears on a reciprocating engine. It is carried in bearings attached to the upper portion of the columns of the engine, and is fitted with one arm for the bridle rods to each link and one arm for connection to the reversing gear. The arms connected to the link bridle rods are slotted with a block working on a hand screw gear which permits independent adjustment of each link.

Shafting. Cylindrical rod or tubing used, in general, for the transmission of rotary motion from the source of power, the engine, to the propelling device, the propeller, or paddle wheel.

High grade machinery shafting and other cylindrical members are manufactured hollow. This is done in order to obtain the requisite strength on a minimum weight and to avoid the possibility of development of serious cracks or other imperfections which are likely to start in the central part of the shaft.

Pages 548, 549, 892, 896, 898.

Shakes. Splits or checks in timbers which usually cause a separation of the wood between annular rings.

Ring Shake. An opening between the annular rings.

Through Shake. A shake which extends between two faces of a timber.

Shallow Draft River Steamer. See RIVER STEAMER, SHALLOW DRAFT.

Shank Painter. A rope or chain passed around the shank and flukes of an anchor confining it to the billboard.

Shaper. A machine for planing small parts in which the work table is stationary, the cutting tool being held by a tool post on a moving ram which travels over the work.

Pages 720, 734.

Shaper, Crank. In this type of shaper a crank motion is used to drive the ram.

Shaper, Double Head. A type of shaper designed with two rams or heads. These machines also have two tables and may be used for planing large pieces of work and for work involving planing two surfaces some distance apart.

Shaper, Geared. In this type of shaper a rack and pinion are used to drive the ram with a slow cutting stroke, a quick return being effected by shifting an open and crossed belt arrangement.

Shapes. Bars of rolled mild steel or of extruded nonferrous metals, having certain forms of cross section throughout their entire length. The forms of cross section given are such as to lend to strength and rigidity in fabrication.

Shear. See SHEARING MACHINE.

Shear, Alligator. A type of shearing machine operated on the principle of a pair of scissors.

The upper part is a heavy cast steel lever supported by a pivot near its center on a stationary base. Shear blades are attached to the base and one end of the lever to form the cutting jaws and the lever is operated by a link connecting the other end to a crank in the driving mechanism. These machines are usually used for shearing flat bars, universal rolled plates, etc.

Page 745.

Shear, Angle. A machine specially designed for cutting off angle bars.

Page 744.

Shear, Gate. A machine for cutting and trimming long sheets or plates. These machines are often designed for making cuts of from two to ten feet in length in one operation, the thickness of plate varying from 1-16″ to 1⅞″, depending upon the capacity of the machine.

Pages 741, 745.

Shear Legs. An apparatus rigged up for raising and moving heavy weights where a crane or derrick is not available. Usually consists of two or more spars or timbers erected in the form of an A-frame with the lower ends spread out and the upper ends fastened together, from which the lifting tackles are suspended.

Shear, Rotary. A type of shearing machine in which a plate is cut or sheared by revolving steel discs.

Page 746.

Shearing. The removing of excess material from the edges of plates or shapes by means of shears.

Shearing Machine. A machine used for splitting or trimming steel plates and for cutting off bars or structural shapes.

Shearing machines are made both in hand and power operated types, and in many cases these machines are also adapted for punching operations by replacing the shear blades with one or more punches and dies.

There are also combination designs having a punch at one end and a shear at the other.

Pages 736, 740, 741, 743, 744, 745, 746.

Sheathed, Sheathing. A term applied to the wood planking fitted over a steel deck, to the planking fitted over the underwater portion of a steel shell, and to the copper plating with which the bottom of a wood vessel or a steel vessel sheathed with wood is covered.

To sheath a steel vessel with copper it is necessary, on account of galvanic action, to first cover the steel plating with wood.

Copper sheathing will keep the vessel's bottom clean as long as it lasts, as no germs or life can remain attached to it. It is, however, very difficult to keep the water from seeping in between the copper and plating in steel vessels, and outside of warships it is seldom resorted to. Copper sheathing of wood vessels is more common, and is particularly necessary in tropical waters. Wood sheathing over steel decks should be thick enough to be efficiently calked and the deck plating beneath should not be calked.

Sheave. A wood or metal disc having a groove around its cylindrical surface to allow a rope or chain to run over it without slipping off.

Wood sheaves are usually made of lignum vitæ and bushed with metal rollers.

A dead sheave is one that does not revolve.

Pages 340, 871.

Sheave Holes. A term applied to apertures cut through a mast, boom, or spar in which sheaves are installed.

Sheepshank. A method of quickly but temporarily shortening a rope. It is made by laying two long bights side by side and half hitching each part over the end of the near bight.

Sheer. The longitudinal curve of a vessel's rails, deck, etc., the usual reference being to the ship's side; however, in the case of a deck having a camber, its centerline may also have a sheer.

The amount by which the height of the weather deck at the after or forward perpendicular exceeds that at the mid perpendicular.

Mean sheer is the average of the sheers forward and aft as just defined.

Sheer. The deformation of a solid body equivalent to a sliding of each of the parallel infinitely thin laminae that may be considered to form it upon that next below it, in the same direction and by the same infinitesimal amount.

Sheer Line. The longitudinal curve of the rail or decks, which shows the variation in height above water or freeboard, throughout the vessel's entire length.

Sheer Mold. A molding placed flush with the top and along the outside edge of a wood deck.

Sheer Off. To steer clear of or keep away from some danger or object.

Sheer Pole, Sheer Batten. A term applied to a steel or iron rod fitted, fore and aft, along the lower portion of the shrouds to hold them in place.

Sheerstrake. The strake of shell plating that runs along the level of the main or upper decks. Plates running along the level of lower decks are not called sheerstrakes.

Sheerstrakes, on account of their distance from the neutral axis of the ship, are important strength members, and when adjacent to a strength deck they are made thicker than the side plating.

The sheerstrake in wood ships is the strake of outside or shell planking that runs along the sides of the main or upper decks.

Sheerstrake Plate. See PLATE, SHEERSTRAKE.

Sheet. A rope or chain used to haul the clew of a sail out toward the yard arm or downward toward the deck and aft.

Sheets take their names from the sails they extend, as "fore sheet," "main-staysail sheet," "mizzen-topgallant staysail sheet," etc.

Sheet Metal Workers. Workmen who fashion and fabricate such articles as lockers, drip pans, ventilation ducts, etc. These are usually made from light sheet metal; that is, metal the thickness of which is given in gages rather than in pounds per square foot.

Shelf. A wood ship term applied to the fore and aft timber that is fastened to the frames to form a support for the ends of the deck beams.

Pages 445, 447.

Shelf, Hold Beam, Main, Upper Deck, Etc. A fore and aft timber running under and supporting the ends of the various tiers of beams

Shell Doublings. A term applied to extra plates fitted over the portions of the shell plating requiring additional strength. Also fitted as compensating plates in the way of ports or apertures

Shell Landings. A term applied to that portion of the edges of shell plating occupied by the laps.

Shell Liners. See FRAME LINERS.

Shell Lugs. Short pieces of angle bar fitted to the shell plating between frames for the purpose of attaching stringer plates to the shell plating.

Shell Plating. See PLATING, SHELL.

Shell-Room. Spaces or compartments devoted to the stowing of projectiles.

Shellac. See PAINT.

Shelter Deck. See DECK, SHELTER.

Shelter Deck Sheerstrake. The strake of outside plating adjacent to the shelter deck.

Shelter Deck Stringer. See STRINGER, SHELTER DECK.

Shelter Deck Stringer Bar. See BAR, STRINGER.

Shifting Beam. A term applied to a portable beam fitted in a hatchway for the purpose of supporting the hatch covers. The ends of the beams are fitted in slotted carriers attached to the inside of the hatchway coamings.

Shifting Boards. A portable bulkhead generally constructed of wood planking and fitted fore and aft in cargo holds when carrying grain or any cargo that might shift when the vessel is rolling.

Shifting Valve. See VALVE, SHIFTING.

Shim. A piece of metal or wood placed under the bedplate or base of a machine or fitting for the purpose of truing it up. Also applied to pieces placed in slack spaces behind or under frames, plates or planks to preserve a fair surface.

Page 920.

Ship. A vessel having three or more masts. In a three-masted ship the masts are fore, main and mizzen, and all are square rigged. In a four-masted ship the

aftermost mast is called the jigger. It may be either square of fore-and-aft rigged.

Ship Chandler. An individual or firm handling provisions, outfit, or other commodities for a ship's use.

Ship, Longitudinal Framed. A ship constructed of widely spaced, deep or belt frames which support a relatively large number of small fore and aft frames. This system, although patented, is generally used in oil tankers and is frequently found in other types of ships.

Ship Plate Bender. See FLANGING MACHINE, HYDRAULIC.

Ship, Transverse Framed. A ship consisting of a large number of relatively small, closely spaced, athwartship frames, reinforced in the bottom by vertical floor plates and working in conjunction with widely spaced, fore and aft, deep girders, such as the keel, longitudinals, and side stringers.

This is the usual type of vessel.

Shipfitter. A mechanic who lays out the shape, location of rivet holes, or openings, and bevels upon hull plates and shapes by means of templates or dimensions from the ship or from data obtained from plans or mold loft, in order that such plates and shapes may be satisfactorily fitted into their proper places in the ship's structure.

Shipfitter, Contracting. See CONTRACTING SHIPFITTER.

Shipshape. A nautical term used to signify that a whole vessel or the portion under discussion is neat in appearance and in good order.

Shipwright. A nearly obsolete term applied in wood shipbuilding where but a small amount of mold loft work was necessary to the men who set the frames, kept the form fair, and performed such work as would not lie within the province of a carpenter.

Shoes. See KEEL, FALSE.

Sholes. Small pieces of timber or plank placed under the heels of shores, etc.

Shore, Spur. A brace placed with one end resting on the side of a ship to keep it at a desired distance from the side of dock or dry dock.

Shores. Pieces of timber placed in a vertical or inclined position to support some part of a ship, or the ship itself, during construction.

Shores, Bilge. Short heavy timbers used in addition to the bilge blocks as supports for a vessel at or near turn of the bilge.

Short Splice. A splice made where the rope is not required to render through a block and where an increased diameter is not objectionable as in straps, slings, pendants, etc.

Less length of rope is required than when a long splice is made, which is sometimes the paramount consideration. The strands are first unlaid for a short distance, the ends of the ropes brought together, the strands interlaced and tucked through the lay of the other rope.

Shoveling Boards. Boards placed in the bottom of coal bunkers forming a level surface.

Shroud. A principal member of the standing rigging, consisting of hemp or wire ropes which extend from or near a mast head to a vessel's side or to the rim of a top to afford lateral support for the mast. Formerly, shrouds were made of shroud-laid tarred hemp rope having eyes seized in at the upper end and passed over the mast head, the lower ends being fitted either with a dead eye connected by lanyards to a dead eye attached to the chain plates or with rigging thimbles for receiving the upper ends of the rigging screws. Wire rope shrouds as now fitted have thimbles spliced in and seized at both ends, the upper ends for taking shackles connecting to the mast head; the lower, for attaching to rigging screws fitted with a turnbuckle. When of hemp, shrouds are wormed, parceled, and served at the ends around the eyes only, but when of wire they are red leaded, wormed, parceled, again red leaded and served the entire length. Shrouds take their names from the masts they support, as "fore shrouds," "main shrouds," "mizzen topmast shrouds," etc.

Pages 332, 333, 338, 343, 597, 598.

Shroud-laid Rope. See ROPE, SHROUD-LAID.

Shroud Ring, Turbine. See TURBINE SHROUD RING.

Shunt Motor. See MOTOR, SHUNT.

Sick Bay. A name applied to the space on board ship where the members of the crew or passengers are given medical treatment. As generally used, the term covers all rooms or compartments assigned for treatment of the sick, such as the dispensary, operating room, contagious ward, etc.

Side Bar Keel. See KEEL, SIDE BAR.

Side Bunker. A bunker located in a vessel's wings usually in way of the boiler rooms. Bunkers of this type are common on coal burning vessels largely because of the facilities thus afforded for feeding coal into the fire rooms.

Side Frame. See FRAME, SIDE.

Side Girders. See STRINGER, SIDE.

Side Keelson. See KEELSON, SIDE.

Side Lights. See LIGHTS, SIDE.

Side Plating. A term applied to the plating above the bilge in the main body of a vessel. Also to the sides of deck houses, erections, etc.

Side Scuttle. A term applied to an opening in the side of a ship provided for the discharge of garbage, etc.

Side Stringer. See STRINGER, SIDE.

Siding of a Frame. The fore and aft dimension of a frame.

Siding of a Keel. Its width.

Siding of a Stem. Its athwartship dimension.

Siding of a Sternpost. Its athwartship dimension.

Sienna. See PAINT.

Signal Equipment, Electric. See CODE CALLING SYSTEM.

Sill. The foundation timber of a deck house, on which the framing is erected. Also called Coaming.

Sill, Dry Dock. The stone, concrete or timber ledge at the bottom of the entrance of a graving dock against which the gates or caisson abuts when closed.

Sill, Window Frame. The horizontal piece at the bottom.

Silver. Described under Metals.

Single Acting Pump. See PUMP, SINGLE ACTING.

Single Riveting. See RIVETING, SINGLE.

Single Whip. A rope rove through a single fixed block.

Siren, Steam. A form of whistle in which the sound is produced by the action of steam in passing through corresponding openings in two concentric and oppositely revolving discs or cylinders. The pitch and intensity are raised and increased respectively with the speed of rotation. The steam is permitted to escape through a funnel shaped opening or trumpet so as to increase the volume of sound as much as possible.

Sister Blocks. See BLOCKS, SISTER.

Sister Hooks. Hooks made in halves and set on eyes

facing each other in such a manner that they may be made to function as a link.

Page 347.

Sister Keelson. See KEELSON, SIDE.

Skeg. The after end of the keel. It forms a support for the sternpost and sometimes projects sufficiently to form a step for the rudder post.

Skeleton Mold. See MOLD, SKELETON.

Skeleton of a Vessel. The transverse and longitudinal members comprising the framework of the shell and decks.

Skew Inclination. The inclination resulting from the simultaneous action of both transverse and longitudinal forces.

Skiff. A lightly built pulling boat.

The term is sometimes loosely used as applying to pulling boats in general.

Skin. This term is usually applied to the outside planking or plating forming the watertight envelope over the framework. It is also applied to the inner bottom plating where it is called the inner skin.

Skin, Inner. A term applied to the inner bottom plating. This usually extends only across the bottom, but sometimes is carried up the sides.

Page 484.

Plates XXXV, XXXVI.

Skin, Outer. A term applied to the outside plating, shell or planking of a ship.

Pages 478, 479.

Plates XXXIII, XXXIV.

Skin Resistance. See RESISTANCE, SKIN.

Skylight. A built up frame of metal or wood having glass lights fitted in the top and installed over a deck opening for the purpose of furnishing light and, where the top covers are hinged, ventilation to the spaces below.

Skylight Coaming. The vertical sides of a skylight frame whether of steel or wood.

Skylight Cover. The top of a skylight, having glass lights fitted in it and often hinged and operated from below. Brass rods are generally fitted over the glass for protection.

Skylight Gratings. A term applied to the gratings protecting the glass lights in a skylight cover. They are usually constructed of brass rods.

Skylight Lifting Gear. A gear composed of rods, pinions, worms or gears, levers and hand wheel for opening and shutting a skylight cover from below. This gear should be designed to operate easily and to support the cover firmly when open.

Pages 564 to 567, 815.

Slab, Bending. See BENDING SLAB.

Slabs or Blocks, Bending. Square or rectangular iron castings of adequate strength, fitted with numerous regularly spaced holes for the reception of dogs or other holding devices. A number of these units are fitted side by side, their upper surfaces uniting to form a continuous floor of sufficient area. Upon this floor heated shapes such as frame bars are bent to the required contour and then fastened by means of dogs placed in the holes until a permanent set has been assumed.

Slack. The opposite of taut, not fully extended as applied to a rope; to slack off means to ease up, or lessen the degree of tautness; as applied to water, that state of the tide when it has ceased running and appears stationary just before it turns, either at high or low water.

Slack Away, To. To pay out a rope or cable by carefully releasing the tension while still retaining control.

Slackness. The contrary of ardency, being that property of a ship by virtue of which she tends to throw her head away from the wind. Ships possessing this characteristic must be held on their course by keeping the helm a-lee. The reason for this tendency is found in the resultant lateral resistance of the vessel being behind or abaft of her resultant wind pressure.

Sleepers. Timbers placed upon the ground or on top of piling for supporting the cribbing, keel and bilge blocks.

Sleeve. A casing, usually of brass, fitted over line or other shafting for protection against wear or corrosion.

Page 891.

Slew. To yaw from side to side while at anchor or being towed.

Sling. A length of chain or rope employed in handling weights with a crane or davit. A cask or barrel sling usually consists of a length of rope having the two ends spliced together; the chains or ropes attached at the bow and stern of a small boat to which is hooked the tackle when it is hoisted or lowered; the chain or rope extending from a mast head to the center of a yard forming a support for same.

Pages 335, 878, 880.

Slip. The difference between the pitch of a propeller or the mean circumference of a paddle wheel and the advance of same through the water corresponding to one revolution. An inclined launching berth.

Slipways or Berths. The space in a shipyard where a foundation for launching ways and keel blocks exists and which is occupied by a ship while under construction. The term berth also designates the space a ship occupies at a pier or at an anchorage.

Sloop. A vessel having one mast and fitted with fore-and-aft sails.

Sloop-Rig. A single masted fore and aft rigged vessel. Distinguished from a cutter principally by her broad, shoal hull with its accompanying center board.

Slop Chute. A chute hung over the ship's side or built into the ship with discharge through the ship's side, for discharging garbage overboard.

Slotter. See SLOTTING MACHINE.

Slotting Machine. A machine which operates on the same general principles as a shaper, except that the ram which carries the planing tool moves in a vertical direction at right angles to the work table.

Page 734.

Slotting Machine, Crank. In this type of slotting machine, a crank motion is used to drive the ram.

Page 734.

Sluice. An opening in the lower part of a bulkhead fitted with a sliding watertight gate or door having an operating rod extending to the upper deck or decks. These openings are advantageous in center line bulkheads, as in case of damage to one side of the ship the water may be quickly admitted to the other side before the ship is dangerously listed.

Sluice Cock. Either a cock or valve attached directly to a bulkhead to permit flow of liquid from one compartment directly into another. A cock differs from a valve in that the liquid flows through a channel bored through the tapered plug forming the cock and

in no case is it necessary to turn the handle more than a quarter turn to open it fully.

Sluice Valve. See VALVE, SLUICE.

Sluice Valve Rod, Sluice Valve Spindle. The operating rod by which the sluice valve, usually located at the bottom of a compartment, can be opened or closed from a deck above.

Slush. Grease obtained from the meat boiled in the coppers and used as a lubricant and for slushing the spars after scraping.

Smoke Box. The casing attached to the end of a boiler to which the uptake is connected.

Smoke Box Door. A door attached to the smoke box to provide access for inspecting and cleaning the tubes.

Smoke Sail. A piece of canvas hoisted close to the galley smokepipe to carry the smoke from the deck during a head wind or hoisted at the foremast to prevent soiling the mast.

Smoke Stack. A metal chimney or passage through which the smoke and gases are led from the uptakes to the open air.

Page 672.

Smoke Stack Cover. A canvas cover used to close the top of the smoke stack when the fires are drawn for any length of time such as during a repair period.

Smoke Stack Paint. See PAINT.

Snap Switch. An electrical device for opening and closing a circuit by turning an insulated button. A snap switch for marine work is usually arranged so that the electrical connections are protected by a watertight cover.

Snatch Block. See BLOCK, SNATCH.

Snubbing. The checking of a vessel's headway by means of an anchor and short cable. The checking of a line or cable from running out by taking a turn about a cleat, bitts, or similar fitting. Also drawing the waterlines or diagonals of a vessel in suddenly at their ends.

Socket, Davit. See DAVIT SOCKET.

Socket Wrench, Ratchet. See WRENCH, RATCHET SOCKET.

Soda Cock. See CONDENSER SODA COCK.

Sole-Piece of Stern Frame. The lower fore and aft piece of a stern frame connecting the propeller and stern posts.

Page 499.

Sole Plate. A term applied to the top plate of a foundation to which the base of a machine or piece of equipment is bolted.

Solenoid Brake. A brake in which the friction material is directly controlled by electric magnets. These brakes are made in three forms as follows: the shoe type, the band type, and the disc type. Disc type brakes are usually set by a spring and released by the pull of the magnet, while the shoe type and band type brakes for ordinary applications are set by the weight of the magnet core and released by the pull of the magnet.

Page 956.

Solid Frame. Described under frame.

Soot Blower. A cleaning gear designed to clean the fire surfaces of steam boilers and remove the soot. These results are accomplished by means of steam jets.

Pages 998, 999, 1000, 1001.

Sounding. Measuring the depth of water or other liquid.

Sounding Line. The fine piano wire or wire rope used with a sounding machine. A log line.

Sounding Machine. A machine which has almost wholly superseded the antiquated and clumsy deep-sea lead, being designed to ascertain, accurately and quickly, the depth of water at rather high speeds, say up to 16 or 17 knots, in depths not exceeding 100 fathoms.

Of the various machines in use in the past and at the present, that designed by Lord Kelvin, formerly Sir Wm. Thompson, is the best known and most generally used. It consists essentially of a frame carrying a wheel or drum on which is wound about 300 fathoms of fine steel piano wire. The drum is controlled by a brake which allows the wire to be paid out or stopped.

Attached to the end of the wire is a metal cylinder whose lower end is perforated and the upper end closed by a cap and a heavy sinker having a hollow at the bottom to receive the usual "arming" of tallow to bring up a specimen of the bottom.

The metal cylinder carries a glass tube closed at one end about two feet long coated on the inside with a compound of silver which changes color upon actual contact with sea water.

The tube is placed in the cylinder with the open end down. The pressure of the water varying with the head compresses the air with which the tube was filled and the water rising in the tube discolors the coating of the tube. The extent of this discoloration compared to properly graduated scale shows the depth, in fathoms, to which the tube has been lowered.

To obviate the inconvenience and expense connected with glass tubes, a depth recorder is often used in lieu of them.

A special type of machine is fitted with an electrical motor for reeling in the wire after a sounding has been made.

Pages 1085, 1092.

Sounding Pipes. See TUBES, SOUNDING.

Sounding Rod. A light metal rod, graduated as desired, for lowering into a sounding tube to determine the depth of liquid in a compartment or tank.

Sounding Tube Deck Plate. See DECK PLATE, SOUNDING TUBE.

Sounding Tubes. See TUBES, SOUNDING.

Soya Bean Oil. See PAINT.

Spacing of Frames. See FRAMES, SPACING.

Span. A rope whose ends are both made fast some distance apart, the bight having attached to it a topping-lift, tackle, etc. A line connecting two davit heads so that when one davit is turned the other follows.

Spanish Windlass. A makeshift purchase consisting of a rope, a post or roller and a lever. One end of the rope is attached to the object to be moved, a turn is taken around the post and the other end secured to a fixed object. The lever is then inserted in the bight of the rope at the post and by turning it around a considerable strain is produced.

Spanker. Sometimes termed the driver. The fore-and-aft sail carried on the mizzen mast of a three masted vessel.

Spanner. A form of open head wrench for use with special fittings whose character is such as to preclude the use of the ordinary type of wrench.

Spar. A term applied to a pole serving as a mast, boom,

gaff, yard, bowsprit, etc. Spars are made of both steel and wood.

Page 813.

Spar Deck. See DECK, SPAR.

Spar Deck Sheerstrake. The strake of outside plating adjacent to the spar deck.

Spar Deck Stringer. See STRINGER, SPAR DECK.

Spar Deck Stringer Bar. See BAR, STRINGER.

Spar-Decked Vessel. A merchant vessel constructed with a complete deck above the main deck and having scantlings above the main deck heavier than those of an awning deck vessel but lighter than those in a full three decked vessel.

Spar Varnish. See PAINT.

Spare Bunker. A bunker for reserve coal.

Spark. See GAS ENGINE SPARK.

Special Lights. See LIGHTS, SPECIAL.

Spectacle Frame. A single casting containing the bearings for and supporting the ends of the propeller shafts in a twin screw vessel. The frame consists of arms of pear-shaped section extending outboard from each side of the center line of the ship to bosses taking the bearings of the propeller shafts. These arms are usually inclined downward from the center line at an angle of about 30 degrees from the horizontal. The shell plating is worked outboard to enclose the shafts and is attached at the after end to the bosses and arms of the spectacle frame.

They are used on steam yachts and large merchant vessels in place of shaft struts or brackets.

Pages 231, 500.

Speed Lathe. See LATHE, SPEED.

Speed Length Ratio. The ratio of the speed in knots to the square root of the waterline length in feet.

It is expressed thus: $\frac{V}{\sqrt{L}}$

Similar ships at corresponding speeds have the same value for this expression.

Pages 155, 157.

Speeds, Corresponding. See CORRESPONDING SPEEDS.

Spelter. Described under Metals.

Spent Condition. The condition of a vessel when all consumable provisions, stores, fuel and fresh water are exhausted.

Spikes. A stout metal pin headed on one end and pointed on the other. Spikes are used for securing heavy timbers together. Spikes are generally made of square bar with diamond, button or nail type of head and of round bar with countersunk head.

Page 800, 833.

Spirketting. A wood ship term applied to the first strake of inside planking or ceiling above a waterway.

Spirketting-Plate. A vertical side stringer plate attached to the inside of the frames at a lower deck or tier of hold beams.

Splice. A method of uniting two ropes by first unlaying, then interweaving and tucking the strands. See Long Splice, Short Splice, etc.

Sponson Beam. The outer fore and aft girder supporting the paddle wheel box and holding the outer bearing of the paddle wheel shaft.

Sponsons. Fore and aft beams supporting the paddle box structure.

Spot Face. The finishing off of the surface around a hole.

Sprayhood. A canvas hood which may be designed in several different shapes, used aboard a boat to prevent the spray from coming on deck or into an enclosure.

Spread. The distance measured transversely to a vessel's longitudinal axis.

Spring. The deviation from a straight line or the amount of curvature of a sheer line, deck line, or beam.

Spring Bearing Foundation. A structural steel foundation built up of lightened plates and angles and surmounted by a heavy base plate to which the holding down bolts of the lower bearing piece are attached.

Pages 548, 549.

Spring Bearings. Bearings designed to take the weight of the propeller shaft. If bearings and shaft are properly in line and adjusted, the shaft weight is the only load to which the bearings are subjected. Such bearings quite commonly consist of a lower bearing piece of brass, iron or steel, lined with white metal, and a cap for the protection of the bearing surface and the support of lubricating apparatus.

Page 550.

Spring Line. A hawser run out from any part of a vessel to a point on shore, as a dock, to prevent her going ahead or astern. In the first instance, the line extends from well forward to a point on shore abreast the stern; in the latter, the operation is reversed. Spring lines are also used to turn or spring a vessel around a wharf or dock.

Spring Stay. A horizontal stay between two lower mast heads, derrick posts, etc.

Sprit. A small spar designed to raise the peak of a sail having neither boom nor gaff. The upper end of the spar bears against a becket and its lower end is stepped against and near the foot of the mast.

Page 813.

Sprit Sail. A boatsail carried by a sprit. Originally it was spread under the bow sprit of seagoing vessels from the sprit sail yard.

Sprocket Chain. A chain designed to transmit motion from one sprocket to another.

This type of transmission is used in connection with certain types of steering gear and in ammunition hoisting gear.

Spun Yarn. A rough two, three or four-yarn, left-handed, small stuff, made from long tow or old rope yarns loosely twisted together. It is extensively used on shipboard for the coarser seizings, service, etc.

Differs from Marline, Houseline and Roundline in that no additional twist is given. Spun yarn is used more extensively on shipboard than any other variety of "small stuff," being convenient for seizing and serving, where great neatness is not required. It is left handed of two, three or four strands.

Spun Yarn Rope. See ROPE, SPUN YARN.

Spur Beam. A beam running diagonally or fairing into the sides of a ship from the end of a sponson beam. Used on paddle wheel boats.

Square Knot. See KNOT, SQUARE.

Square Stern. The stern of a ship whose decks terminate aft in rectangular form. Generally the stern contour is a straight line approximately perpendicular to the surface of the water.

Squatting. The increase in trim by the stern assumed by a vessel when running at high speed over that existing when she is at rest.

Squatting Speed. That speed at which a vessel changes

trim by the stern because of the large bow wave. Squatting speeds occur in the neighborhood of $\frac{V}{\sqrt{L}} = 1.1$ to 1.2 where V = the speed in knots.

Also sometimes called the critical speed.

Squeegee. A wood block or hoe shaped implement fitted with a handle and a narrow rubber blade secured by screws projecting from the lower edge. The implement is used for removing water from the decks, glass and other smooth surfaces. Also a strap with toggles in the end used to confine a studding sail while being set.

Stability. The tendency which a vessel has to return to the upright when inclined away from that position.
Page 230.

Stability, Dynamical. The amount of mechanical work necessary to heel a ship to an angle from the upright position. It is usually expressed in foot-tons.

Stability in Damaged Condition. The stability which remains after the flooding of one or more compartments with consequent loss of displacement and possible change in character or area of waterplane.
Pages 233 to 236.

Stability, Initial. The resistance offered by a ship to inclination from the upright and measured by the metacentric height.

Stability, Range of. The number of degrees through which a vessel lists before her curve of righting arms becomes 0.

Stability, Statical. The effort which a ship makes when held steadily in an inclined position to return to her natural upright position of equilibrium.

Stabilizer, Gyroscopic. A device for utilizing the gyroscopic properties of a rotating wheel to prevent a vessel from rolling. The wave forces tending to cause roll are exactly counterbalanced by the gyroscopic forces. Rotation of the wheel is by electrical motor and the gyroscopic stabilizing forces are controlled in direction and amount by other electric devices. The stabilizer is usually installed in or near the engine room, but it may be located elsewhere on the ship.
Pages 690, 1094.

Stable Equilibrium. See EQUILIBRIUM, STABLE.

Stack, Smoke. See SMOKE STACK.

Stage. A floor or platform of planks supporting workmen during the construction or while cleaning and painting either the inside or the outside of a vessel.

Stage Builder. A carpenter who erects platforms or stages in and about a ship on which the workmen stand to perform conveniently the necessary operations incidental to the construction of the ship.

Staggered Riveting. See RIVETING, STAGGERED.

Staging. Upright supports fastened together with horizontal and diagonal braces to which common boards are secured to form a platform.

Staging is necessary to provide access to the work both in construction and repair.
Plate XXXII.

Stairs. A built-in staircase aboard a ship.
Pages 573, 585.

Stanchion Bulwark. A post or stanchion supporting a bulwark. The stanchions or stays are often made of plating having the inboard edge flanged or of channel bar, the stay making a slight angle with the bulwark plating and being clipped to the top of the bulwark and the deck.

Stanchion, Hold. See PILLAR, HOLD.

Stanchion, Middle Line. See PILLAR, MIDDLE LINE.

Stanchion, Quarter. See PILLAR, QUARTER.

Stanchions. Short columns or supports for decks, handrails, etc. Stanchions are made of pipe, steel shapes or rods according to the location and purpose they serve.
Page 575.

Stand By. A preparatory command intended to convey to some one the meaning that he is to be ready to execute promptly a command soon to follow. For one ship to remain in the vicinity of another in order to render whatever assistance may be necessary.

Standing Rigging. Rigging that is permanently secured and is not hauled upon such as shrouds, stays, bob-stays, martingales, mast pendants, etc.

Staple. See COLLAR, ANGLE.

Starboard Side. That side of a vessel to the right hand when looking from the stern toward the bow.

Starboard the Helm. See PORT THE HELM. A term originally applied to the operation of putting the tiller over to right or starboard side causing the rudder and ship to turn to the left or port.

Different countries and different branches of the marine have their own rules as to whether this order means to turn the ship to the right or left.

Stateroom. A private room or cabin for the accommodation of passengers or officers.

Static. See RADIO.

Staunch. A maritime term signifying that a vessel is strong, sound, seaworthy.

Stay Bolt. A bolt used for bracing flat surfaces in a fire tube boiler.

Stay Rods, Condenser. See CONDENSER STAY RODS.

Stays. The ropes, whether hemp or wire, that support the lower masts, topmasts, top-gallant masts, etc., in a fore and aft direction. They extend from the heads of the masts they support to the next lower mast head of the adjacent forward mast except the lower mast stays which extend to the deck. Any rope used as a tension member, as an awning stanchion stay, a canopy frame stay, etc.; a bar, pipe, or plate used as a support against racking, bending, etc.

Stays, Boiler. See BOILER STAYS.

Steady. The quality by virtue of which a ship experiences little natural tendency to depart from the upright position when subjected to the action of the waves in a sea-way. It results from a moderate metacentric height.

Stealer Plate. See PLATE, STEALER.

Steam Engine Generator Set. A combination consisting of a reciprocating engine and an electric generator on the same shaft. Such sets are used for power and lighting in shipyards as well as on board ships.

Lloyd's Rules suggest that great care should be taken that generators, motors or electric leads on board ship are not located in such a place that they will influence the compasses.

Steam Fitter. A pipe fitter that fits and installs the main and auxiliary steam and exhaust piping on shipboard.

Steam Gage. See BOILER GAGE, STEAM.

Steam Hammer. See HAMMER, POWER FORGING.

Steam Hoist. See HOIST, STEAM.

Steam Hydraulic Hammer. See HAMMER, POWER FORGING.

Steam Jacket. A chamber surrounding the cylinder barrel of a reciprocating engine. To this chamber fresh steam is admitted for the purpose of keeping the body of the cylinder as nearly as may be at a uniform temperature. Such an arrangement is effective in avoiding the injurious effects of the cooling action of the exhaust steam on the cylinder walls. In modern high class engines the heads or covers are jacketed as well as the barrel.

Steam, Mixed. The intermingling of saturated with superheated steam.

Steam Ports. The passages from the steam chest to the cylinder through which the steam enters and those from the cylinder to the outer air or condenser for the escape of exhaust steam.

Such passages are made as short as possible so that the clearance volume is not unduly increased, but they must be of sufficiently great area so that the pressure of incoming steam is not unduly decreased or excessive back pressure developed in outgoing steam.

Steam Reducing Valve. See VALVE, REDUCING STEAM.

Steam, Saturated. Steam containing as much water as it is possible for it to absorb. When steam separates from the water in which it is generated, it is saturated and has the same pressure and temperature as the water. If in addition to the saturation, it contains water in suspension, it is called wet steam.

Steam, Superheated. Dry steam having a higher temperature than saturated steam at the same pressure. Superheated steam is produced by adding heat to saturated steam that has been removed from contact with the water from which it was generated.

Steam Trap. An apparatus used to collect the water of condensation in steam cylinders and piping and to discharge it automatically either to the boiler, feed tank, condenser or hot well, without wasting steam.

There are two classes of steam traps:—Return and non-return.

Non-return Traps may be divided into five types, depending upon their principle of operation, viz.:—Float, bucket, bowl, differential, expansion.

Return Traps are mostly of the tilting type and use live steam to return the condensation directly back to the boiler, whereas the non-return traps return the condensed steam into some receiver. From here it is pumped back to the boiler.

The Float Trap consists of a cast iron receiver of special design in which is placed a ball float which operates the valve that permits the condensation to be removed from the trap. When this trap is empty the discharge valve is closed, then, as the condensation flows in, the ball float rises and opens the discharge valve. The condensation is then blown out of the trap by the force of the steam acting on the surface of the water in the trap. As soon as the proper level of the water in the trap has been obtained the valve closes and the cycle is repeated. Generally these traps act continuously.

The Bucket Trap consists of a cast iron shell, in which is placed a cast iron bucket similar in shape to the shell but smaller, to which is fastened the discharge valve. The condensed steam flows into this trap and causes the bucket to float and at the same time the discharge valve is closed. When the water gets high enough in this trap, it flows into the bucket and so causes the bucket to sink and the discharge valve is opened. The steam pressure acting on the surface of the water in the trap expels the water from the bucket through the discharge valve. As soon as all the water has been removed from the bucket, the bucket rises and closes the valve and the cycle is repeated. This trap acts intermittently.

The Bowl Trap is made up of three principal parts:—The bowl, counterweight, and valve. The condensed steam flows into the bowl, through a special type of valve, and the condensation is counter balanced by a weight. As the water flows in, the bowl sinks and the discharge valve opens and rids the trap of its water by the force of the steam as in the other traps.

The Differential Trap is quite an elaborate trap and is used very little today. In this trap there are two columns of water acting on opposite sides of a diaphragm which operates the discharge valve. When the height of the condensation becomes greater in one column than in the other, the discharge valve is opened and the condensation is removed. The columns of water are again equalized and the cycle is repeated. This is a continuous, non-return type of trap.

Expansion Traps depend for their operation either on the action of metal, a saturated vapor or a liquid. Metal expansion traps are not used largely at the present time, but saturated vapor and liquid expansion traps are finding a great demand both in stationary and marine work.

These expansion traps are very simple, economical, efficient and inexpensive. The operating feature of the modern type of expansion trap is either a diaphragm containing a volatile fluid such as ethyl alcohol which becomes a gas when heated or a corrugated tube operated by the expansion of a heavy hydro-carbon oil. In the liquid expansion type, when the steam comes in contact with this corrugated tube or diaphragm, the liquid is expanded and this causes the discharge valve to be closed. As soon as the fluid has cooled, the discharge valve opens and so allows the condensation to be removed from the line by the force of the steam acting upon the condensation. When the condensation has been removed the discharge valve closes and the cycle is repeated.

The saturated vapor type of trap is suitable for pressures up to fifteen pounds, but the liquid expansion trap can be used for any given pressure from 0 to 200 pounds and is suitable for the draining of cargo winches and deck machinery. As it is always open except when steam is in the line, it will not freeze or permit the freezing of the line.

Pages 1006, 1019, 1020, 1021.

Steam Vessel. See VESSEL, STEAM.

Steel Deck. See DECK, STEEL.

Steel and Iron. Steel is primarily an alloy of iron and carbon, the carbon content ranging from a trace to nearly two per cent. It is capable of being cast into ingots or molds of various shapes. Sulphur and phosphorus are generally present as impurities while silicon and manganese are added for definite reasons. Classes—Steel may be classified with relation to the common method of manufacture employed such as crucible, open-hearth, Bessemer, Electric, etc., or by the use for which it is suitable such as machinery or tool steel.

Page 704.

Machinery Steel

Machinery Steel is often classified as mild, medium or hard; also applied to alloy steel such as nickel, vanadium, chrome-nickel, and chrome-vanadium and zirconium steel.

Mild Steel

Mild Steel is soft, having a carbon content of not over 0.02 per cent and it will not harden when suddenly cooled by quenching.

Purpose: Mild Steel is used in the manufacture of chain; it is rolled into sheets and strips for flanging, cupping and drawing, galvanizing and corrugating; it is rolled into rods for rivets and bolts; it is used for electric welding, and also for crucible stock.

Mechanical Properties: The mechanical properties of chain steel are as follows: It should have a tensile strength of from 48,000 to 58,000 lbs. per sq. in., a yield point of about one-half that of the tensile strength, with an elongation in 8 inches equal to a percentage of $\frac{1,500,000}{\text{T. S}}$ and a reduction of area equal to about 50 per cent.

The mechanical properties of the flat black, galvanized and corrugated galvanized sheet steel should be such as to permit bending flat upon itself without fracture.

The mechanical properties of slabs, blooms, billets or bars for reforging should be, as follows: a minimum tensile strength of 48,000 lbs. per sq. in., and a yield point of at least 24,000 lbs. per sq. in. with an elongation of at least 32 per cent.

Chemical properties: The chemical properties of mild steel should be not over 0.02 per cent carbon, 0.04 per cent phosphorus, 0.04 per cent sulphur and the manganese content from 0.30 per cent to 0.50 per cent.

Medium Steel

Medium Steel is harder and stronger than mild steel and will appreciably harden when suddenly cooled by quenching.

Purpose: Medium steel is used in miscellaneous castings and forgings such as engine and machinery forgings, deck plates, floor plates, boiler plates, structural steel shapes, rods for rivets, bolts and nuts, etc. For castings such as stern frames, rudder frames, high pressure steam piping and fittings, engine bed plates, etc.

Mechanical Properties: The mechanical properties of medium steel when used in forgings are as follows: It should have a tensile strength of from 60,000 to 80,000 lbs. per sq. in., a yield point of from 30,000 to 45,000 lbs. per sq. in., an elongation in two inches of from 22% to 30%, and a reduction in area of about 40%. The test specimen should bend cold through 180° about a diameter of 1-inch, without cracking on the outside of the bent portion—the bending specimen being 1"x½".

When used in structural steel for ships the tensile strength should be from 58,000 to 68,000 pounds per sq. in., having a yield point of ½ the tensile strength and an elongation in 8 inches equal to a percentage of $\frac{1,500,000}{\text{T.S.}}$ For material ¾" in thickness or under it should bend through 180°, around a pin equal to thickness of the specimen, for material over ¾" to and including 1¼" in thickness, through 180° around a pin equal 1½ times the thickness of the specimen.

When used in boiler or hull plates the mechanical properties should be approximately as follows: 58,000 to 75,000 lbs. per sq. in. tensile strength, yield point ½ the tensile strength, elongation 22% to 25% in 8 inches and the ability to stand without cracking a bending test through 180° about an inner diameter equal to the thickness of the plate.

When rolled into bars for rivets, bolts and nuts, the tensile strength should be at least 58,000 lbs. per sq. in., the yield point 30,000 lbs. per sq. in. and the elongation 28% in 8 inches.

Medium steel castings should have a tensile strength of not less than 60,000 lbs. per sq. in., a yield point of not less than 45% of the tensile strength, an elongation in 2 inches of at least 22%, a reduction of area of at least 30% and the ability to stand without cracking a bending test through 120° about an inner diameter of 1 inch. When cold rolled or cold drawn the tensile strength should be at least 70,000 lbs. per sq. in. and the yield point 70% of the tensile strength. Chemical Properties expressed in percentages.

	Carbon Max.	Phosphorus Max.	Sulphur Max.
Forgings	.40-.60	.04	.045
Boiler Plates		.035	.035
Hull		.05	.05
Hull Rivets		.04	.04
Boiler Rivets		.04	.035
Castings		.06	.06
Cold rolled rods		.06	.06
Structural steel shapes		.04	.05

Hard Steel

Hard steel is steel harder than medium steel and thus less ductile. It fatigues more quickly under repeated stresses.

Purpose: Hard steel is used in forgings for machinery and engines; it is rolled into plates and rods and employed in the manufacture of steel castings.

Mechanical Properties: The mechanical properties of hard steel when used in forgings are as follows: It should have a minimum tensile strength of 80,000 lbs. per sq. in., a minimum yield point of 50,000 lbs. per sq. in., a minimum elongation in 2 inches of 25% a reduction of area of 45%, and the ability to stand without cracking, a bending test through 180° about an inner diameter of 1 inch.

When rolled into plates, it should have a minimum tensile strength of 80,000 lbs. per sq. in., a minimum elongation of 8 inches of 20%, and the ability to stand without cracking, a cold bending test through 180° about an inner diameter about twice the thickness of the plate.

When employed in castings, it should have a minimum tensile strength of 80,000 lbs. per sq. in., a yield point of 45% of the tensile strength, a minimum elongation in 2 inches of 17% and the ability to stand without cracking, a cold bending test through 90° about an inner diameter of 1 inch.

Alloy Steels

Nickel Steel usually contains about 3% nickel, the the addition of which causes greater toughness thus increasing the percentage of elongation.

Purpose: Nickel steel is employed in the manufacture of forgings for shafts and shafting, connecting rods, guns, etc., and in steel castings where great

strength and ductility are required. Chemical properties except for the addition of nickel are similar to mild steel.

Chrome-Nickel is a nickel steel to which about 1% of chromium is added as a hardening agent.

Purpose: Chrome-Nickel Steel is employed where hardness and toughness are required such as in crank shafts, gears, armor plate, etc.

Mechanical Properties: It resists repeated shocks and stresses. Chrome-nickel forgings should have a minimum tensile strength of at least 105,000 lbs. per sq. in., a minimum yield point of 80,000 lbs. per sq. in., an elongation in 2 inches of 20%, a reduction of area of 50% and the ability to stand without cracking a bending test through 180° about an inned diameter of 1 inch.

Chemical Properties: Carbon contents should not be over .50%, sulphur not over .04% and phosphorus not over .04%.

Vanadium Steel is usually medium steel to which vanadium has been added. Vanadium acts as a scavenger and the resulting steel, although showing but a trace of vanadium in its chemical analysis, is both stronger and more ductile, especially if heat treated.

Zirconium Steel is usually medium steel to which Zirconium is added. The addition of Zirconium increases the tensile strength, yield point, and percentage of elongation, thus producing a steel more shock-resisting and of higher ballistic proof.

Tool Steel

Tool Steel is generally divided into two types, namely: Carbon tool steel and high speed or alloy tool steels.

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Carbon Tool Steel relies primarily upon its carbon content as its hardening agent.

Purpose: Carbon tool steel is used for the manufacture of hand tools such as chisels, hammers, hatchets, drills, etc. It is also used for machine tools such as twist drills, lathe cutting tools, etc., where high speeds are not employed, in the manufacture of a large assortment of instruments, and in fact where material of great hardness and strength is required.

High Speed or Alloy Tool Steels rely upon other elements than carbon as their hardening agents. These elements are Tungsten, Chromium, Molybdenum, Cobalt, etc. Tungsten is by far the most common element employed and it is usually added to the amount of from 8% to 35%, depending upon the use to which the steel is to be put. For general purposes 18% Tungsten has been found most satisfactory.

Purpose: Tungsten tool steel is employed in the manufacture of high speed twist drills and other metal cutting tools and will retain a cutting edge at high temperatures. Chromium is usually alloyed with Vanadium and produces a tool steel exceedingly tough and that hardens readily. The chromium content has much the same effect as carbon. This steel is used in the manufacture of the finer tools and cutlery such as razors, etc. Molybdenum and cobalt are often employed in producing steel for the manufacture of lathe cutting tools.

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Process Definitions

Crucible Steel is manufactured by the crucible process, which consists of charging crucibles made of high refractory materials, with known ingredients and submitting them to a temperature sufficiently high to melt all of the charge. This temperature is then held until the charge becomes homogeneous, after which the several crucible charges are usually poured into a ladle and from that poured into ingot molds or molds of special patterns, producing steel castings. All grades of machinery steel may be made by the crucible process as well as all grades of tool steel.

Open Hearth Steel is produced in a furnace known as an open hearth. The open hearth furnace is a reverberatory, regenerative furnace, and is usually heated by producer or natural gas. The gas and air pass through a series of heated checker work which raises the temperature of the gas and air before they enter the combustion chamber in which the metal is charged. Open Hearth furnaces are of two types, depending upon the lining of the bottom. All grades of machinery steel are made by the Open Hearth Process and also the cheaper grade of tool steel.

Acid Open Hearth Steel is produced in an open hearth furnace, the bottom of which is lined with ganister or silica brick. The sulphur and phosphorus content of the charge is not appreciably changed by the acid open hearth process.

Basic Open Hearth Steel is produced in an open Hearth furnace, the bottom of which is lined with magnesite brick. Generally a layer or two of chrome brick is placed between the magnesite lining and the silica brick sides to prevent chemical action. Both the sulphur and phosphorus content of the charge may be appreciably reduced by this process, the amount of reduction being dependent upon the temperature and the length of time employed for the melt.

Bessemer Steel is produced by the Bessemer process, which consists of a large receptacle usually lined with ganister, the bottom of which is provided with holes through which air is forced. The charge consists of molten pig iron direct from the blast furnace and the effect of the current of air passing through the molten metal is to burn out the carbon until only the required content is remaining. Only certain grades of machinery steel are made by this process.

Tropenas Steel is produced in a furnace similar to the Bessemer except the blast of air enters through the side of the converter and thus passes over the charge instead of through the charge. Tropenas steel is employed extensively in the production of steel castings.

Electric Steel is produced in a modified open hearth furnace; it is not provided with checker work and is heated by means of an electric current. On account of the absence of gases which contain sulphur, which the steel absorbs at high temperature, and on account of the ease with which the temperature may be regulated in the better designs, a superior grade of steel may be produced by this process. All grades of machinery and tool steel are produced by the Electric Furnace Process.

Iron

Iron rarely occurs in the free state. It is obtained by the reduction of its ores. Iron usually occurs as oxides called Magnetite, Hematite, Gothite, etc. The iron ore is reduced in the blast furnace and the product obtained is called pig iron.

Pig Iron as produced in the blast furnace contains 2% to 4½% of carbon together with varying percentages of Silicon, Sulphur, Phosphorus and Manganese. The carbon exists partly in solution,

called hardening carbon, and partly in the graphitic state.

Cast Iron is usually remelted pig iron and is divided into two classes namely, grey and white.

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Grey Cast Iron contains about one per cent. of combined carbon, the remainder being graphitic or combined. Grey Cast Iron is used in the manufacture of iron castings of all sizes and descriptions where no further heat treatment is employed, such as motor frames, engine frames, machine tool frames and beds, steam and gas engines, cylinders and valve chests, cylinder liners and piping, etc.

Mechanical Properties: The mechanical properties of grey cast iron are as follows: It should have a minimum tensile strength of 20,000 lbs. per sq. in. A test bar one inch square, loaded at the middle and resting on supports one foot apart should not break under a transverse load of less than 2,200 lbs. The hardness of grey iron is controlled by the silicon and manganese contents.

White Cast Iron is exceedingly hard, practically all the carbon content existing in the combined form. It is used where great hardness is desired and where a shock resisting material is not required. White cast iron is often heat treated in such a manner as to change its combined carbon to graphitic carbon. This process is called malleabilizing.

Malleable Iron Castings are produced by submitting white cast iron castings properly packed to a high temperature for a long period of time. Often these castings are packed in a carbon absorbing material such as mill scale, producing white heart malleable castings.

Purpose: Malleable iron is employed in the manufacture of pipe fittings and miscellaneous small castings subjected to shock but where great strength is not required.

Mechanical Properties: The mechanical properties of malleable iron are as follows: It should have a tensile strength of at least 36,000 lbs. per sq. in., an elongation in 2 inches of at least 3% and a test bar one inch square, loaded at the middle and resting on supports one foot apart, should not break under a transverse load of less than 3,000 lbs. The deflection of this bar should not be less than ½ inch before rupture occurs.

Chemical Properties: The chemical properties of malleable iron should be not over .08% sulphur and not over 0.225% phosphorus.

Wrought Iron is nearly pure iron, containing less than .03% carbon. It is produced by reducing the carbon content of pig iron by burning out, as in puddle iron, or by employing burning charcoal, as in the sinking process, the latter producing charcoal iron. The various processes of manufacture of wrought iron are often referred to as follows:

(a) Puddling, (b) bushelling, (c) faggoting, (d) bushelled steel, (e) muck bar, (f) common iron, (g) merchant bar iron, (h) refined bar iron, (i) double refined iron, and (j) bushelled steel bars.

(a) Puddling is the operation of boiling pig iron in a reverberating furnace, thus oxidizing and removing most of the silicon, carbon, manganese and phosphorus. The process is continued until the charge becomes a pasty mass when it is removed and rolled through squeezing rolls and finally rolled into "muck bar."

(b) Bushelling is similar to the above process except that the charge consists of scrap iron and steel instead of pig iron. The resulting product is inferior and is called "merchant bar."

(c) Faggoting is the process of forming a box of muck bar and filling the same with small pieces of scrap iron and steel, then heating to a welding temperature and rolling into bars.

(d) Bushelled steel is a process similar to puddling except that the charge is made up entirely of small steel scrap. The product is similar to that produced by bushelling.

(e) Muck Bar (See Puddling).

(f) Common iron is produced by re-rolling steel and iron scrap together.

(g) Merchant Bar (See Bushelling).

(h) Refined Bar Iron is produced from first class muck bars piled or from muck bars and wrought iron scrap.

(i) Double Refined Iron is produced from piled Refined Iron Bars box piled or slab piled.

(j) Bushelled Steel Bars (See Bushelled Steel). The bars are unfinished.

Purpose: Wrought Iron is used for the manufacture of chain, bolts and nuts and in the manufacture of various articles where great toughness and dependability are required.

Mechanical Properties. Wrought iron is extremely ductile, soft and shock resistive. Due to its method of manufacture it contains slag in streaks and when broken it has a fibrous appearance. The tensile strength should be at least 45,000 lbs. per sq. in., yield point at least ½ of the tensile strength, an elongation in 8 inches at least 25% with a reduction of area of at least 40%, and the ability to stand without cracking, a cold bending test through 180° about a diameter equal to the thickness of the rods or flats. An additional test known as the nick test is usually applied. This consists in nicking the bar approximately 20% of its thickness, and bending it back through 180°. It must then show a long, clean, silky fibre, free from slag or dirt, or any coarse crystalline spots.

Corrosion of Iron and Steel

There are three popular theories upon which corrosion is based, namely:

(a) The Carbonic Acid theory.

(b) The Hydrogen Peroxide theory.

(c) The Electrolytic theory.

(a) Those supporting the carbonic acid theory claim corrosion of iron and steel due to the presence in the air or water of carbonic acid, which attacks the iron, forming iron carbonate ($Fe\ CO_3$), liberating hydrogen, which in turn combines with oxygen. The formula proposed is similar to the following:

$2\ Fe + 2CO_2 + 2H_2O = 2Fe\ CO_3 + 4H.$

$4\ H + 2FeCO_3 + 3O = Fe_2O_3 + 2CO_2 + 2H_2O.$

It may be noted that CO_2 ion as soon as liberated as indicated in the last equation again attacks the iron and the rusting continues.

(b) The Hydrogen Peroxide theory is based on the belief that iron and water react to form ferrous oxide and hydrogen dioxide; these then unite and form ferric hydroxide; hydrogen peroxide is left which again attacks the pure iron and ferric hydroxide is again formed.

(c) The electrolytic theory is the most widely accepted and is considered due to the galvanic action,

caused by the impurities existing in all steel and iron as well as parts of the mass being under internal stresses. In the case of iron particularly free from impurities the above is true on account of the tendency of metals to pass into solution in the ionic form. When metal passes into solution it assumes a positive charge of electricity and leaves the remaining metal negatively charged. Hydrogen ions then leave the solution, in order to maintain electrostatic equilibrium, and charge the metal positively; this leaves the solution negatively charged. The result of this action is an electrolytic current which is carried from one point on the iron to the solution by the iron ions and from the solution to the iron by the hydrogen ions.

As soon as the iron enters the solution it is attacked by the free oxygen and iron oxide is formed. It is claimed that an impurity will give rise to a positive annulus if it is negative to the iron surrounding it and cause the iron to go into solution. Iron or steel corrode more rapidly in damp air than when immersed in pure water.

Many experiments have been conducted in the attempt to establish the relative merits of wrought iron and steel with respect to their susceptibility to corrosion. The latest results indicate that a steel of good quality resists corrosion better than wrought iron. The popular belief is that wrought iron resists corrosion better than steel and is probably based on the fact that wrought iron of good quality was produced before steel of a like quality. Cold worked steel rusts more quickly than annealed steel. Hardened steel resists rust better than untreated steel.

Steel Clad Wire Rope. See Rope, Wire, Steel Clad

Steep Tub. A wood or galvanized iron receptacle for steeping salted provisions and vegetables in water previous to cooking.

Steerage. The least desirable portions of a vessel as to accommodations for passengers and occupied by those paying the very lowest fare.

Steerage-Way. A term applied when a vessel has sufficient motion to maneuver by the aid of her rudder.

Steering Chain or Ropes. A term applied to the chains or ropes transmitting motion from the steering wheel or engine to the rudder stock.

Steering Column. A pedestal, usually a casting, supporting the steering wheel; and, where shafting is used for steering control, the brass mitre gears attached to the steering wheel and leads. An indicator is usually fitted on top of the column to show the angle of the rudder.

Steering Engine. A steam, electric or hydraulic power machine used for turning the rudder and having its valves or operating gear actuated by leads from the pilot house.

Page 851, 861, 862, 863.

Steering Engine, Chain Drum. A term applied to a cylindrical drum on the steering engine having spiral grooves to take the steering chain.

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Steering Engine Foundation. A term applied to a seating prepared for a steering engine. This seating may be built up from the deck or the deck may be reinforced by thicker or extra plates and shapes.

Page 532.

Steering Gear. A term applied to the steering wheels, leads, steering engine and fittings by which the rudder is turned.

Pages 851, 865, 866, 1084.

The American Bureau of Shipping requires that all Vessels are to be provided with efficient steering gear operating a tiller or quadrant on rudder, and efficient relieving tackle. It is strongly recommended that the after steering gear be under cover in all Ocean-going Vessels. Where steam gears are used there must also be entirely independent arrangements for steering by hand or other power, efficient brakes or other satisfactory means for steadying the rudder in the event of a break-down necessitating a change of gear, and satisfactory arrangements for stopping the gear before the rudder stops take effect. The radius of the tiller or quadrant should not be less than 7 times the diameter of the rudder stock, the depth of boss and breadth of the arm should be equal to the diameter of the stock, and the thickness of the arm should not be less than half its breadth; in quadrants having two arms these may each be 85 per cent. of the breadth and thickness respectively required for a single arm, with three arms they may be each 77 per cent. and with four arms 70 per cent. of the single arm. The diameter of the steering chains with the above radius of quadrant should be at least .145, and the rods .175 of the diameter of the rudder stock. Leading block sheaves should be of large size, say twice the diameter of the rudder stock, with pins about three times the area of the steering chains; these blocks should be placed so as to provide as fair a lead to the quadrant as possible, to the avoidance of sharp angles. All steering chains to be of special quality and tested in accordance with the Bureau's rules.

Steering Leads. A term applied to the shafting, ropes or chains transmitting motion from the steering wheel to the rudder stock.

Steering Wheel. A term applied to a wheel in which the spokes are continued through the rim for a distance sufficient to provide a good grasp for the hands and which is used for actuating the steering engine or the rudder through its leads. Where there are rope leads a drum is fitted to the hub of the wheel upon which the ends of the steering rope are wound and when the leads consist of shafting, gears transmit the motion from the axis of the wheel.

In vessels that are not provided with a steering engine, this wheel usually has a diameter of about five or six feet to provide leverage which is supplemented by gears or purchases in the steering leads.

Large wheels, sometimes single, but usually two or more in tandem are also fitted as an auxiliary hand steering gear at or near the steering engine and sometimes on the deck above it.

Where steering engines are used the steering wheels in the pilot house and on the navigating bridge are usually of small diameter and may be of wood or metal. As their function is limited to operating the steering engine no great leverage is required.

Pages 865, 1084.

Steeromotor. The steeromotor is a complete application of electricity to the handling of the rudder. The steam steering engine is not employed. The use of the steeromotor is particularly adaptable to boats having electric generators and for the motor ship where it is undesirable to maintain a high pressure steam boiler

for the sole purpose of operating steam steering gear.

The operation of the steeromotor is almost exactly that of the electric telemotor except that the motor employed is of sufficient size to take the place of the steam steering engine. The advantage in the use of the steeromotor is to simplify by eliminating the steam steering engine, to eliminate a long line of steam pipe with its consequent condensation, to obtain instant and absolutely accurate response and where storage batteries are employed on the boat to make it possible to steer the vessel when its motive power is not in operation.

The steeromotor is directly connected by gears to the screw gear of the vessel rudder. A movement of the controller handle in the pilot house to either port or starboard completes one of a number of electrical circuits and closing a relay in the engine room. The closing of this relay completes another circuit from the main generator of the boat to the motor of the steeromotor through a five step accelerator. A follow-up is connected to the motor through a train of gears and as the motor turns the follow-up moves until a position is reached that corresponds to the position of the controller in the pilot house. When this position is reached the circuit from the controller to the follow-up is opened and releases the relay which opens the main circuit to the motor and also applies a dynamic brake bringing the steeromotor to rest immediately and positively at the desired point.

The follow-up performs automatically the operation of opening or closing the relays that control the movement of the steeromotor to port or starboard. No reversing switch is required in the wheel house, and overtravels and limit controls are incorporated in the follow up. An overload relay with alarm signal is provided to give notice if a short-circuit or other accident should open the main circuit. No rudder indicator is used with the steeromotor as the position of the controller handle is always a positive indication of the relative position of the rudder.

Pages 867, 1084.

Stem, Stem Post. The bow frame forming the apex of the triangular intersection of the forward sides of a ship. It is rigidly connected at the lower end to the keel. In wood ships the main piece of the bow frame is called the stem.

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Stem Cap. A small plate on top of a stempost.

Stem Deadwood. See DEADWOOD, STEM.

Stem Piece. A filling piece fitted between the stem and knight heads.

Stem Plate. A plate fitted inside the stem on composite ships for strength and fastening purposes.

Stemson. A knee shaped piece joining the forward end of the keelson to the apron.

Stephenson Link. Also Drag Link. A mechanism designed to assist in reversing a reciprocating engine by means of regulating the distribution of the steam in the cylinder.

In consists essentially of a curved slotted link of radius equal to the length of the eccentric rods and to the ends of which these attach. In the link slot a carefully fitted block works. To this block, the end of the valve rod attaches. The manipulation of the link position by means of the reversing rod determines the relative influence of the two eccentrics upon the travel and position of the steam valve.

Step, Mast. See MAST STEP.

Steps. See TREADS AND TREADS, SAFETY.

Steps, Safety. See SAFETY STEPS.

Stern. The after end of a vessel; the farthest distant part from the bow.

Stern Frame. A heavy casting or forging for the purpose of supporting the rudder and the propeller shaft in single screw vessels. It also serves as a frame for rigidly connecting the converging sides of the ship at the stern.

Pages 499, 897, 899.

The American Bureau of Shipping states that Stern Posts and Stern Frames may be forged from unmixed scrap iron or scrap steel; they may be steel castings or welded ingot steel forgings which comply with the following requirements. Plans of stern posts and stern frames are to be submitted to the Bureau for approval.

Welded Steel Forgings may be made from especially Soft Open Hearth Ingot Steel; such forgings are to have a tensile strength between the limits of 49,000 and 56,000 lbs. and the elongations are not to be less than 35 per cent. at 49,000 lbs. nor 32 per cent. at 56,000 lbs.

Steel Castings.—Where steel castings are intended to be used instead of forgings, every care is to be taken to avoid abrupt changes in sectional area; each casting must be thoroughly annealed and subjected to percussive and hammering tests, as well as tests for tensile strength and ductility. The castings are to be made by the "Open Hearth" process, and are to be accurately molded and free from defects. The material is to have a tensile strength of not less than 58,000 lbs. and not exceeding 78,400 lbs. per square inch, with a corresponding elongation varying from 20 per cent. with 58,000 lbs. to 15 per cent. with 78,400 lbs., measured on test specimens of which the length between the gage points is not less than 3½ times the diameter and the sectional area not less than ¼ square inch.

The specimens for testing must have formed part of the actual casting submitted for approval, subjected to similar and simultaneous annealing, and are not to be detached from the casting until after the annealing is completed nor until they have been stamped by the Surveyor. The piece for ductility test should not be less than 1″ by ¾″, with edges rounded to a radius of 1/16″, and must stand being bent cold through an angle of 120°, over a radius of 1″, without any appearance of fracture.

Castings of stern frames, posts, single plate rudder frames, brackets and quadrants, are to be raised to a height of 6 to 10 feet, according to the character and form of the castings, and dropped bodily on to a hard surface, holes being prepared to receive bosses or similar projections. When large stern frames are cast in one piece, they may be dropped through an angle of 45 degrees instead of being lifted bodily. Castings of a complex design may, at the discretion of the Surveyor, be exempted from the drop test, and where the material is thin the limits of elongation may be reduced by 5 per cent. All castings are to be slung clear of the ground, and well hammered all over with a heavy sledge hammer to test the soundness of the material. All steel castings which have satisfactorily passed the requirements are to be clearly

stamped *A. B.* and with the identification marks furnished by the Surveyor.

In the event of any casting proving unsatisfactory or defective in the course of preparation or fitting in the ship, such casting shall be rejected irrespective of any previous certificate of satisfactory testing.

Stern Light. See LIGHT, STERN.

Stern Molding. A term applied to the half rounds, battens or ornamental work fitted around the stern of a vessel.

Stern Pipe. A round or oval casting or frame inserted in the bulwark plating at the stern of a vessel through which mooring hawsers or warps are passed.

Stern Plating. See PLATING, STERN.

Stern Port. See PORT, STERN.

Stern Post. The main vertical post in a stern frame upon which the rudder is hung.

Stern Post, False or Inner. A piece of reinforcing timber bolted to the stern post.

Stern Post Plate. A plate fitted on the inside of the stern post in composite ships for strength and fastening purposes.

Stern Rope. See ROPE, STERN.

Stern Sheets. The seat in the after part of a boat between the thwart and the coxswain's box.

Stern Timbers. See TIMBERS, STERN.

Stern Tube. The bearing supporting the propeller shaft where it emerges from the ship. It consists of a hollow cast iron or steel cylinder fitted with brass bushings, which in turn are lined with a lignum vitae or white metal bearing surfaces upon which the propeller shaft enclosed in a brass sleeve rotates.

In single screw vessels the stern post is bossed out and bored to take the stern tube which projects far enough aft of the post to take a large flat nut. The forward end of the stern tube is connected by a flange to the after peak bulkhead, which in conjunction with a stuffing box fitted around the shaft, makes a watertight joint at this point.

Water can enter the stern tube from the after end through grooves in the lignum vitae or white metal bearings and has been found to be a suitable lubricant when it is not mixed with sand or mud.

The stern tube in single screw vessels takes the heavy weight of the propeller and must also withstand the side thrust caused when blades are broken off or come out of water. In twin screw vessels there is generally a strut or bracket aft of the tube to support the screw.

In twin screw vessels the stern tubes are supported by the side framing and a bulkhead worked at the forward end of the tube. On account of the angle they make with the shell plating the tubes are generally longer than in single screw vessels.

Pages 530, 531.

Stern Tube Bearing. A common bearing surface for stern tubes consists of lignum vitae blocks or strips. Water gains access to the stern tube through the grooves in the bearing and on account of the hard oily nature of lignum vitae it forms a satisfactory lubricant.

Where the water is sandy or muddy a bearing surface of white metal will be found more satisfactory.

Pages 530, 531.

Stern Tube Bushing. A hollow brass cylinder with an outside diameter equal to the inside diameter of the stern tube. There are usually two bushings, one of which is inserted in the after end and the other in the forward end of the stern tube. A flange is cast on one end of the after bushing which shoulders up against the outboard end of the stern tube and is fastened to it by tap bolts. The forward bushing has no flange but is feather keyed to the stern tube to keep it from turning with the shaft. The inboard end of the forward bushing serves as a shoulder for the packing in the stuffing box.

Pages 530, 531, 891.

Stern Tube End Plate. A flat ring having its inside diameter about an inch less than the inside diameter of the after bushing. It is tap bolted to the flange of the after bushing and serves the purpose of holding the lignum vitae bearing strips from slipping out.

Pages 530, 531.

Stern Tube Gland. A term applied to a short hollow cylindrical casting having a flange on one end and used for compressing the packing in the stuffing box. The compression is obtained by stud bolts inserted in the forward end of the stern tube and passing through holes bored in the flange of the gland. The gland on a stern tube is usually made in halves so that it can be removed easily.

Pages 530, 531.

Stern Tube Retaining Strip. A strip of metal of trapezoidal wedge shaped section, riveted or screwed to the inner surface of a stern tube bushing for the purpose of holding the lignum vitae bearing strips from falling out.

Pages 530, 531.

Stern Tube Ring Nut. A term applied to a large flat nut that is screwed onto the after end of the stern tube which projects a short distance aft of the stern post. The stern tube is shouldered at the forward end of the post so that when the ring nut is tightened up the tube can not move forward or aft.

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Stern Tube Stuffing Box. A term applied to the receptacle for packing around the propeller shaft in the forward end of the stern tube.

Pages 530, 531.

Stern Wheel. A paddle wheel located at the vessel's stern and used for her propulsion.

Stern Wheel Steamer. A steam vessel driven by a paddle wheel located at the stern.

Sternson. A knee connecting the after end of the keelson with the stern post. Used in wood ships.

Stiff, Stiffness. The tendency of a vessel to remain in the upright position or a measure of the rapidity with which she returns to this position when inclined by any external force. The degree of stiffness is directly affected by the value of the vessel's metacentric height.

Stiffeners, Bulkhead. See BULKHEAD STIFFENERS.

Stiles, Window Frame. The vertical sides of the frame.

Stirrups. Short ropes suspended from the jackstay on a yard, having eyes spliced into the lower ends through which the foot rope reeves.

Stock, Rudder. See RUDDER STOCK.

Stocks. A term applied to the keel, blocks, bilge blocks, and timbers upon which a vessel is constructed.

Stokehold. That portion of the ship's boiler room from which the fires are fed and cleaned.

Stokehold Ventilator. A ventilator supplying air to the stokehold or fire room. If forced draft is supplied on the closed stokehold system the ventilator supplies air to the forced draft blowers, the quantity of air being that required for combustion in the boilers.

Stoker. An automatic gear for feeding coal to the fires in a boiler.

The overfeed type consists of grates inclined toward the rear of the furnace. Coal is fed through hoppers on the front end of the furnace and is worked back by an up and down motion of the grates.

The underfeed type is fed from underneath on to horizontal or inclined grates and the green coal is in this way placed below the coked and burning fuel.

The traveling grate type consists of short sections made into an endless grate and running over sprockets placed at the front and rear ends of the furnace.

Although called automatic they require expert attention and unless the coal and ashes are also automatically handled in their transit to the hoppers and from the ash pit respectively, the economy of their use on ship board is somewhat doubtful.

Also a term applied to a fireman.

Stokers. Members of a ship's boiler room force who attend to the fires in the boiler furnaces.

Stool, Pipe. A term applied to small castings or fittings supporting piping. The small castings supporting the deck piping to capstans, winches and windlass are examples.

Stools, Shaft. See SHAFT STOOLS.

Stop Bead. A thin and narrow piece of wood fitted around a door or window frame for the purpose of holding them in place when they are closed.

Stop Valve. See VALVE, STOP.

Stop Water. A wood plug driven through a scarph joint to stop water from leaking into the ship. The term is also applied to pieces of canvas soaked in oils, red lead, etc., placed between the faying surfaces of plates and shapes where water or oil is apt to work its way through.

Stopper Chain. See CHAIN STOPPER.

Stops, Rudder. See RUDDER STOPS.

Storage Battery. See BATTERY, ELECTRIC STORAGE.

Store Rooms. Any space or compartment in which are stowed the stores and supplies that are used aboard the ship.

Page 683.

Storm Valve. See VALVE, STORM.

Stow. To pack away, to lash in place, or to otherwise secure in position for a sea voyage.

Stowage. The proper distribution and securing of cargo in a vessel so as to avoid damage to either cargo or vessel by the shifting of cargo or by the undesirable conditions of trim and stability resulting from such a shift.

Stowage, Boat. See BOAT STOWAGE.

Straightening Rolls. See ROLLS, MANGLE.

Strain. The measure of the alteration of form which a solid body undergoes when under the influence of a given stress.

Strainer, Fuel Oil. A strainer located in the pipe line to the oil pump to prevent refuse from reaching and clogging the pump.

Pages 962, 989.

Strainer, Macomb. A type of strainer located in a pipe line near a pump to prevent refuse from reaching and clogging the pump.

Page 607.

Strainer, Strum. A strainer fitted on a strum box where box and strainer are separate fittings. The strainer usually consists of a perforated plate or sometimes a bell-shaped casting with projecting lugs to permit flow of water under the edge of the bell.

Page 606.

Strake. A term applied to a continuous row or range of plates. The strakes of shell plating are usually lettered, starting with A at the bottom row.

Strake, Bilge. A term applied to a strake of outside plating running in the way of the bilge.

Strake, Bottom. Any strake of plating on the bottom of a ship that lays between the garboard and bilge strakes.

Strake, Doubling. A term applied to a strake made up of two thicknesses of plates. Also to the extra range of plates fitted in conjunction with the regular strake. The sheer strake and topside plate are often doubled amidship for extra strength.

Strake, Drop. A term applied to a strake that is terminated before it reaches the bow or stern. The number of strakes dropped depends on the reduction of girth between the midship section and the ends.

Strake, Garboard. The strake of shell plating adjacent to the keel. This row of plates act in conjunction with the keel and are made heavier than the other bottom plates.

Strake, Inner. A term applied to the inner strake of an in and out system of shell plating. The strakes adjacent to the molded frame line.

Strake, Limber. A term applied to the inside strake nearest the keelson in wood ships.

Strake, Outside. A term applied to the outer strake of an in and out system of shell plating. The strakes which lap on the inner strakes and which are the thickness of the plating outside of the molded frame line.

Strake, Topside. The strake next below the upper or strength deck sheerstrake. The second range of shell plating down from the upper of strength deck.

Strand (of a Rope). An element of a rope; consisting in a fiber rope, of a number of rope yarns twisted together while in a wire rope a primary assemblage of wires.

Strap, Butt. See BUTT STRAPS.

Strap, Seam. See SEAM STRAPS.

Strapped Joint. See JOINT, BUTT.

Straps, Seam. See SEAM STRAPS.

Straw Boss. A workman who, while working at his trade, directs the work of other tradesmen of the same kind. He usually receives slightly higher pay than the men whose work he directs.

Stream Anchor. See ANCHOR, STREAM.

Stream Forms. Regular shapes conforming to the lines of flow of a liquid.

Stream Lines. The paths followed by particles of water as they pass over the immersed surface of a body moving through the water.

Strength Girder. See GIRDER, STRENGTH.

Strength Member. Any plate or scantling which contributes to the strength of the vessel. Some members may be strength members when considering longitudinal strength but not when considering transverse or vice-versa.

Stress. The intensity of the force which tends to alter the form of a solid body; also the equal and opposite resistance offered by the body to the change of form.

Stresses, Longitudinal. See LONGITUDINAL STRESSES.

Stresses, Pounding. Stresses induced in a vessel as she rides among waves by the beating of the water against her bottom. Pounding stresses are of special moment in flat bottom vessels of shallow draft.

Stringer. A term applied to a fore and aft girder running along the side of a ship and also to the outboard strake of plating on any deck. There are three sets of fore and aft girders in the framing of a ship, viz.: Longitudinals or keelsons, which are the approximately vertical strength members in the bottom; Stringers, which are the approximately horizontal strength members on the sides; and Girders, which are the approximately vertical members under the decks. The word stringer is sometimes used to apply to all three groups but it should only be used for the side girders. Also applied to the side pieces of a ladder or stair case into which the treads and risers are fastened.

Stringer Angle Bar. A term applied to the angle bar connecting a deck stringer plate to the outside plating or bulwark. They are usually made up of short lengths running between frames. A continuous angle bar connecting the inner flange of the frames to the stringer plate is sometimes called a stringer bar.

Stringer, Awning Deck. A term applied to the outboard strake of plating on the awning deck.

Stringer, Bar. A continuous fore and aft strength member made up of angle bars or shapes attached to the inside flanges of the frames. Also applied to the angle bar connecting a stringer plate to the shell or frames in which case the name of the stringer is usually placed before it, as Main Deck Stringer Bar.

Stringer, Bilge. A term applied to the fore and aft girder running along the turn of the bilge.

Stringer, Boat Deck. A term applied to the outboard strake of the plating on the boat deck.

Stringer, Bridge Deck. A term applied to the outboard strake of plating on the bridge deck.

Stringer, Bulkhead. See BULKHEAD STRINGER.

Stringer, Deck. A term applied to the outboard strake of plating on any deck.

Stringer, Forecastle Deck. A term applied to the outboard strake of plating on the forecastle deck.

Stringer, Gunwale. A term applied to the stringer worked along the sides of a weather deck.

Stringer, Hold. Any stringer, plate or bar, fitted along the sides of a ship between the tank top and the lower decks.

Stringer, Hold Beam. A fore and aft plate attached to the top flanges of hold beams at the sides of a vessel and to the shell and frames.

Stringer, Intercostal. A stringer made up of plates cut to fit between frames. Each plate is attached to the frames and shell plating by short angle or bar clips. The plates are usually made deep enough to allow a continuous bar to be attached to the inner edge and to the inner edge of the frames.

Stringer, Lower Deck. A term applied to the outboard strake of plating on the lower deck.

Stringer, Main Deck. A term applied to the outboard strake or strakes of plating on the main deck.

Stringer, Orlop. A term applied to a stringer fitted about half way between the tank top and lower deck in vessels having deep holds. The plates are wider than those composing ordinary stringers and are supported by brackets attached to the frames. They should extend as far fore and aft as possible.

Stringer, Orlop Beam. A fore and aft plate attached to the top flanges of the orlop beams at the sides of a ship, and to the shell and frames. Applicable to a deep hold vessel with beams fitted between the lower deck and tank top.

Stringer, Orlop Deck. A term applied to the outboard strake of plating on the orlop deck.

Stringer, Panting. A fore and aft plate, angle, or built up girder fitted in between the side stringers in the bow and stern. Its purpose is to reduce the in and out vibrations or panting of the frames and plating.

Pages 498, 501.

The American Bureau of Shipping requires that Panting Beams and Stringer Plates are to be fitted abaft the fore peak and forward of the after peak, of such number and in such positions as are required to meet the effects of sheer and flatness of form. The frames between panting beams are to be efficiently connected to the panting stringer plate. The proposed arrangements at the ends of the Vessel are to be submitted for approval.

Stringer Plates. A term applied to the outboard plates on any deck or to the plates attached to the top flanges of any tier of beams at the sides of a vessel.

Stringer, Poop Deck. A term applied to the outboard strake of plating on the poop deck.

Stringer, Promenade Deck. A term applied to the outboard strake of plating on the Promenade Deck.

Stringer, Quarter Deck. A term applied to the outboard strake of plating on the quarter deck.

Stringer, Shade Deck. A term applied to the outboard strake of plating on the shade deck.

Stringer, Shelter Deck. A term applied to the outboard strake of plating on the shelter deck.

Stringer, Side. A term applied to a fore and aft girder supporting the side plating and located between the bilge and lower deck. The stringer may be intercostal and attached directly to the shell plating, or it may be continuous and attached to the inner flanges of the frames.

Page 501.

Stringer, Spar Deck. A term applied to the outboard strake or strakes of plating on the spar deck.

Stringer, Trunk Deck. A term applied to the outboard strake or strakes of plating on the trunk deck.

Stringer, Turret Deck. A term applied to the outboard strake or strakes of plating on the turret deck.

Stringer, Upper Deck. A term applied to the outboard strake or strakes of deck plating on the upper deck.

Stroke. The distance travelled by the piston in moving from its extreme position at one end to its extreme position at the other.

Structural Bulkhead. See BULKHEAD, STRUCTURAL.

Strum. See PUMP STRAINER.

Strum Box. The enlarged terminal on the suction end of a pipe and forming a strainer which prevents the entrance of material liable to choke the pipe. Also called Rose Box.

Page 606.

Strut, Shaft. See SHAFT STRUT.

Stud Link Chain. See CHAIN, STUD LINK.

Studding. The vertical timbers or framing of a deck house, fitted between the sill and the plate.

Stuffing Box. A fitting designed to permit the free passage or revolution of a rod or pipe while controlling or preventing the passage of steam, water, etc.

Stuffing boxes generally consist of:

1. The Stuffing Box proper, a sleeve whose internal

diameter is greater than the shaft or rod which passes through it.

2. The gland, a sleeve of such an internal diameter and thickness as to fit closely around the rod or shaft and at the same time pass easily into the stuffing box.

3. The packing, a filling material for the space between gland, stuffing box, and shaft. The packing may be compressed as desired by forcing the gland home.

4. Bolts, units, etc., with which to control the position of the gland.

Page 1073.

Stuffing Box, Bulkhead. A fitting attached to a bulkhead where it is desired to pass a rod, pipe or shaft through without destroying the steam, air, or water-tightness of the bulkhead.

A hole of the proper size is bored through the fitting and a receptacle for packing concentric with it is bored part way through. The packing is held in place by a gland.

Pages 550, 624, 1073.

Stuffing Box, Deck. A fitting similar to a bulkhead stuffing box and attached to a deck where it is desired to pass a rod, pipe or shaft through without destroying the steam, air or water-tightness of the deck.

Pages 625, 691.

Stuffing Box Recess. See TUNNEL RECESS.

Stuffing Box, Rudder Stock. A stuffing box fitted where the rudder stock pierces a flat or deck. According to where it is located, its purpose may be either to prevent the sea from coming up into the vessel or water on deck from coming down.

Page 578.

Stuffing Box, Stern Tube. See STERN TUBE STUFFING BOX.

Submarine. Beneath the surface of the sea.

A vessel capable of service below as well as on the surface of the water.

Submarine Cable. See ELECTRIC WIRE AND CABLE.

Suction Head. The distance the pump has to lift the fluid to the suction cylinder plus the frictional resistance. For high lifts and relatively small quantities the reciprocating pump is desirable, while for low heads and large quantities of fluid the centrifugal pump is better.

Hand pump suctions may be dispensed with if there are separate boiler rooms, or if there is a donkey boiler installed above the upper deck and there are also pumps in separate compartments with connections to both main and donkey boilers. On a large ship hand pumps are not of much use.

Suction Pipe. See PIPE, SUCTION.

Suction, Pump. See PUMP SUCTION.

Suctions, Ballast Tank. Pipes and valves connecting the ballast tanks with the pumps for emptying the ballast tanks of water.

Pages 600 to 605.

Plate XLII.

Summer Load Line. The waterline to which a vessel is allowed to load when going to sea in the summer time.

Sunflower Seed Oil. See PAINT.

Sunk Forecastle. A forecastle, the deck of which is raised only a partial deck height above the level of the upper or weather deck.

Sunk Poop. A poop, the deck of which is raised only a partial deck height above the level of the upper or weather deck.

Superheated Steam. See STEAM, SUPERHEATED.

Superheater. A device fitted to steam boilers and intended to extract from the gases of combustion heat which would otherwise escape. Admiral Dyson, page 161 of "Practical Marine Engineering," Seventh Edition, writes: "Roughly speaking, for every 10 degrees F. rise in temperature of the steam above that temperature corresponding to its dry or saturated condition, the gain in efficiency is one per cent."

For cylindrical boilers of the Scotch and similar types the superheater is generally formed of a drum built into the uptake. The hot boiler gases pass through tubes in this drum and the steam from the boiler is brought into contact with these heated tubes.

In water tube boilers the superheater consists of additional steam coils located within the boiler casing in the path of the gases through the tube nests.

Pages 966, 976, 979, 980, 981.

Superstructure. A structure built above the uppermost complete deck, a pilot house, bridge, galley house, etc.

Surface Condenser. See CONDENSER, SURFACE.

Surfacer. A type of wood planing machine.

Swab. A mop made of cotton rope or twine secured to a handle and used for cleaning decks; an opprobrious term applied to a worthless or useless person on board ship.

Swallow. The space or opening through which a rope passes between the rim of the sheave and the frame of the block.

A term applied to an oval or round opening in a chock or mooring ring.

Swamp. To become covered or filled with water.

Swash Plate. A term applied to a vertical plate fitted either athwartship or fore and aft in a tank for the purpose of retarding the flow of the liquid therein.

Swash plates are especially necessary in fuel oil tanks and water tanks that are apt to be only partially full as the unrestricted flow of the liquid against the sides of the tanks would be severe.

Sweet Line. A term applied to a curved line when it is smooth and without humps or abrupt breaks. A fair line.

Swifter. The forward shroud on either side of a mast, a length of rope used to keep the capstan bars in their places or passed from bar to bar around the ends in order to distribute the stresses.

Swing Saw. See SAW, SWING.

Swinging Ship. An operation for determining the local magnetic deviation of the ship's compass and making the proper adjustment. The ship's head is successively brought to each point of the compass and the bearing of a well defined distant object observed.

Switch, Air-Break. An electric switch, the contacts of which make and break contact in the air as contrasted with an oil break switch in which the contacts make and break under oil.

Switch, Automatic Reclosing Battery Charging. A switch used in the charging circuit of a storage battery which prevents the battery from discharging back into the source of supply by automatically opening the circuit when the charging voltage drops too low to maintain the charging current, and which will reclose automatically when circuit conditions return to normal.

Pages 1064, 1075.

Switch, Knife. A device with one or more hinged

copper blades equipped with a handle and so arranged as to open or close an electric circuit.

Page 950.

Switch, Lightning. A switch used to disconnect Radio equipment from the antenna to protect the equipment from being damaged by lightning.

Switch Oil. An electric switch, the contacts of which are submerged in oil. Such switches are commonly used on high voltage alternating current circuits.

Switch, Watertight Snap. See SNAP SWITCH.

Switchboard, Power. One or more panels made of some insulating material such as slate or marble, equipped with apparatus for controlling electrical machinery or circuits.

Pages 936, 939, 948, 949, 950.

Swivel. A special link constructed in two parts which revolve on each other. It is used to prevent fouling due to turns in chains, etc.

Swivel Block. See BLOCK SWIVEL.

Symbols. Conventional characters or marks indicating certain operations to be performed or observed.

Synchronous Converter. An electrical rotary machine having one armature and with the windings so arranged that it operates on alternating current and delivers direct current, or vice-versa. Sometimes called a rotary converter.

Page 953.

Synchronous Generator. See GENERATOR, SYNCHRONOUS.

Synchronous Motor. See MOTOR, SYNCHRONOUS.

T

Tabling. The broad hem worked along the borders of a sail, awning or other canvas work.

Tack, to tack. So to change the course of a sailing vessel by coming about as to take the wind from over the opposite bow to that over which the wind previously came. When the wind is coming over the port bow the vessel is said to be on the port tack, and when it comes over the starboard bow she is on the starboard tack.

Tackle. Any combination of ropes and blocks that multiplies power. A single whip usually called a tackle, though erroneously so classed, gives no increase of power but simply a change in direction of the power applied.

Tackles, Relieving. A term applied to a pair of tackles, generally stowed in the vicinity of the rudder quadrant or spare tiller. The tackle usually consists of a fixed double or multiple block with a hook or shackle for attachment to the structure and a movable block for attachment to the tiller. Manila rope is usually rove through the blocks.

In case of an accident to the steering gear, the relieving tackles are attached to the spare tiller or quadrant. These tackles may be worked by a capstan, a drum or gypsy or by hand.

Tactical Diameter. The horizontal distance from the original course to the position where a ship has turned through 16 points of the compass.

Taff Rail. A term applied to the rail around the top of the bulwark or rail stanchions on the after end of the weather deck, be it upper, main, raised, quarter or poop.

Tail or Guide Rod. An extended portion of rod working in a bearing as a guide for parts in motion.

Tail Plate. See HORSESHOE PLATE.

Tail Shaft. See PROPELLER SHAFT.

Tallow, Launching. See LAUNCHING TALLOW.

Tank, Ballast. A space or compartment which may be filled with water to add weight when it is necessary to produce a change in trim or in the stability of the ship.

Tank Foundation. A term applied to the seating supporting a tank and given the name of the tank which it supports, as Oil Filter Tank Foundation.

Page 663.

Tank, Peak. All classification societies require that transverse bulkheads be built near each end of a ship to prevent water from flowing into the larger compartments should the ends of the ship become damaged. The observation of this rule leaves narrow "V" shaped compartments in which no cargo is stored, but they may be filled with water to alter the longitudinal inclination of the ship.

Tank, Sanitary. A tank arranged to receive the discharge from the various sanitary or plumbing fixtures located below or close to the water line and which cannot drain overboard by gravity. Contents of sanitary tanks are pumped overboard.

Page 668.

Tank Testers. Men from the calking and chipping gangs who test tanks or compartments for leaks and who perform such work as the tests indicate to be necessary in order to insure water or oil tightness.

Tank Top Plating. See PLATING, TANK TOP.

Tank Trimming. A space or compartment at the end of a ship which is filled with water in order to produce an alteration in the longitudinal inclination of the ship.

Tank Vessel. A vessel designed for the carriage of oil in bulk and fitted with especially constructed tanks for this purpose. The term is applied to both sail and power driven ships.

Pages 420 to 429, 1104, 1105.
Plates XVII to XIX.

Tanks. Compartments for liquids or gases. They may be formed by the ship's structure as double bottom tanks, peak tanks, deep tanks, etc., or may be independent of ship's structure and installed on special supports.

Pages 660 to 668.

Tanks, Gunwale or Topside. Compartments near the gunwale, or the top of the sides of a ship, used as water ballast tanks.

Tanks, Settling. See SETTLING TANKS.

Tanks, Wing. See WING TANKS.

Tap. A tool with interrupted threads for cutting internal screw threads as in a nut, etc., consisting of a conical hardened steel screw grooved longitudinally to form a cutting edge.

Collapsible types of this tool are also made.

The act of cutting internal screw threads by means of a tap.

To strike with a gentle blow.

Page 698.

Taper Sockets. A sleeve used for holding the shank of small drills.

Tapered Liners. See LINERS, TAPERED.

Tapered Rope. See ROPE, TAPERED.

Tar, Hard Wood. A tar obtained from the destructive distillation of a hard wood.

Tar, Pine, Kiln and Retort. A dark, oily liquid obtained by slowly burning resinous pine wood in a kiln or by its destructive distillation in a retort.

It is used as a paint and a preservative for cordage, etc.

Tarpaulin. A term applied to a pliable canvas hatch cover. One or more tarpaulins are stretched over the wooden hatch covers and the edges are held in place by battens wedged into cleats on the hatch coaming. Also applied to pieces of canvas used as a shelter for workmen or as a cover for deck equipment.

Taut. The condition of a rope wire or chain when under sufficient tension to cause it to assume a straight line, or to prevent sagging to any appreciable amount.

Tee Bar. A rolled shape, generally of mild steel, having a cross section shaped like the letter T.

In ship work it is used for bulkhead stiffeners, bracket and floor clips, etc.

The size is denoted by dimensions of cross section and weight per running foot.

Tee, Branch. A tee with side or branch outlets.

Tee, Bull Head. A term applied to a tee in which the outlet is larger than the entrance.

Telegraph. An apparatus, either mechanical or electrical, for transmitting orders from a ship's bridge to the engine room, steering gear room, or elsewhere, or between firerooms, and from engine room to firerooms.

The transmitting apparatus, operated by the sender, is termed the transmitter, and the receiving apparatus, the indicator. A gong is usually fitted in order to call attention to the movement of the indicator.

Pages 1081, 1082, 1083.

Plate LXI.

Telemotor. A device for operating the valves of the steering engine from the pilot house either by fluid pressure or by electricity.

When fluid pressure is utilized, two leads of pipe are necessary so that the fluid may move aft in one pipe and forward in the other, or vice-versa. The movement is provided for by a small pump or ram actuated by the steering wheel.

Page 866.

Telemotor, Electric. The function of a telemotor, either electric or other, is to control from the pilot house, the movement of the valve of the steam steering engine which turns the rudder. On small boats where the distance from the wheel house to the steam steering engine is short, satisfactory results have been obtained by the use of wire rope or shafting and gears to control the engine valve. On large boats the mechanical difficulties are multiplied and the physical exertion required, considerable and objectionable. The essential of all telemotors is that they have a perfect follow-up system to insure positive and accurate control of the steam steering engine.

The electric telemotor is the application of electricity to the control of the steering engine. The telemotor is located near the steam engine and connected to the valve of the engine by mechanical arms or links. The controller is located in the pilot house and may be either a horizontally moving lever mounted upon a standard or a small wheel. The movement of the controller completes a circuit to a relay panel which is located near the engine. Completing one of these circuits from the controller causes one of two relays to close which in turn completes a circuit from the main generators of the ship to the motor of the telemotor. This motor is connected, through a suitable train of gears, to a cross-head which in turn is mechanically connected to the valve arm of the steam steering engine. Also connected to the motor through gears is the electrical follow-up. The starting of the motor moves the cross-head and engine valve starting the engine. This also moves the follow-up which whole movement continues until a position is reached by the follow-up corresponding to the position of the controller in the wheel house. At this point the circuit is automatically broken releasing the relay and opening the circuit to the motor. This stops the movement of the steam steering engine and consequently the rudder stops at the desired point.

No reversing switch is required in the pilot house as the follow-up is automatic and prevents overtravel and also has automatic limit control, making its operation very positive and accurate. Where batteries are employed on the boat an automatic switch changes from generator to batteries as required. The electric telemotor is becoming very popular on account of its simplicity, accuracy and reliability. No rudder indicator is required with this telemotor as the position of the controller handle at all times indicates the position of the rudder.

Page 866.

Telephone, Intercommunicating. See INTERCOMMUNICATING TELEPHONE.

Telephone, Loud Speaking. The performance of the loud speaking telephone on battleships and merchant vessels in the past three years has shown it to be the quickest, safest and most reliable means of communication yet developed for use on ships.

The loud speaking telephone transmits a message so loudly and clearly that it can be heard at a distance from the instrument without the use of an ear receiver. The person talking merely brings his lips to within a few inches of an opening in the housing containing the transmitter and the receiver and touches a key.

This housing is made of heavy, non-corrosive metal and is waterproof. It need not be opened and the instrument is always ready for instant service. At the same time the sensitive parts of the instrument are protected from accidental injury and from the damp sea air which quickly ruins the ordinary telephone.

The loud speaking telephone does not pick up ship noises and is always heard distinctly—even in the noisiest engine room. It does not destroy the watertight integrity of the bulkheads as does the voice tube. It is more convenient, more sanitary, and far

more efficient than either the voice tube or the ordinary marine telephone.

Page 1087.

Telephone, Radio. See RADIO TELEPHONE.

Telescope. An optical instrument intended for the use of one eye only and designed to enlarge and clarify the images of distance objects. It consists essentially of a tube having a large converging lens that forms the optical image of the object observed and a small lens or combination of lenses which magnify the image.

Tell Tale. An indicating device employed on automatic machinery or in a specific operation which gives audible or visual indication, or both, as to the exact time a specific function is begun or completed.

Telltale, Rudder. A term applied to an instrument that indicates the angle of the rudder with the center line of the ship. It is generally fitted in front of the steering wheel.

Tempering Drawing Plate. See FURNACE, HARDENING OR TEMPERING.

Tempering Furnace. See FURNACE, HARDENING OR TEMPERING AND FURNACE, TEMPERING POT.

Tempering Plate. See FURNACE, HARDENING OR TEMPERING.

Template. A mold or pattern made to the exact size of a piece of work that is to be laid out or formed and on which such information as the position of rivet holes, size of laps, etc., is indicated.

The most common types of template used in ship work are made out of paper or thin boards.

Template, Pattern. A wood frame, a paper or cardboard outline of a part of a ship showing the shape of the part, location of holes, and giving by means of notes made thereupon dimensions and information as to the fabrication of the part.

Templates, Transferring. Patterns made from the mold loft lines or from some part of the ship by means of which an outline and form of a part is retained and conveyed to wherever needed.

Temporary Bulkhead See BULKHEAD, TEMPORARY.

Tender. A small boat, usually power driven, used for purposes of general utility by the personnel of a large vessel.

A vessel of moderate size fitted with repair facilities, reserve stores of provisions, fuel, water, etc., for the use of a number of smaller naval vessels, such as destroyers or submarines.

Tenoning Machine. A power operated machine which usually has a hand feed and cuts a tenon on pieces of timber by means of knives carried in short revolving cutter heads.

Tensile Strength. The measure of a material's ability to withstand a tensile or pulling stress without rupture. Tensile strength of a material is usually measured in pounds or tons per square inch of cross section.

Test Head. The head of water corresponding to the pressure prescribed as a test for bulkheads, tanks, compartments, etc. Test heads are prescribed to insure satisfactory water or oil tightness and also as tests of strength.

Thermometer. An instrument for measuring the degree of heat or temperature.

Page 1090.

Thermotank. A box or tank containing steam coils through which air for ventilation is heated in passing.

Page 1013.

Thimble. An iron ring, oval or heart shaped fitting whose outer surface is concave in order that it may be held in place when worked into the corner of a sail as a cringle or in the bight of a rope. It serves as a lining to prevent the chafe of a hook, shackle, pin, etc.

Pages 349, 870.

Tholes; Thole Pins. A term applied to the pins of wood or metal that are fitted snugly into holes in the gunwale of a pulling boat for the purpose of forming a rowlock for the oars.

Thread. The spiral part of a screw.

Thread, Common. A standard machine thread as distinguished from a pipe thread.

Threading Machine. A machine used for cutting screw threads. This would apply to a lathe, bolt cutter, pipe threading machine, etc.

Threading Machine, Bolt. See BOLT CUTTER.

Three-Ply Riveting. See RIVETING, THREE-PLY.

Throat. A term applied to that part of a boom or a gaff lying immediately behind the jaw.

Throat Sheet, Boiler. See BOILER THROAT SHEET.

Throttle Valve. See VALVE, THROTTLE.

Throttle Valve Lever. A lever used to operate the throttle valve.

Through Fastening. See FASTENING THROUGH.

Thrums. Short pieces of rope yarns used in making mats, being sewed by their bights to the canvas or cloth. Thrums are made by cutting old and worn out gear into lengths and unlaying the strands.

Thrust. The net reaction of a propeller or wheel tending to force the vessel through the water. For a model propeller the thrust is generally measured in pounds, but for full sized vessels it is oftentimes reduced to pounds per ton of displacement.

Thrust Bearing. A bearing designed primarily to take the propeller thrust from the shaft and transfer it to the structure of the ship. It is constructed with a series of rings and channels for the reception of the collars of the thrust shaft. The rear faces of the thrust bearing rings and the forward faces of the thrust shaft rings bear on one another when the screw is turning ahead. The opposite takes place in backing. The faces of the bearing channels are usually of white metal so as to provide steel on white metal wearing surfaces. At the forward and after ends of the thrust bearing casing spring bearings of the usual type are fitted to carry the weight of the thrust shaft. Special methods of lubricating and cooling are provided.

The horse shoe collar bearing is a development based on the simpler type above described. It consists of a series of horse shoe collars carried on side shafts. These side shafts transmit the thrust from the horse shoe collars to the bearing casing and finally to the ship. This arrangement permits of the adjustment or replacement of an individual collar. The collars are usually of cast steel, brass or bronze with bearing surfaces of white metal. Lubrication and cooling are provided in a manner similar to that of the ordinary thrust bearing.

More recently a highly efficient thrust bearing has been developed which involves the use of pivoted shoes for the purpose of preserving the oil film.

Thrust bearings are generally, though not always, placed in the engine room immediately aft the main engine bed plate.

Thrust Block. The American Bureau of Shipping requires that Thrust Stools are to be of ample size and strength in proportion to the power transmitted to the thrust bearing; they are to extend well beyond the thrust block and are to be stiffened and supported by extra intercostals, double reverse angles, etc. All shaft stools are to be of ample strength and stiffness, in proportion to the weight of shaft and height of stool. Details of the proposed construction of thrust and shaft stools are to be submitted to the Bureau for approval.

Thrust Block Foundation. A term applied to the seating to which the thrust block is attached. As the whole push or pull exerted on the ship by the propeller is taken through the thrust block it is necessary to construct a strong foundation that will distribute the pressure to the hull of the ship without undue local strain. This foundation should be built as high up to the center line of the shaft as possible to decrease the overturning moment on the bolts holding the thrust block in place.

Page 536.

Thrust Horse Power. See PROPELLER THRUST.

Thrust, Propeller. See PROPELLER THRUST.

Thrust Recess. A small compartment off the main engine room designed to contain and give access to the thrust shaft and block.

Thrust Shaft. That length of shafting which is fitted for the purpose of transferring the thrust of the propeller to the thrust bearing. This is effected by means of circular collars or rings worked on the thrust shaft.

Thwarts. Boards extending across a row boat just below the gunwale to stiffen the boat and to provide seats.

'Thwartship Bunker. A bunker having its largest dimension in a transverse direction. It is frequently a fore hold compartment located immediately forward of the boiler spaces. Such a bunker is sometimes used as a reserve bunker or it may be used for cargo.

Tides. The alternate rise and fall, averaging twice in 24 hours and 51 minutes, of the level of the ocean and the accompanying inflow and outflow of rivers, bays, channels, etc. Corresponding high and low tides, therefore, occur 51 minutes later each day. The cause of tides is the combined result of the mutual attraction of the earth, moon and sun for each other. When the sun and moon are in conjunction or in opposition, that is, both on the same side or on opposite sides of the earth, their tide producing effects conspire to produce the SPRING TIDES. These occur at the time of and for two or three days after the full and new moon. When the moon and sun form a right angle or the moon is in quadrature, the crest of the solar tide occurs in the trough of the lunar tide or vice-versa, and the NEAP TIDES result. These occur after the first and third quarter of the moon.

The semi-diurnal variations of the tide are HIGH TIDE, when the tide ceases to rise and before it begins to recede; EBB TIDE, the falling tide; LOW TIDE, when the tide ceases falling and before it begins to rise; FLOOD TIDE, the rising tide.

Tie Plates. A term applied to long narrow plates used for the purpose of tying deck beams together where there is no steel deck plating.

Tiller. A heavy bar or lever having one end bored to fit on the rudder stock and having the other end fitted for connection to steering leads or relieving tackle.

The function of the tiller is to turn the rudder, but as on most ships this is accomplished by a steering engine through a quadrant or yoke, the tiller is only a spare fitting to be used with the relieving tackles when there is a breakdown in the steering engine.

Page 577.

Tiller Rope. See ROPE, TILLER.

Tilt Hammer. A hammer, the head of which mounted on the end of a lever delivers its blow under the action of gravity generally augmented by the spring of the lever itself. The hammer is raised periodically to position by means of a cam.

Timber, Horn. The center line frame in the stern of a wooden ship, extending aft from the stern post.

Plate XXV.

Timber Sizer. A machine used for the conversion of logs into timber. Usually a huge band saw mounted alongside a heavy track along which a carriage is designed to travel. A log is secured to the carriage and is sawed to size as the carriage moves past the saw.

A heavy type of planer used in mills to dress down large timbers.

Timbers, Counter. The inclined frames projecting aft from the wing transom and forming the counter. (Wooden ship.)

Timbers, Ship's. A general term referring to the individual sticks or members of which a wood vessel's frame work is composed.

Timbers, Stern. The aft upper stern frames in a wooden ship corresponding to the cant frames in a steel ship.

Time Stamping Clock. A stamping device carrying a a time piece, so connected that the manipulation of the stamp registers date, hour and minute.

Page 697.

Timenoguy. A rope stretched between two points to prevent gear from fouling or chafing.

Tin. Described under Metals.

Tin Knocker. A workman who fabricates articles from thin sheet metal.

Tip Clearance. The clearance or distance between the circumference of the tip circle of a propeller and the hull of the vessel.

To Overhaul a Tackle. To separate the blocks of a tackle thus giving a greater drift to the moving blocks.

Toggle Pin. A pin, usually having an eye worked on the head, and having a point so constructed, that a portion of it may turn on a pivot pin, forming a tee shaped locking device to keep the pin in place.

Pages 691, 815.

Tomahawk. A riveting hammer with a long heavy head used in driving large rivets.

Tongue and Groove. A term applied to a plank one of the edges of which is cut away to form a tongue and the other recessed to form a groove. The tongue on one plank is matched with the groove on the other.

Tongue and Groove Deck. See DECK, TONGUE AND GROOVE.

Tonnage Deck. See DECK, TONNAGE.

Tonnage, Gross. The entire internal cubic capacity of a vessel expressed in tons of one hundred cubic feet each. The peculiarities of design and construction of the various types of vessel and their parts necessitate certain explanatory rulings in connection

with the above. For these, see "Navigation Laws of the United States," Chapter on Measurement.

Tonnage, Gross Registered. The gross tonnage as entered on the register or other official certificate of the tonnage of the vessel.

Tonnage, Net. The internal cubic capacity of a vessel which remains after the capacities of certain specified spaces have been deducted from the gross tonnage. These deductible spaces include principally crew's quarters, working spaces and machinery compartments. See "Navigation Laws of the United States," Chapter on Measurement.

Tonnage, Net Registered. The net tonnage as entered on the register or other official certificate of the tonnage of a vessel.

Tons Per Inch of Immersion. The number of tons of additional weight required to immerse a vessel one additional inch of draft. The approximate tons per inch of immersion at any draft for salt water is equal to the area of the waterplane in square feet divided by 420.

Tool Grinders. Men who shape and sharpen the cutting tools for the several machines by grinding.

Tool Re-manufactured. Tools which have been reconditioned. They are sometimes reground to a smaller size and again they are restored to their original size.

Page 729.

Tool Steel. See STEEL AND IRON.

Tools, Calking. Hand operated tools used in calking either wood or metal.

Tools, Pneumatic Calking. Tools used for metal calking in which the power is supplied by compressed air.

Top Timbers. A term applied to upper portions of frames in wood ships.

Topgallant Mast. See MAST, TOPGALLANT.

Topmast. See MAST, TOP.

Topmast, Fidded. A term applied to a topmast that laps over the upper portion of the lower mast. This form of topmast is supported at its lower end by a bar, called a fid, which passes through a slot in the topmast and also a slot in a pair of brackets which are attached to the lower mast. A band is worked around both masts at the level of the top of the lower mast.

Withdrawal of the fid allows the topmast to be lowered.

Page 345.

Topmast Stay. Stay secured to topmast near upper end, set up with turnbuckles located near stem on deck. Sometimes both forestay and topmast stay are secured to the same pad on deck near stem.

Topping Lift. A rope or chain extending from the head of a boom or gaff to a mast or to the vessel's structure for the purpose of supporting the weight and permitting the boom or gaff end to be raised or lowered.

Pages 332, 338.

Topping Lift Tackle. Tackle between the boom and masthead used for lowering and raising boom.

Topside. That portion of the side of the hull which is above the designed waterline.

Topside Planking. The outside planking on a wooden ship lying above the water line.

Topside Plating. A term applied to the shell plating above the waterline.

Topside Strake. See STRAKE, TOPSIDE.

Torpedo. A steel plug, sometimes of spherical shape, designed for use in expanding a lead lining tube against its outer jacket of steel or iron pipe. To accomplish this the torpedo is forced through the lead tubing from end to end.

Torpedo Boat. A type of war vessel now practically obsolete. Its principal characteristics are high speed, light construction, small displacement, and a main battery of torpedo tubes. The type was intended for use in the attacking of capital ships by means of the torpedo. The advent of the destroyers together with the increasing demands for greater seaworthiness and personal comfort has ended the building of vessels of this type.

Torque. The moment of a system of forces that causes rotation.

Tow Rope. See ROPE, TOW.

Tow Rope Resistance. See RESISTANCE, TOW ROPE.

Towboat. See TUG.

Towing Lights. See LIGHTS, TOWING.

Towing Machine. A machine that automatically, according to the strain on the rope, reels in or out a towing hawser. They act as shock absorbers preventing sudden tension and danger of parting. Their drums are designed to reel up and stow the hawser.

Page 854.

Towing Winch. See TOWING MACHINE.

Trailing Lines. Light lines fastened to the handles of oars and secured to the boat inboard. They are used for trailing the oars alongside when the crew is not pulling.

Transfer Pump. See PUMP, TRANSFER.

Transformer, Electric. A stationary electric machine consisting of primary and secondary coils, insulated from each other, wound on a laminated iron core. They are usually designed to transform a high voltage to a low one or conversely to transform a low voltage to a high one.

Page 954.

Transmitter. See RADIO.

Transom Beam. See BEAM, TRANSOM.

Transom Floor. See FLOOR, TRANSOM.

Transom Frame. See FRAME, TRANSOM.

Transom, Wing. An athwartship timber attached to the top of the stern post. (Wood ship.)

Transoms, Filling. Athwartship timbers attached to the forward side of a stern post.

Transport. A vessel intended for the carriage of troops, equipment, ordnance, military or naval stores, etc. The carriage aboard ship of passengers or merchandise.

Transverse. At right angles to the ship's fore and after center line.

Transverse Bulkhead. See BULKHEAD, TRANSVERSE.

Transverse Frames. See FRAME, TRANSVERSE.

Transverse Number or Numeral. A key number used by classification societies in their rules for determining the scantlings of the frames and transverse members. These numbers with the corresponding scantlings are tabulated in the rules and are the results of experience and comparison. The numbers are arrived at in different ways by the various classification societies, but they are always identification numbers indicating the general size of the vessel as well as the proper scantlings of the structural members.

Transverse Stability. The tendency of a ship to return

to the upright or initial position when inclined transversely by an impressed force.

Transverse Stresses. Stresses acting at right angles to the centerline of a vessel or, if referring to a beam or girder, acting at right angles to the length.

Transverse Subdivision. The subdivision of a ship resulting from the fitting of transverse or athwartship bulkheads.

Trap, Steam. See Steam Trap.

Trawler. A vessel designed for fishing and fitted for handling sweeping nets. Vessels of this type are of robust construction, have considerable sheer, great draft aft, good maneuvering qualities and large fish holds.

Tread. The length of a vessel's keel.

Treads. The steps or horizontal portions of a ladder or staircase upon which the foot is placed.

Treads, Safety. A special non-slipping metal tread fitted to the deck at the foot of ladders and stairways. They are also often fitted to the upper surface of the steps of ladders and stairs. When the steps themselves are safety treads they are called safety steps.
Page 977.

Treble Purchase. A purchase in which two treble blocks are used.

Treble Riveting. See Riveting, Treble.

Tree Nail Turners. Men who operate wood cutting machines which make tree nails.

Tree Nails (Trunnels). A cylindrical wooden pin used to secure the planks of a wooden ship to the frames. After the tree nail is firmly driven into place and cut off flush with the planking its head is expanded by means of a small wedge.

Trestle-Trees. A term applied to fore and aft pieces, whether of wood or steel, that are fitted at the hounds of a mast for the purpose of supporting the crosstrees or platform at the top of a mast.

Trim. The longitudinal deviation of a vessel from her designed waterline at a given draft. When expressed in feet and inches it is equal to the sum of the distances that points on the waterline at the bow and stern are above or below the designed waterline at the mean draft at which the vessel is floating. The variation in a vertical direction of the fore and aft extremities of the actual position of a vessel's plane of floatation from its designed position.

Trim by Head. That condition of trim in which a vessel inclines forward so that her actual plane of flotation is not coincident with or parallel to her designed plane of flotation.

Trim by Stern. That condition of trim in which a vessel inclines aft so that her actual plane of flotation is not coincident with or parallel to her designed plane of flotation.

Trimming Tank. See Tank, Trimming.

Trochoidal Wave. A wave, the contour of which is the curve traced out by a point on a radius of a circle, which latter is rolled on the underside of a given line. This is the wave contour which is usually adopted for use in connection with calculations of bending moment for a vessel among waves.

Tropenas Steel. See Steel and Iron.

Trough Tool. A smoothing tool for use on structural shapes.

Truck. The pedestal or ball at the extreme top of the topmast or topgallantmast.

Trundle Head. The circular portion of the capstan head designed to take the ends of the capstan bars for turning.

Trunk. A vertical or inclined shaft formed by bulkheads or casings extending one or more deck heights, around openings in the decks, through which access can be obtained, cargo stores, etc., handled or ventilation provided without disturbing or interfering with the contents or arrangements of the adjoining spaces.

Trunk Bulkhead. See Bulkhead, Trunk.

Trunk Cabin. A cabin which extends but a partial deck height above the upper or weather deck.

Trunk Deck. See Deck, Trunk.

Trunk Deck Stringer. See Stringer, Trunk Deck.

Trunk Deck Stringer Bar. See Bar, Stringer.

Trunk Deck Vessel. A vessel having a long continuous opening or hatch in the weather deck. The longitudinal coamings of this hatch are carried up about a deck height above the weather deck and connected at their upper edges by a flat or deck.

Trunk Hatchway. See Hatchway, Trunk.

Trunk, Ventilating. Trunks through which air is led for supplying fans and blowers, or through which heated air is allowed to escape.
Pages 674, 675, 676, 678.
Plate LI.

Truss. An iron band around a lower mast having a pivot attachment to the center of a lower yard, thus forming the center of motion for bracing the yard around and at the same time holding it in position at the mast; to brail up a sail.

Tub. A short cask or half barrel. Also an opprobrious or contemptuous term applied to a vessel to signify that it is out of date or faulty in design.

Tube Cleaners, Boiler. See Boiler Tube Cleaners.

Tube Expander. A tool used to expand the end of tubes into the sheets or headers of boilers, and into flanges, etc.

Tube Sheet, Condenser. See Condenser, Tube Sheet.

Tube Sheets. See Boiler Tube Sheets.

Tubes, Boiler. See Boiler Tubes.

Tubes, Condenser. See Condenser Tubes.

Tubes, Sounding. Small pipes leading vertically up from a tank and arranged with the lower end opening into the tank so that the liquid rises in the pipe so its height can be measured by lowering a sounding rod into the pipe.
Pages 600 to 603.
Plate XLIII.

Tuck Plate. See Plate, Tuck.

Tug; Tugboat. A vessel, equipped with heavy duty engines and machinery, used for towing miscellaneous types of floating craft.

Tug or Towboat. A small, handy, power-driven vessel fitted with slow-turning powerful machinery, especially designed for towing.
Pages 448 to 468.

Tumble Home. The decreasing of a vessel's beam above the waterline as it approaches the rail. (The opposite of flare.)

Tumbler. An attachment to the jaws of a gaff to prevent the chafing of the mast.

Tuning. See Radio.

Tunnel Frames. See Frames, Tunnel.

Tunnel Plating. The plating composing the structure of a tunnel.
Page 507.

Tunnel Recess. The enlarged end of a shaft tunnel. At the forward end this enlargement is termed the thrust recess and at the after end the stuffing box recess.

Page 507.

Tunnel, Shaft. (Shaft alley.) A long narrow compartment running from the propelling machinery to the stern tube and containing the line shafting and its bearings. Fitted in order to provide access to the shaft and shaft bearings as well as to protect the shafting from the cargo in the after holds.

Page 507.

Turbine. A machine in which the kinetic energy of the the steam is transformed into direct rotary motion. A reciprocating engine produces work by the relatively slow overcoming of resistance by the pressure of the steam up to the cut off and by the hyperbolic expansion of the steam up to the release while a turbine does its work through the impulse reaction of steam or steam jets at high velocity on rotary vanes.

There are many arrangements of turbine depending on the speed of the vessel, the maneuvering qualities required, the number of propellers and so forth. For a triple screw ship of ordinary size a common arrangement consists of three ahead and two astern turbines with one H. P. turbine on the center shaft and one L. P. turbine on each wing shaft. The backing turbines are arranged either within the casings of the L. P. turbines or on the same shaft. A combination arrangement for a triple screw steamer consists of two triple expansion reciprocating engines one on each wing shaft with a low pressure turbine on the center shaft. The steam in this case passes through the reciprocating engines and from there to the low pressure turbine, the pressure of the steam upon entrance to the turbine being somewhat less than the atmosphere. For low speed cargo ships it has been found very advantageous to utilize reduction gears so that the efficient high speed of the turbines may be reduced through pinion and gear wheels to the desirable low number of revolutions for the propeller. In this case a high pressure turbine on one side and a low pressure turbine on the other side of the engine room may work together on one shaft. In addition to the above is a method called the Electric Drive in which the turbines operate generators which in turn drive the propeller shafting through motors. In this way differences in speed and backing may be handled at the motor and the same turbine used for both backing and going ahead.

Turbines have the following advantages over reciprocating engines:

1. A lower center of gravity and less weight. It is noted, however, that the floor space is about the same.

2. A minimum of vibration and freedom from the danger due to the inertia of the reciprocating parts which of course increases rapidly with the size and speed of a reciprocating engine.

3. The turbine allows more direct action of the steam from the boiler, is not seriously affected by excess moisture in the steam, nor is the feed water polluted by cylinder oil carried over by the steam.

4. The turbine is less apt to break down due to the absence of pistons, slide valves, connecting rods, etc., inclosure of working parts and lack of vibration.

5. For high speeds in particular the steam consumption is less.

Lloyd's rules require that in single screw vessels fitted with steam turbine engines, arrangement shall be made so that steam can be led direct to the low pressure turbine and that either the high pressure or low pressure turbine can exhaust direct to the condenser. Also that two astern turbines be fitted.

Pages 889, 921, 922, 926, 927, 928, 929, 930, 941, 953, 970, 1012, 1041, 1062.

Plates XIV, XLVII, XLVIII.

Lloyd's rules require in vessels with steam turbine installations that the following spare gear shall be carried on the ship, viz.:

2 bolts and nuts (or studs and nuts) for each size of rotor bearing.
2 bolts and nuts (or studs and nuts) main gear wheel bearing.
2 bolts and nuts (or studs and nuts) pinion bearing.
1 set of coupling bolts of each size used.
One-twentieth of total number of bolts and nuts (or studs and nuts) for each gear case joint.
One-twentieth of total number for each turbine casing joint.
2 thermometers for oil circulation system.
1 set of bearing brushes for one gear wheel shaft.
1 set of bearing brushes for rotor.
1 set of bearing brushes for pinion shafts.
One-half set of packing rings or segments for each gland of rotor shafts so fitted and half the number of springs fitted.
2 ordinary thrust horse shoes (or thrust rings) for main thrust block, or sufficient pads for one face of Mitchell type of main thrust block.
Turbine thrust and adjusting brushes with rings complete, or one set of pads of Mitchell type for one turbine of each size fitted.
1 set of liners for adjusting block of different thicknesses.
1 set of feed pump valves.
1 set of bilge pump valves.
1 set of valves for lubricating oil pump.
1 bucket and rod for lubricating oil pump.
1 escape valve spring of each size fitted.
A quantity of assorted bolts, studs and nuts.
Bars and plates of iron or mild steel.
In addition to the foregoing, the following articles are recommended by Lloyd's to be carried with a view to expedite repairs and lessen delay in distant ports, viz.:
1 propeller of each hand, or one set of blades of each hand.
1 propeller shaft.
Lignum vitae lining for one stern bush.
Sufficient material for one gland and one dummy ring of each size where labyrinth packing is used.
1 air pump rod, bucket and valves.
1 circulating pump rod, bucket and valves, or impeller and shaft.
2 dozen boiler tubes.
5 per cent of the number of condenser tubes and packing glands for same.
10 per cent of the tubes for oil cooler and packing glands for same.
1 set of boiler feed check valves.

Turbine Annulus Area. The net area available for steam flow through the blade rings of a turbine.

Turbine Blades. The vanes either on rotor or casing

which are subject to and directly effect the travel of the steam through the turbine.

The dimensions, shape of cross section, and spacing largely determine the turbine efficiency.

For the casing or guide blades the principal stresses are bending due to the impulse of the steam.

For the rotor blades the centrifugal force due to high speeds of rotation results in a tensile stress also.

Blades are set in grooves worked in casing or rotor and are accurately spaced by means of calking or packing pieces. The sides of the grooves and ends of the blades are usually serrated or given some other special shape suited to better holding the blading in place.

Once set in the proper groove, the blades and packing pieces are, after calking and lining up, wire laced and silver soldered.

Turbine Blade Friction. The friction produced by the flow of steam across the turbine blades. This friction is much increased by the presence of water in the steam. It is accordingly advantageous to make the surfaces of all blading as smooth as may be and to use superheated steam.

Turbine, Compound Impulse Reaction. A turbine in which the principal expansion of the steam occurs in the vanes. The steam velocity is moderate but for good efficiency the peripheral speed of the rotor must be about three-quarters that of the steam speed. Owing to the low rotor speeds used, this type is especially suited to ship propulsion.

Turbine, Cruising. A turbine designed for use at relatively low speeds as compared with the vessel's maximum. They are designed and fitted to give reasonable economy under cruising conditions.

They may be installed either as separate units or be built within the same casing as the high pressure turbine. When fitted independently they are placed on the low pressure turbine shaft.

Turbine Cylinder or Casing. The outer and stationary portion of the turbine. For purposes of construction and access it is made in two portions, the upper and lower half respectively. In large units each part may itself be made up of two or more parts.

Turbine casings are generally made of cast iron of various designs as to ribbing and thickness of material.

Essentially the turbine casing consists of a series of cylinders of differing internal diameters, these several diameters corresponding to changes in stage. The diameter is least at the inlet end and increases in order to accommodate the increased volume of the steam resulting from its expansion during its passage through the turbine.

Special care is exercised in testing and steaming the casing preparatory to finishing in order to permit distortion under actual operating conditions.

Nozzles for steam inlet and exhaust are fitted in suitable locations.

Suitable palms with webs and ribs attaching to the casing are cast with the casing and afford means of transmitting the casing weight to the structure of the ship. Provision for longitudinal expansion when heated is made by fitting large bolt holes for the forward feet while the after feet are securely bolted.

Turbine Diaphragm. A division member or plate which separates two adjacent turbine stages from each other. It consists of a wrought or cast steel division plate riveted at its outer edge to a cast steel rim and at its center to a hub through which the rotor shaft passes. The rim dovetails into the turbine cylinder. The hub is provided with close fitting grooved packing to reduce steam leakage.

Turbine Effective Blade Height. The clear distance between the inner face of shroud ring and the top of foundation ring.

Turbine Efficiency. The ratio of theoretical to actual steam consumption in turbines.

The principal turbine losses are those due to steam friction, both against itself and against the blades; exhaust steam velocity; leakage over blade tips at glands, etc.; mechanical friction; radiation.

The above losses total almost 40 per cent.

Hence the average efficiency to be anticipated in practice may be taken as slightly in excess of 60 per cent.

Turbine Foundation. See ENGINE FOUNDATION.

Turbine Guide Blades. Fixed or stationary blades carried on the casing of an impulse-reaction type of turbine. These blades receive the steam from the moving blades and while changing its direction of flow also increase its velocity.

Turbine Lifting Gear. Gear designed for lifting the upper casing of the turbine for examination, erection, repairs, etc. When ready for use guides are provided so as to insure movement without damage to blading. The gear proper consists of a motor acting through a system of worms and worm wheels.

Turbine Moving Blades. Blades carried by the rotor and therefore having motion relative to the fixed blades carried by the casing. These blades, or blades having the same function, are fitted in both the impulse and impulse-reaction types of turbine. They receive the steam directly from the nozzles or guide blades and by changing its direction of flow are able to transmit a rotative effort to the turbine shaft.

Turbine, Multiple Stage Impulse. A turbine in which the expansion of the steam takes place in sets of nozzles and from which the steam impinges on vanes set on several revolving discs. Only a limited pressure drop is allowed for each set of nozzles. This keeps down the velocity of exit steam from same and thus reduces blade velocity. Several rows of moving blades are fitted on each wheel and the steam speed falls from row to row. It is accordingly possible to use a much lower peripheral disc speed in the single stage impulse type. Hence turbines of this class are successfully used for main propulsive units in marine installations.

Turbine Nozzle. A device for supplying steam in the proper amount and direction to the rotating buckets of the turbine.

The number and size of nozzles are directly dependent upon the horse power desired.

In the first stage, nozzles occupy only a part of the turbine circumference, but in the last stages the entire circumference is taken up.

Nozzles are made in segmental castings of suitable size and shape for the location desired.

Turbine Operating Gear. A mechanism for turning the rotor over for repair or examination. It consists

of worm wheels on the turbine shafts. These worm wheels are actuated by removable worms and shafts operated by turning engines or other means.

Turbine Reduction Gearing. See Reduction Gearing.

Turbine Rotor. The rotating part of the steam turbine. It is built up of the following principal parts: a cylinder or drum; wheels; shafting; dummy piston.

In the construction of the rotor, balance and rigidity are of the first importance in order to insure absence of vibration and accuracy of clearance.

The cylinder or drum is worked out of the solid ingot. In large installations two drums may be used, an additional wheel being fitted at the juncture of the drums.

Great care is required in handling and boring the drum to avoid distortion due to concentrations of pressure.

Wheels may be of various forms and are either cast or forged. Steel forgings are the best practice at the present time.

The shafting is suitably turned and the wheels are shrunk thereon. Pins are fitted to guard against the motion of wheel on shaft.

The cylinder or drum is then shrunk on to the wheels and secured thereto by riveted screws fitted with means to prevent backing off.

The grooves for the reception of the moving blades are worked in the outer surface of the drum.

Journals are provided on shafting and the entire weight of the rotor thus transmitted to the main bearings.

A dummy piston is placed at the steam end of the rotor. It consists of a series of collars formed on the rotor extension and rings attached to dummy casing and fitted with small clearance corresponding to the collars. Steam leakage is prevented by the wire drawing action of this contrivance.

Turbine Shroud Ring. A ring designed to take the ends of turbine blading, so as to maintain alignment and protect against the action of centrifugal forces.

Turbine, Single Stage Impulse. A turbine in which the expansion of the steam takes place within a set of nozzles and from which the steam issues in jets of high velocity impinging upon vanes set securely upon a revolving disc. The jet velocity of this type has between 2,500 and 4,000 feet per second. The peripheral disc speed is always considerably less than half the jet velocity. Owing to the high speed of this type it is not suited to use for the main drive of an ordinary sea-going vessel. It is, however, much used for driving dynamos on shipboard.

Turbo-Electrical Ship Propulsion. See Electric Drive.

Turbo Generators. A combination consisting of a steam turbine and an electric generator generally on the same shaft. The current furnished by the generator is used for lighting the ship and sometimes for motors on the auxiliary machinery and machines in the engineer's work shop.

Lloyd's rules suggest that great care should be taken that the generators, motors or electric leads are not located in such a place that they will influence the compasses.

Pages 934, 936, 937, 953, 1010, 1041, 1062.

Turn. To cause a rope or chain to encircle a spar, pin or bitt one or more times, also to pass the bight of a rope over a bitt or cleat. The act is generally referred to as taking or catching a turn.

Turn In. To retire for the night.

Turn Turtle. To capsize or to founder. To turn completely over.

Turnbuckle. A device for connecting two parts of a bar, rod or rope together with an adjustable tension. It consists of an internally threaded link turning on screws at each end threaded in opposite directions or one end may have a swivel and the other a screw. The link is operated by means of a wrench or a lever. Frequently the link is constructed with a hole through the center for applying a marline spike as a lever.

Pages 334, 347, 870.

Turning Circle. The approximate circle described by a vessel in turning when the helm is hard over.

Turning Engine. See Engine, Turning.

Turning Gear. An arrangement or device for turning the main engine by power other than its own.

In large installations a turning engine, either steam or electric, is used to actuate a large worm wheel carried on the main shaft.

In smaller engines the worm wheel may be operated by hand lever or by jack.

In very small engines the wheel may be operated by a pinch bar and toothed gear wheel.

Turning Gear Wheel. A large worm wheel mounted on the main shaft in power and the larger hand-operated turning gears. In the smaller hand-operated gears, a toothed wheel mounted on the main shaft and arranged for operation by means of a pinch bar.

Turpentine, Wood. The resinous juice of pine or fir trees used in mixing paints, varnishes, etc. See Paint.

Turret Armor. Armor fitted to the turret structure for the protection of the gun and ammunition handling mechanism.

Turret Deck. See Deck, Turret.

Turret Deck Stringer. See Stringer, Turret Deck.

Turret Deck Stringer Bar. See Bar, Stringer.

Turret Deck Vessel. A merchant vessel constructed with a side having an abrupt round over or tumble home at about the level of the main deck from which point the sides are carried up in a reverse curve to the narrow deck termed the turret deck.

Turret Lathe. See Lathe, Turret.

Turret Ship. A war vessel in which the main battery guns are mounted in structures (generally protected with armor) carried on rollers and capable of rotation.

Turrets. Structures designed for the mounting and handling of the guns and accessories (usually main battery guns) of a war vessel. Turrets are constructed so as to revolve about a vertical axis usually by means of electrical or hydraulic machinery.

Turtle-Back. Usually applied to the weather or forecastle deck forward as, in naval practice, to protective decks in the vicinity of the water line when of excessive camber or sharply sloped or curved down at side.

Turtle Deck, Turtle-Back. See Deck, Turtle.

'Tween Deck. See Deck, 'Tween.

'Tween Decks. A term applied to the space between any continuous decks.

'Tween Deck Tonnage. The enclosed space between decks expressed in tons of one hundred cubic feet.

Twice-Laid Rope. See ROPE, TWICE-LAID.

Twine. Small cotton or flax cord or thread used by sail-makers in working on canvas.

Twofold Purchase. A purchase in which two double blocks are used.

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Ultramarine Blue. See PAINT.

Umber. See PAINT.

Umbrella. A metal shield in the form of a frustrum of a cone, riveted to the outer casing of the smoke stack over the air casing to keep out the weather. Page 672.

Under-Deck Tonnage. The enclosed volume of a vessel below the tonnage deck expressed in tons of one hundred cubic feet. Pages 232, 233.

Under Way. A vessel is under way according to the navigating laws, "when she is not at anchor, made fast to the shore or aground."

Generally speaking, it means that she is proceeding on a course.

Underhung Rudder. See RUDDER, UNDERHUNG.

Union. A fitting used to connect pipes, particularly where it is not desirable to disturb the position of the pipes as must be done with a coupling. They are usually made of malleable iron or brass. Unions less than 2 inches in diameter usually have screw connections and those above that size flange connections.

Union Jack. A small flag flown from a jack staff forward. It is set Sundays and when dressing ship. The design embodies that of the upper inner corner of the national ensign. In the United States the design is stars on a blue field. In Great Britain the design is composed of the crosses of St. George, St. Andrew and St. Steven, on a blue field. Page 1102.

Universal Joint. A joint designed to transmit torsional effort from a given length of shafting to another independent of alignment.

Unship. To remove anything from its accustomed or stowage place; to take apart.

Unstable Equilibrium. See EQUILIBRIUM, UNSTABLE.

Upper Deck. See DECK, UPPER.

Upper Deck Sheerstrake. The strake of outside plating adjacent to the upper deck.

Upper Deck Stringer. See STRINGER, UPPER DECK.

Upper Deck Stringer Bar. See BAR, STRINGER.

Upper Works. Superstructures or deck erections located on or above the weather deck. Sometimes used with reference to a vessel's entire above water structure.

Upright Drill. See DRILLING MACHINE.

Upsetting Lever. See RIGHTING LEVER OR ARM.

Upsetting Machine. A machine designed for increasing the diameter or size of the ends of bar stock or pipe for a desired distance as in the case of boiler stay rods and tubes.

Upsetting Moment. The product of the displacement and the upsetting lever. The displacement is usually expressed in tons, and the lever in feet and the upsetting couple stated in foot-tons.

Uptake. A sheet metal conduit connecting the boiler smoke box with the base of the smoke stack. It conveys the smoke and hot gases from the boiler to the stack and should be made double thickness with an air space between to prevent radiation.

Swinging dampers for controlling the fires are fitted in the uptake.

Pages 670, 671.

Useful Load. That portion of a vessel's designed displacement which is devoted more or less definitely to the particular object for which the vessel is intended.

In merchant vessels it includes cargo, fuel, stores and water, both potable and reserve feed.

In naval vessels it includes protection proper, battery, ammunition, fuel, stores and water, both potable and reserve feed.

When reference is made to merchant vessels the term is synonymous with "dead weight." Like this latter term, it relates exclusively to weight, not volume. Pages 155, 156.

V

Valve. A mechanical contrivance used for controlling or shutting off the passage of air, steam, water, etc., into or out of a boiler, cylinder, tank, compartment, or through a pipe line. Pages 390 to 392, 600 to 605, 608, 610, 612 to 621, 624, 625, 627, 632, 634, 646 to 659, 686, 687, 884, 1007, 1032, 1033, 1034, 1035, 1036, 1037. Plates XII, XLIII, XLIV, XLVI, XLVII, XLVIII, XLIX, L.

Valve, Air. Any valve on a compressed air line. Also used in reference to the control mechanism on front of a boiler for regulating the supply of forced draft to the boilers.

Valve, Alarm. Any valve which automatically gives an alarm. Sometimes it it used in a fuel tank to indicate when the tank is full and consists of a float valve with electric contacts. Also used as a small safety valve on a boiler, where it is set to open at a pressure of 5 or 10 lbs. below the regular safety valves, thus giving warning of the approach of the maximum allowable pressure.

Valve, Angle. A valve with a spherical shaped body having a screwed or flanged inlet at the bottom and a screwed or flanged outlet at the side.

A circular valve, fitting snugly on a circular seat, is actuated by a valve stem or rod having a screw thread cut on it which engages in a thread cut in the bonnet or cover. The valve stem is turned by means of a hand wheel. Pages 1032, 1034, 1035, 1036.

Valve, Balanced Whistle. See WHISTLE VALVE, BALANCED.

Valve, Blow-Off. A valve for discharging the contents of a boiler, evaporator or other container. Valves are used to discharge from the surface of the water in the boiler and also from the bottom. Page 1033.

Valve, Brass Mounted. A term applied to a valve where such parts as the disc and ring, stem, seat and bonnet are made of brass.

Valve, Butterfly. A valve in which a disc revolves on a diametrical axis similar to a damper. Also applied to a valve in which two semi-discs are hinged on a diametrical axis so that they both open and close similar in manner to the wings of a butterfly.

Valve, By-Pass. A small valve used on a larger valve for the purpose of by-passing the pressure from one side to the other of the larger valve so that it will open easily.

Valve, Check. A valve so arranged as to permit flow in one direction only. Usually it consists of a valve disc carried from a hinged support and hanging at an angle of about 45°, or it may be of the ordinary

type of valve without valve stem and fitted with a spring to insure rapidity of closing. See also Non-Return Valve. Pages 1032, 1034, 1035.

Valve, Check, Boiler Feed. A screw down, non-return valve, installed in the pipe lines between the main and auxiliary feed pump and the boilers. Its object is to prevent the water in the boiler from backing up through the feed lines between strokes or when the pump has stopped or broken down.

Valve, Cross. A term applied to a valve fitted on a by-pass between two lines of piping, thus providing communication between them. It is usually an angle valve with two side outlets. Page 1032.

Valve, Delivery. Usually refers to the main outboard delivery valve controlling the discharge of water from the condenser to the sea.

Valve, Engine-Room Control. The main stop valve on the steam line to the main engines controlling the supply of steam to the engines and located in the engine room.

Valve, Escape. A valve on a steam engine or boiler intended for the relief of excessive pressure and for the escape of steam.

Valve, Flap or Storm. A simple form of check valve at the bottom of a scupper pipe which permits water to discharge from the scupper overboard but prevents sea water from backing up the pipe. Page 609.

Valve Gate. A valve with an inlet on one side and an outlet directly opposite on the other side. The gate consists of a nearly flat tapered disc which slides in a groove that is perpendicular to the passage through the valve.

When open the gate is drawn up into a slot in the bonnet of the valve leaving the passage clear. The valve stem is threaded and is worked by a hand wheel.

The distance from face to face of the inlet and outlet flanges or connections is much less than in a globe valve. Pages 1033, 1034.

Valve, Globe. A valve with a spherical shaped body having a screwed or flanged side inlet and outlet. A circular valve fitting snugly on a circular seat, is actuated by a valve stem or rod having a screw thread cut on it which engages in a thread cut in the bonnet or cover. The valve stem is turned by means of a hand wheel.

Globe valves are strong, compact, and tight. When fitted, care should be taken to set them so that they will close against the pressure, otherwise they can not be opened if the valve stem is broken or becomes detached. Pages 1032, 1036.

Valve, Kingston. A sea valve so arranged that the pressure of the sea forces the valve on its seat or closes it, thus differing from most valves which are so arranged that the pressure is in the direction of opening of the valve.

Valve, Main Check. Check valves located in the feed water discharge pipes at or near the boiler.

Valve, Maneuvering. A term applied to valves used to vary the speed in turbines.

Page 997.

Valve, Needle. A valve which controls the flow of a gas or liquid by a long tapered point, permitting extra fine adjustments of the flow.

Valve, Non-Return. A type of check valve with a swinging valve disc. See also CHECK VALVE.

Valve, Outboard Delivery. See SEA CHEST.

Valve, Pet. A small valve used in the regulation of pump action by means of regulation of an air supply.

Valve, Piston. A steam valve consisting essentially of two pistons, one to each port, connected by a rod or spindle. The steam enters round the outer edges of the pistons and exhausts past the inner edges or vice versa. The steam ports and passages are cast in the cylindrical chamber in which the piston valves move. Thus the piston valve is perfectly balanced in so far as the steam pressure is concerned and the frictional load induced by the excess steam pressure on the back of the ordinary slide valve is eliminated, there remaining only such frictional resistance as is necessary to obtain tightness against steam leaks.

Valve, Poppet. See VALVE, THROTTLE.

Valve Quadrant. That portion of the reversing gear on a steam engine to which the ends of the eccentric rods are attached and which is curved to the arc of a circle.

Valve, Radiator. A valve controlling the flow of hot water or steam to a radiator. It is usually an angle valve. Page 963.

Valve, Reducing. It is located in the steam supply line in order to reduce the pressure of the steam supplied to auxiliaries. Such reductions are made in the interest of production economy and steadiness of operation. Pages 997, 1022.

Valve, Reducing Steam. A self-acting valve so arranged by means of diaphragms and springs that the steam pressure will be reduced after passing through the valve.

Valve, Regulator. A valve so constructed that it will deliver a liquid or a gas at a given pressure. Pages 1019, 1021, 1022, 1043.

Valve, Relief. A valve designed to open automatically at a desired pressure. They are installed on the cylinders of reciprocating engines and sometimes on the valve casings. Pages 1007, 1023, 1037.

Valves, Safety. Valves arranged to open at any predetermined pressure and, by permitting the escape of vapor, gas or other medium, to prevent explosion or damage to the boiler, tank or other container. Pages 1004, 1005, 1007.

Valve, Sea. A valve located at or near the outside plating of a vessel to supply sea water to the fire pumps and for flooding the ballast tanks, etc., also for discharging water overboard from bilge pumps, ballast pumps, condenser circulating pumps, boiler blows, etc. Page 608.

Valve, Sea Suction. See SEA CHEST.

Valve, Sentinel. See VALVE, ALARM.

Valve, Shifting. A small sized valve placed on condensers, pipes or, in general, other low pressure parts to allow the escape of air trapped in pockets, the valve closing automatically to prevent inflow from the atmosphere.

Valve, Slide. A device intended to regulate the admission of steam to and its exhaust from the cylinder of a reciprocating engine. For this purpose it is given a straight line reciprocating motion bearing a definite relation to that of the piston itself. This relation is such that the steam ports in opposite ends of the cylinder are alternately uncovered so that the steam is admitted first to one side of the piston and then to the other at the proper points in its stroke, the exhaust taking place regularly

meanwhile. The operation of the engine then becomes continuous.

For purposes of economy in practice the supply of steam must be cut off early and expanded during the remainder of the stroke. Also the exhaust should be closed before the end of the stroke in order to obtain cushioning and steam must be admitted just before the end of the stroke. The provision of lap and lead assists in accomplishing the foregoing.

Valve, Sluice. A valve secured to a bulkhead usually without any connecting pipes, for use in allowing water to flow to and from adjoining compartments.

Valve Stem. The rod connecting the valve with its means of motion, in the case of a steam engine with the eccentric and rod, and in the case of a water valve with the handwheel.

Valve Stem Guide Bracket. The bracket forming a guide support for the outboard end of the valve-stem, some distance away from the valve chest, and intended to keep the valve stem in straight line motion.

Valve-Stem Stuffing Box. The box on the end of a valve, through which the valve-stem travels, containing the packing, which prevents the escape of a gas or fluid under pressure from the valve. The stuffing box generally consists of an enlargement in the valve for the reception of the packing and a gland for pressing the same into place against the rod.

Valves, Stop. Generally considered as the valves especially fitted to cut off the supply of steam from the boilers to the engines. Also designated to distinguish from check valve, stop check valve, stop check lift valve, etc. Stop valves are fitted in pipe lines where it is desired to permit flow or to shut off the flow, the check valve being intended to permit flow in one direction only, the stop check acting as a stop valve in shutting off flow and also a check, but limiting the flow at all times to one direction, while the stop check lift serves as a stop valve, may act as a check valve, and may, if desired, permit flow in both directions.

Valve, Stop, Boiler. A valve installed on the line connecting each boiler with the main steam line.

By this valve any boiler may be cut off completely or the steam from it regulated.

Valve, Storm. A simple form of check valve or flap valve on the end of a pipe discharging through the ship's side above the waterline to prevent the sea from backing into the pipe.

Valve, Throttle. A valve designed to control the supply of steam to the engine when stopping and starting.

It is fitted in the main steam pipe near its point of connection to the high pressure valve chest.

The principal requirements to be met are rapidity of operation and minimum obstruction to the flow of steam when open.

Any one of several types of valve may be used, depending on the size and type of engine involved.

The gridiron valve is a type of unbalanced valve sometimes used as a throttle. This is a slide valve in which a large area of opening for the passage of steam may be obtained by means of a relatively small movement of the valve.

This valve operates with excessive friction.

The butterfly type of balanced valve is frequently used as a throttle. In one form it consists of an oval disc swung on a spindle across the pipe to an oblique position. In another form it is a circular disc slightly smaller than the internal diameter of the pipe intended to swing square across the pipe when in operation. Both these types swing into a position in line with the pipe axis when not in operation.

The double beat poppet valve is a type of balanced valve frequently employed as a throttle. It consists of two discs of nearly the same area carried on and operated by a common spindle. Steam is admitted so that the loads on the two valves are opposite in direction.

This type of valve is easily operated but is subject to steam leaks.

A disc valve with a balance piston carried on the same spindle is a common type.

In large installations the throttle is frequently power operated by means of an auxiliary cylinder.

Valve or Steam Chest, sometimes termed **Valve Box.** The casting in which steam passages and ports are formed and through which the rod which actuates the valve works. It is provided with covers for access and inspection, is fitted with a stuffing box through which works the valve rod and with openings for the attachment of the main steam pipe from the boiler as well as for the exhaust steam pipe to the open air or condenser.

Valves, Under-water. Valves such as sea valves which can only be repaired or replaced while the ship is in dry dock.

Valves and Cocks, Sluice. Sluice valves and cocks may only be fitted on watertight bulkheads under conditions where they are at all times accessible for examination; the control rods are to be workable from the bulkhead deck, and are to be provided with an index to show whether the valve or cock is open or shut, the control rods are to be properly protected from injury, and their weight is not to be supported by the valve or cock. No sluice valve or cock is to be fitted on a collision bulkhead.

Vanadium Steel. See STEEL AND IRON.

Vane. A fly made of bunting and carried at the truck, which being free to rotate on a spindle, indicates the direction of the wind.

Vangs. Ropes secured, generally one on each side, to the outer end of a cargo boom, the lower ends being fastened to tackles secured to the deck. The vangs are used for guiding and swinging the boom and for holding it in a desired position, as over a cargo hatch. The term is also applied to ropes secured to the after end of a gaff and led to each side of a vessel in order to steady the gaff when the sail is not set. Page 333.

Variety Molder. See MOLDING MACHINE, VARIETY.

Varnish. See PAINT.

Veer-Chain. A command to allow the anchor chain to run out.

Veering. Changing direction, used in referring to the wind and also to the course of a vessel.

Vehicle. See PAINT.

Veneer Press. A press designed to hold or clamp a thin layer of high class or expensive wood on a backing of inferior grades of wood until the glue uniting the two is hard and set.

Veneering. The art of facing inferior grades of soft wood with a thin layer of more expensive hard wood.

Venetian Red. See PAINT.

Ventilating Flooring. See GRATINGS.

Ventilating Trunk. See TRUNK, VENTILATING.

Ventilating System. A system consisting of light metal pipes, blowers, special intakes, etc., for supply fresh air to and removing foul air from the various compartments in a vessel.

Ventilation. The process of providing fresh air to the various spaces and replacing foul or heated air by fresh air. Pages 673 to 678, 1051, 1052, 1053. Plate LI.

The American Bureau of Shipping states all holds, 'tween decks, and bunkers are required to have two ventilators placed as nearly as possible at the ends of each compartment; and a ventilator must be led into peaks, tunnels, or other compartments where gas is likely to accumulate. Mechanical means of ventilation will be accepted, provided the arrangements are approved by the Committee.

Ventilators on the weather portions of Freeboard Decks and on Forecastle Decks are to have coamings 36 inches high; those on the weather portions of Bridge Houses and Poops may be 30 inches high. The thickness of the coamings is not to be less than .30″ in vessels not exceeding 100 feet length, and .40″ in vessels 200 feet length and above; the thickness for vessels of intermediate lengths may be obtained by interpolation. The coaming angles are to be .10″ thicker than the plates and secured to deck plating of sufficient thickness and properly stiffened, by rivets spaced not more than 4 diameters center to center. If coamings are more than 36 inches high and are not supported by adjacent structures, they are to have additional strength and riveting. Ventilator cowls are to fit closely over the coamings and are to have at least 15 inches of housing. Ventilator coamings are to be provided with strong plugs and canvas covers or efficient metal covers which can be rapidly and effectively secured in place.

Ventilation, Funnel. The expanding or bell mouth end of a ventilation pipe which is supplied with air from a mechanical system. Its object is to reduce the velocity of air entering the space.

Ventilation, Mechanical. Ventilation supplied by fans or blowers and sometimes by compressed air, the fans being operated by electric motors, steam engines or other mechanical means. The ventilation in this case is forced or induced by the fan through a pipe or pipes to one or more compartments whereas natural ventilation would require a separate pipe and cowl for each compartment.

Ventilation, Natural. Ventilation depending on the wind blowing into the cowls and down the ventilators, and also on the natural tendency of heated air to rise and escape through the pipes and trunks provided. Pages 673 to 678. Plate LI.

Ventilation, "Thermotank" System. A ventilation system in which the air is heated by passing over or around tubes through which steam or hot water is circulated. The box or tank containing the steam coils is called the thermo tank.

Ventilator, Mushroom. See MUSHROOM VENTILATOR.

Ventilator Turning Gear. Simple form of rack and pinion with handwheel and shafting arranged so that the ventilator of the cowl type located on an open deck can be turned so as to face the wind if a supply ventilator, and away from the wind if an exhaust ventilator. Pages 677, 1052.

Ventilators, Bell-Mouthed or Cowl. Terminals on open decks in the form of a 90 degree elbow with enlarged or bell shaped openings, so formed as to obtain an increase of air supply when facing the wind and to increase the velocity of air down the ventilation pipe. Pages 673, 1052.

Ventilators, Goose-Neck or Swan-Neck. Terminals consisting of a 180 degree bend used only on ends of exhaust pipes and so shaped as to make the clogging of the outlet difficult. Page 675.

Vermilion. See PAINT.

Vertical Borer. A vertical spindle drilling machine used for drilling holes in wood.

Vertical Center Keelson. See KEELSON, VERTICAL CENTER.

Vertical Punch. See PUNCH, VERTICAL.

Vessel. A craft designed to float on and pass from place to place over the water. The term usually refers to types larger than boats.

Vessel, Sailing. A vessel propelled by sails. Where there is an auxiliary power plant she is only a sailing vessel as far as the navigating laws are concerned when the machinery is not in operation or when she is not under steam.

Vessel, Steam. A vessel propelled by steam power. According to the rules to prevent collisions in the navigation laws, "all vessels over sixty-five feet in length propelled by machinery and tugboats and towboats of any length propelled by steam are considered steam vessels. If both machinery and sails are installed, she is considered a sailing vessel only when not under steam.

Virtual Center of Gravity. The point at which the weight of a liquid with a free surface may be considered to be concentrated when taking account of its effect upon the initial stability of a vessel.

The virtual center of gravity of a free liquid is in a vertical line directly above the actual center of gravity and the distance between the actual and virtual centers of gravity equals the moment of inertia of the free surface divided by the volume of the liquid.

Vise, Combination. A type of vise designed for securely holding work of irregular form while filing, etc.

Vise, Hinged Pipe. A type of vise especially designed for use on pipe works. It is usually mounted on a work bench or table and the frame is made in two parts hinged on one side and locked with a toggle pin on the other. The upper jaw is operated in a vertical direction by a threaded spindle passing through the upper frame. The jaws are made in a diamond shape to give a better grip on the pipe. Page 773.

Visible Lights. See LIGHTS, VISIBLE.

Visor. A small inclined awning supported by a pipe frame running around the pilot house of a steamer, over the windows, to exclude the glare of the sun or prevent rain from coming in over the tops of the window sashes.

Voice Tube. A tube designed for the carriage of the human voice from one part of or station in the ship to another.

In its simplest form the voice tube system includes a speaking connection between the pilot house and engine room only. In large war vessels the system becomes very complicated.

Voice tubes are generally made up to about four

inches in diameter and fitted with appropriate speaking and listening terminals.

Pages 679, 680.

Plates LII to LX.

Volt. The practical unit of electromotive force. It represents that pressure which produces a current of ampere in a resistance of 1 ohm.

Voltage Regulators. An instrument usually mounted on a switchboard for the purpose of keeping the voltage at a predetermined value.

Page 954.

Voltmeter. An instrument for measuring the difference in potential between two points in a circuit.

W

Wake. The disturbed water left behind a moving vessel. When dealing with propellers and propeller design a special significance attaches, which may be explained as follows. When a ship moves through the water a forward motion is imparted to the particles of water lying close to the hull of the vessel. This forward motion of the water close to the hull increases in intensity as it approaches the stern of the vessel so that the propeller actually revolves in water which has a decided motion in the forward direction. This forward moving water has a marked influence upon the efficiency of the propeller and for convenience is referred to as the "Wake."

Wake. The water at and immediately abaft a vessel's stern which follows the vessel with differing velocities at various points as she moves ahead.

The wake is due to several causes, among which are: the effect of the natural stream line flow round a vessel's after body; the increase in thickness and velocity of a vessel's frictional belt as the stern is approached; with very full lines the actual forward drag of the water behind the stern; and, under certain conditions, the vessel's own wave action.

For information in greater detail see:

"Speed and Power of Ships," by Admiral D. W. Taylor, and

"Ship Form, Resistance and Screw Propulsion," by G. S. Baker.

Wake Gain. The increase in the effective thrust of a propeller, for a given power delivered thereto, on account of the forward motion of the water forming the wake behind a vessel's hull. The wake gain is only realized to its full extent when the water enters the propeller disc in unbroken lines of flow closely parallel to the propeller shaft and when the clearance between blade tips and hull and blade tips and surface of water is ample.

Wales. The side planking on a wood ship lying between the bottom and topside planking.

Walk Way. See Bridge, Connecting.

Wall Crane. See Crane, Jib.

Wane. Bark or lack of wood from any cause on edges of lumber.

Wardroom. A room or space on shipboard set aside for use of the officers for social purposes and also used as their mess or dining room.

Wardroom Country. All the space on a deck devoted to the quarters of the wardroom officers.

Warp. A light hawser or tow rope; to move a vessel along by means of lines or warps secured to some fixed object; the lengthwise threads in woven material so called from the operation of assembling and arranging the threads known as warping. Page 825.

Warping. A term applied to the operation of moving a vessel from one place to another about a dock or harbor by means of hawsers. The operation of changing a vessel's berth when it is not performed by tugs or its own propelling machinery.

Warping Winch. See Winch, Warping.

Wash Bulkhead. See Bulkhead, Wash.

Wash Plates. Plates fitted fore and aft between floors for the purpose of checking the flow of bilge water when the vessel is rolling.

Wash Port. See Port, Bulwark, Clearing or Freeing.

Watches. Nautical divisions of time usually four hours each for standing watch or being on deck ready for duty. The first watch extends from 8 p. m. to midnight, the mid watch from midnight to 4 a. m., the morning watch from 4 a. m. to 8 a. m., the forenoon watch from 8 a. m. to noon, the afternoon watch from noon to 4 p. m.; the watch from 4 p. m. to 8 p. m. is usually divided into two equal parts known as the first and second "dog watches"; division, usually one-half, of the officers and crew who together attend to the working of a vessel during the same watch. These are designated as the starboard and port watches, each of which is alternately on duty.

Water Ballast. See Ballast, Water.

Water Ballast Tank. A tank in which sea water for ballast is confined.

Water-courses. A term applied to limber holes and to gutters in the lower portions of compartments between limber holes.

Water Gage, Boiler. See Boiler Gage, Water.

Water Light. An apparatus for automatically lighting a ring life buoy, life boat, or raft when in the water. The light, which is self-igniting and non-poisonous, consists of a cylindrical copper receptacle filled with calcium carbide and calcium phosphide. A plug fitting into the cylinder is automatically withdrawn when casting the buoy overboard, water is admitted to the chemical compound, thereby producing in about one minute a brilliant flame lasting an hour or longer.

Waterline (Light). See Light Waterline.

Waterline (Loaded). The waterline to which a vessel sinks when fully loaded.

Water-logged. So saturated or filled with water as to be unmanageable.

Waterplane. A plane coincident with or parallel to the surface of the water and limited by the line of its intersection with the vessel's hull.

Waterplane Area. The area of the waterplane at which the ship floats.

Waterplane, Coefficient. See Coefficient, Waterline.

Water Pump. See Pump, Water.

Water Service Pump. See Pump, Water Service.

Water Tenders. Members of a ship's boiler room force who are responsible for the proper supply of water to the boilers.

Watertight Bulkhead. See Bulkhead, Watertight.

Watertight Conduit Box. See Conduit Box.

Watertight Compartment. A space or compartment within a ship having its top, bottom and sides constructed in such a manner as to prevent leakage.

Watertight Door. See Door, Watertight.

Watertight Electric Light Fixtures. See Electric Light Fixtures, Watertight.

Watertight Hatch. See Hatch, Watertight.

Watertight Plug, Electric. See Plug, Watertight Electric.

Watertight Snap Switch. See Snap Switch.

Water Tube Boiler. See BOILER, WATER TUBE.

Waterway. On wood ships the margin plank running along the edges of the decks adjacent to the inside faces of the frames. This timber is always thicker than the regular deck planking. On steel ships with planked decks the gutter formed along the sides of a deck by the waterway and stringer angle bars.

Waterway Bar. A term applied to an angle bar attached to a deck stringer plate forming the inboard boundary of a waterway and serving as an abutment for the wood deck planking.

Watt. The unit of electrical power. It is the amount of power given by 1 ampere under a pressure of 1 volt. One watt equals 0.00134 horsepower.

Wattmeter. An instrument for measuring electrical power.

Wave Length. See RADIO.

Wave Profile. In the case of the bow wave which for a given speed and ship assumes a fairly constant size, shape and position relative to the ship's length, it is the wave outline against the ship's side.

For the purposes of the strength calculation a deep sea wave is assumed and its profile considered as conforming closely to a mathematical law.

Ways. A term applied to the tracks and sliding timbers used in launching a vessel. Also applied in a general sense to the building slip or space upon which a vessel is constructed.

Ways, Ground. The stationary timbers or tracks laid upon the ground or foundation cribbing upon which the sliding timbers or ways, supporting a vessel to be launched, travel.

Ways, Launching. Two sets of long heavy timbers arranged longitudinally under the bottom of a ship with one set on each side, and sloping towards the water. Each set is composed of two separate members with the adjoining surfaces well lubricated with oil and tallow. The lower members are called the ground ways and remain stationary while the upper members are called the sliding ways and support the weight of the ship upon the removal of the shores and keel blocks and slide overboard with the ship at its launching.

Ways, Sliding. Timbers supporting a vessel to be launched which slide with the vessel along the stationary track or ground ways.

Weather Bow. That side of the bow toward the wind.

Weather Brace. A brace leading to that side of a vessel from which the wind comes. The opposite of the lee brace.

Weather Deck. See DECK, WEATHER.

Weather Quarter. That quarter of a vessel toward the wind.

Web. That portion of a beam or girder between the flanges which acts to hold the flanges in place and to resist the internal sheer stresses of the girder.

Web Frame. See FRAME, WEB.

Web Frame Angle Bars. See FRAME, WEB, ANGLE BARS.

Web Frame Angle Clips. See FRAME, WEB, ANGLE CLIPS.

Web Plate. See PLATE, WEB.

Wedge of Emersion. Consider the waterplane of a vessel floating upright as a plane fixed in its relation to the vessel. Term this the U plane. Incline the vessel to an angle from the upright. In the process of inclination the U plane forms two wedges with the surface of the water. The wedge which is above the surface of the water with the ship in the inclined position is called the wedge of emersion, while the wedge below the surface of the water is the wedge of immersion.

Wedge of Immersion. See WEDGE OF EMERSION.

Wedges. Wood or metal pieces shaped in the form of a V, used for driving up or for separating work.

They are used in launching to raise a vessel up and on to the cradle from the keel blocks.

Weeping. The very slow issuance of water through the seams of a ship's structure or from a containing vessel in insufficient quantity to produce a stream.

Weigh. To take the weight of the anchor on the chain; to hoist the anchor.

Welders. Workmen making joints by means of gas or electricity.

Welding. The art of joining or uniting two pieces of iron, steel or other metal together into one piece.

Welding iron and steel by heating the parts to be united to a plastic state and putting them together and hammering the joint has been practised for centuries.

Recently, gas, electricity and "Thermit" have come into extensive use for welding in shipwork, as machines and appliances have been devised whereby the work can be done with the parts to be welded in place on the structure.

The importance of welding, both in construction and repair work, was recognized by the Government during the war and a committee was appointed to study and promote its application. The repairs made to the damaged machinery of the interned German liners were accomplished by autogenous welding with a great saving of time and expense.

Welding, Autogenous. The process of fusing and uniting metals by the application of intense heat, without compression or hammering. Steel, cast iron, copper, brass, bronze and aluminum can be united by autogenous welding.

Welding, Electric. A term applied to the art of welding by the use of the electric current. Two general methods of electric welding are now in use, one of which is accomplished by resistance and the other by the arc.

Resistance welding may be subdivided into three groups, butt, spot, and seam. In this method the pieces to be united are clamped together in the final position desired and a current passed through the joint until the metal becomes plastic. Pressure is then applied to bring the surfaces to be united into close contact and also to exclude the oxides.

Arc welding may be subdivided into two groups, carbon and metallic arc welding. With the carbon electrode, an arc is struck at the joint to be welded, which supplies the heat and the end of a rod of metal is placed in the arc supplying the material for the weld.

In the metallic arc method, an arc is struck at the joint to be welded, which not only supplies the heat but also projects, from a globule that forms on the end of the metal electrode, the minute particles of metal that make up the material of the weld.

Metallic arc welding is performed with either a bare metal electrode or by a metal electrode coated with a flux. Either alternating or direct current may be used.

In castings and where the metal has little chance

to expand, preheating of the pieces to be welded is desirable. Pages 757, 759, 939, 957.

Lloyd's have the following tentative regulations for electric arc welding:

General

The following Provisional Rules have been adopted as a tentative measure for the classification in Lloyd's Register Book of vessels electrically welded, subject to the notations "Experimental" for electric arc welding:

The approval of the Society will be given to any system of welding which complies with these Regulations and consideration will be given to any alternative constructional arrangements which may be submitted for approval.

System of Welding and Workmanship

The system of welding proposed to be used must be approved and must comply with the regulations and tests laid down by Lloyd's Committee.

The process of manufacture of the electrodes must be such as to ensure reliability and uniformity in the finished article.

Specimens of the finished electrodes, together with specifications of the nature of the electrodes, must be supplied to the Committee for purposes of record.

The Society's Surveyors shall have access to the works where the electrodes are manufactured, and will investigate, from time to time as may be necessary, the process of manufacture to ensure that the electrodes are identical with the approved specimens.

Alterations from the process approved for the manufacture of electrodes shall not be made without the consent of the Committee.

The regulations for the voltage and amperage to be used with each size of electrode, and for the size of electrode to be employed with different thicknesses of material to be joined, are to be approved by the Committee.

The Committee must be satisfied that the operators engaged are specially trained, and are experienced and efficient in the use of the welding system proposed to be employed.

Efficient supervisors of proved ability must be provided, and the proportion of supervisors to welders must be submitted for approval.

Details of Construction

The details of construction of the vessel and of the welds are to be submitted for approval.

Before welding, the surfaces to be joined must be fitted close to each other and the methods to be adopted for this purpose are to be approved.

All butt and edge connections are to be lapped or strapped.

With lapped connections the breadths of overlaps of butts and seams and the profiles of the welds are to be in accordance with the following table:

.40 and under	2¼	.28
.60	2½	.38
.80	2¾	.48
1.00	3	.50

Intermediate values may be obtained by direct interpolation, and for thicknesses below .40 the throat thickness is to be about 70 per cent. of the thickness of the plate.

A "full weld" extends from the edge of a plate for a distance equal to the thickness of plate to be attached, and the minimum measurement from the inner edge of plate to the surface of weld is the throat thickness given in the table above.

A "light closing weld" is a single run of light welding worked continuously along the edge of the plate. Such a weld may, however, be interrupted where it crosses the connection of another member of the structure.

An "intermittent or tack weld" has short lengths of weld which are spaced three times the length of the weld from centre to centre of each short length of weld. Such tack welding may vary in amount of weld between a "full weld" and a "light closing weld."

The general character of welds is to be in accordance with the following table:

		Inside edge.	Outside edge.
(*a*)	Butts of shell, deck and inner bottom plating	F	F
(*b*)	Butts of longitudinal girders and hatch coamings		
(*c*)	Edges of shell, deck and inner bottom plating	L	F
(*d*)	Butts and edges of bulkhead plating		
		Toe.	Heel.
(*e*)	Frames to shell, reverse frames to frames and floors	T	L
(*f*)	Beams to decks		
(*g*)	Longitudinal continuous angles		
(*h*)	Side girders, bars to shell, intercostal plates, floors and inner bottom		
(*i*)	Bulkhead stiffeners		

F = full weld, L = light weld, and T = tack weld.

All bars required to be watertight are to have continuous welding on both flanges with tack welding at heel of bar.

The welded connections of beam, frame and other brackets are to be submitted for special consideration.

The Committee may require, when considered necessary, additional attachment beyond that specified above, and the welding of all other parts is to be to their approval.

Welding, Gas. A method of welding in which the heat is supplied by a torch through which a stream of gas and oxygen are united producing a flame of high temperature.

The torch is applied to the joint to be welded and the end of a metal rod is placed in the flame to supply the welding material. Acetylene gas is most commonly used for this purpose.

In castings and in work where the metal has little chance of expansion preheating of the pieces to be welded is desirable. Pages 754, 755, 756.

Welding Machine. A term commonly applied to the generator, motor generator set or transformer which comprise the principal part of an electric welding outfit. In the case of a spot welding machine, the term is generally used to include the complete outfit. Pages 757, 759, 939, 957.

Welding Outfit. The apparatus used in making welds. Such equipment may vary greatly, depending upon the welding process employed. Pages 754, 755, 756.

Welding Rods. A rod of metal either with or without a flux coating, used to supply the material in making a weld. Page 758, 890.

Well. The space between the first bulkhead of a long poop deck or deck house and a forecastle bulkhead.

Well-Deck Vessel. A merchant vessel having a sunken deck fitted between the forecastle and a long poop or continuous bridge house or raised quarter deck.

Well-Hole. A companionway or staircase enclosed on three sides.

Wells. See PUMP WELLS.

Wet Dock, Wet Slip. Wet docks are basins into which vessels are admitted at high tide through gates which when closed retain the water at a constant level, not being affected by change in tides without. A wet slip is an opening between two wharves or piers where dock trials are usually conducted and the final fitting out is done.

Wetted Surface. The area of the immersed surface of the hull. It may or may not include the wetted surfaces of the appendages.

Whaler. A vessel designed for or used in the whale trade.

Wharf. A structure built on the shore of a harbor, river, canal or the like and extending out into deep water so that vessels may lie close alongside to receive or discharge cargo or passengers

Wheel Port. See APERATURE.

Wheel, Steering. See STEERING WHEEL.

Wheelhouse. A shelter built over the steering wheel. The term is generally used relative to the house in which a hand steering wheel is located.

Whelp, Chain. A term applied to wood drums on a windlass having iron strips attached to them to grip the anchor chain and prevent wear on the drums.

Whip. The term whip is loosely applied to any tackle used for hoisting light weights and serves to designate the use to which a tackle is put rather than the method of reeving the tackle. The "single whip" or the "double whip" is the usual reference when using the term, but hatch whips, mast whips, etc., are often rove as luff tackles or as two fold purchases. A single whip gives no increase in power but simply a change in direction of the power applied.

Whip-Upon-Whip. One whip arranged to haul on the fall of another.

Whipping. Turns of twine or small stuff wound around the end of a rope to prevent it from unlaying.

Whistle. A steam or air whistle should be fitted on the forward side of the smoke stack for signaling. Pages 1006, 1035, 1037.

Whistle Control, Electric. To eliminate the danger of breakage to the whistle rope and to reduce the physical labor required to blow the whistle frequently in fog, the electric control has been developed. It consists of a controlling switch located in the pilot house and on the bridge and electrically connected to a relay located in the engine room. The closing of the control switch in the pilot house causes the relay to close which completes a circuit through a solenoid located just below the whistle valve. The pull of this solenoid operates the whistle valve. Page 1086.

Whistle Pull. A cord or rope of small diameter extending from the whistle to the pilot house and used to operate the same.

Whistle Valve, Balanced. To overcome the strong pull required to open the simple type of whistle valve against high pressure the balanced valve was developed. The principle involved is usually the same in different designs. The pull on the valve lever opens a small port which allows the full pressure of steam to pass to the atmospheric side of the valve or an extension of the main valve. This balances the pressure of the boiler side and makes the complete opening of the valve very easy. It is principally employed where the electric control is used.

White Lead. See PAINT.

White Rope. See ROPE, WHITE.

Wildcat. A special type of drum whose faces are so formed as to fit the links of a chain of given size.

Winch. A hoisting or pulling machine fitted with a horizontal single or double drum. A small drum is generally fitted on one or both ends of the shaft supporting the hoisting drum. These small drums are called gypsies, niggers, or winch heads. The hoisting drums are either fitted with a friction brake or are directly keyed to the shaft. The driving power is usually steam or electricity but hand power is also used. A winch is used principally for the purpose of handling, hoisting and lowering cargo from a dock or lighter to the hold of a ship and vice versa. It is also used to top the booms, take up on lines in miscellaneous work aboard ship, in warping a ship into dock and in some cases for working windlasses and pumps by messenger chain. Pages 322, 333, 845, 846, 847, 848, 849, 850, 852, 854, 856, 857, 858, 859, 860, 862, 863, 864, 884, 959.

Winch, Crab. A term applied to a small winch.

Winch Foundations. In the first place the deck itself in the way of a winch should be sufficiently strengthened and stiffened by stanchions, heavier deck beams or both. In case the deck is not plated it is desirable that plating of the approximate size of the base of the winch should be fitted not only to reduce vibration but also to take the holding down bolts. It is recommended that this plating be placed both on the top and bottom of the deck beams and firmly connected to them, with wood filling between the plates. With thin deck plating a doubling plate under the winch should be fitted. While it has been the custom in some yards, particularly on the Pacific Coast, to place a wood sole on the deck under a winch, this practice is objectionable because of the difficulty of keeping the wood from rotting. It is better to set the winch on the deck or on channel bar bearers and in case of a wood deck to fit a bounding bar around the winch to form an abutment for the planking. Pages 532,536.

Winch Head. A small auxiliary drum usually fitted on one or both ends of a winch. The method of operating a winch head is to take a couple of turns with the bight of a rope around the drum and to take in or pay out the slack of the free end.

The winch head is used for topping booms, handling whips, warping, etc.

Wind-catchers. Special devices, such as wind sails, air port at scoops, etc., placed facing the wind so as to create a draft of air into the space desired.

Winder. A tool used on the bending slab to handle heated shapes.

Windlass. **The American Bureau of Shipping** requires that the windlass must be of good substantial make, suitable for the size of cable required by the Equipment Table. See EQUIPMENT. Care is to be taken to insure a fair lead for the chain from the windlass to the hawse pipes. The windlass is to be well bolted down to a substantial bed; and deck beams below the windlass must be of extra strength, and additionally supported.

Windlass, Electric. See WINDLASS, STEAM. A power driven windlass in which the electric motor replaces the steam engine. The motor may be connected directly or by means of reduction gearing to the windlass mechanism.

Pages 850, 859.

Windlass Foundation. A term applied to a seating prepared for a windlass foundation. This seating may be built up from the deck or the deck may be reinforced by thicker or extra plates and shapes. In

addition pillars or bulkheads fitted under the deck help to carry the weight down to the main structural members.

Windlass, Spanish. See SPANISH WINDLASS.

Windlass, Steam. An apparatus in which horizontal drums or gypsies and wildcats are operated by means of a steam engine for the purpose of handling heavy anchor chains, hawsers, etc.

The engines are usually of the simple reversible type, the cylinders being variously disposed and actuating worm shafts which in turn operate the gypsy and wildcat shaft through the worm wheels.

Pages 853, 859, 862, 863.

Window Frame Sill. See SILL, WINDOW FRAME.

Window Sash. See SASH, WINDOW.

Window Sash, Frame, etc. See SASH, FRAME, STILE, HEADER, etc.

Windsail. A cylindrical canvas apparatus distended by hoops and used to admit air to the lower portions of a vessel. It consists of a head having two large flaps or wings extended by bowlines. These wings catch the air and direct it into an aperture in the sail. A barrel or tail led through hatches conveys the air below decks. In some cases the head is entirely open and is fitted with four flaps avoiding the necessity of constantly trimming the sail with the shift of the wind or the swing of the vessel.

Wing Frames. See FRAMES, WING.

Wing Girder. See GIRDER, WING.

Wing Tanks. Tanks located outboard and usually just under the weather deck. They are sometimes formed by fitting a longitudinal bulkhead between the two uppermost decks and sometimes by working a diagonal, longitudinal flat between the ship's side and the weather deck.

Wing, Winging. A term used to designate structural members, sails and objects on a ship that are placed at a considerable distance off the centerline.

Winging Weights. The moving of weights (already on board a ship) from the middle line towards the sides. This increases the moment of inertia and tends to lengthen the period of roll of the ship.

Winter Load Line. The waterline to which a vessel is allowed to load when going to sea in the winter time.

Wire and Cables, Electric. See ELECTRIC WIRE and CABLES.

Wire Mesh Bulkhead. See BULKHEAD, WIRE MESH.

Wire Rope. See ROPE, WIRE.

Wire Rope Fittings. See ROPE FITTINGS, WIRE.

Wireless. See RADIO.

Wireless House. A small house or enclosure usually built on the uppermost deck to house the wireless equipment and operators. Page 587.

Wood Deck. See DECK, WOOD.

Wood Hatch. See HATCH, WOOD.

Wood Grating. See GRATING, WOOD.

Working. A term in current use having a variety of applications; as, "working fit," having sufficient clearance to facilitate ease of motion; "working load," the normal load under which a structure or machine is designed to operate; "working material," material that contributes to the strength of a structure; "working part," a movable part in a machine; "working loose," the loosening of a rivet, nut, screw, etc., under strain, vibration, etc.

Worm, Worm Shaft. A threaded shaft designed to engage the teeth of a wheel lying in the plane of the shaft axis. This type of gear is used for the transmission of heavy loads at low speeds.

Worming. Filling the contlines of a rope with tarred small stuff preparatory to serving. This operation gives the rope a smoother surface and at the same time aids in excluding moisture from the interior of the rope.

Work Shop. A small space fitted out with machines and tools in which the crew may do general repair work. An engineer's and a carpenter's workshop are generally considered necessary on large vessels.

Page 682.

Wrench. A hand tool used to exert a twisting strain, such as setting up bolts, nuts, piping and fittings.

Pages 772, 775, 776.

Wrench, Ratchet Socket. A wrench designed to operate in confined spaces. It usually consists of a spindle with a socket at one end which fits over the bolt head or nut and a screw feed on the other end. The spindle is rotated by power supplied through a lever and pawl and ratchet arrangement.

Pages 772, 775.

Wrinkling. Slight corrugations or ridges and furrows due to the action of compressive forces.

Wrought Iron. Described under Steel and Iron.

Wyper. That shaft designed to operate the valve lifter arms on a beam engine.

Y

Yard. A term applied to a spar attached at its middle portion to a mast and running athwartship across a vessel as a support for a square sail.

Page 813.

Yard-arm. A term applied to the outer end of a yard.

Yardage. A term applied to the length per unit of weight of ropes and small-stuff.

Yaw. The act of sheering suddenly and uncertainly from a vessel's course. It may be caused by poor steering, by the condition of the sea, or by the characteristics of the vessel's underbody or by any combination of the foregoing.

Yield Point. The maximum tensile stress which may be impressed upon a material without straining same beyond the elastic limit. When a material is stressed beyond its yield point permanent set occurs and when the stress is removed the material fails to regain its original form.

Yoke. A frame or bar having its center portion bored and keyed or otherwise constructed for attachment to the rudder stock. The connecting rods from the steering engine or the leads from the steering gear are connected to each end of the yoke for the purpose of turning the rudder.

Page 578.

Yoke Lanyards. Line attached at the extremities of the yoke and extending to the stern sheets for use in steering a small boat.

Z

Zee Bar. A rolled shape, generally of mild steel, having a cross section shaped like the letter Z.

In ship work it is used for frames and bulkhead stiffeners.

The size is denoted by dimensions of cross sections and weight per running foot.

Z Bar Frame. See FRAME, Z BAR.

Zee Frame. See FRAME, Z Bar.

Zig Zag Riveting. See RIVETING, STAGGERED.

Zinc. Described under Metals.

Zinc Oxide. See PAINT.

Zirconium Steel. See STEEL AND IRON.

BASIC DESIGN

A TREATISE AND METHOD OF PROCEDURE

FOR DETERMINING

THE DISPLACEMENT, PRINCIPAL DIMENSIONS, COEFFICIENTS, FORM, WEIGHTS, INITIAL STABILITY, STRENGTH AND POWER

OF

MODERN VESSELS

BY

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SPECIALLY PREPARED

FOR

THE SHIPBUILDING CYCLOPEDIA

Foreword

A number of years spent in the basic design of ships of various classes has impressed the author with some of the difficulties involved, as well as with the opportunity offered by this line of investigation for greater usefulness. The present work has been undertaken in an effort to describe methods which have proved of value in such investigations.

While it is recognized that no one method of analysis is applicable in its entirety to all problems, it has been found that most problems arising in the early stages of ship design have in common certain basic considerations. The attempt is hereinafter made to discuss in a general way these basic considerations and to show the relation of each to the problem of design. An order of procedure is also suggested, partly because it has been found of very general application and partly because it affords a reasonable sequence in which to treat the several steps involved.

Treating the subject thus has necessitated partial discussion of the same item at several different places in the work. This is in accord with the principle underlying most investigations of this character; namely, a series of steps or approximations, each approaching more and more nearly to the accurate solution of the problem in hand.

The writer desires to express his appreciation of the able assistance rendered by the following gentlemen:

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Mr. E. H. Monroe, Bureau of Construction and Repair, Navy Department, Washington, D. C.; preparation of the material relative to freeboard and tonnage.

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JAMES L. BATES.

Basic Design for Modern Vessels

INTRODUCTION

BECAUSE OF THE NUMEROUS CONSIDERATIONS involved, it must be recognized that there can be no royal road to the successful design of ships. In other words, in order to become a good designer one must design and must learn through experience those methods which are most satisfactory for the particular class of work in hand.

Much information of a general, and some of a very definite and valuable character is available, but a great portion of it exists in fragmentary form. The difficulty involved in any attempt to bring together these various items of information and at the same time so to relate them as to form a logical and easily comprehended system, is recognized. It is hoped, nevertheless, that a recital of the steps and methods found of value in the actual work may be of assistance both to those already carrying the burden of design and to those beginning the study of the subject.

It is felt, further, that there exists a general tendency to economize time through the early stages of design—namely, during that period in which type, dimensions, coefficients, etc., are fixed—in order to undertake promptly the work of general arrangement, scantlings, etc. It is hoped that the information given herewith will prove of value in the preliminary stages, so that it may be possible to pass over them more promptly and with reasonable assurance that the basis laid down will prove satisfactory as the design develops.

In order to realize the results referred to above it will be necessary to deal to a certain extent in generalities, both on account of the breadth of the field and because of the comparatively wide variations in practice. Whenever possible, however, a general statement will be followed by concrete examples in order that the information may be made as definite as possible.

With the foregoing in mind it will be readily apparent that satisfactory results can be anticipated only when the suggestions made and the information furnished are utilized with a clear conception of the values and limitations inherent in any such general method when applied to a given case.

Importance of Systematic Records

IN BEGINNING THE DISCUSSION in detail of basic design, it seems desirable to touch briefly upon design data. The accurate and systematic recording of information relative to design already completed is of especial importance. If such information be supplemented by reliable reports of performance in actual service its value is greatly increased. It is largely by means of the careful keeping and intelligent study of such records that real progress is assured. It is considered hardly practicable to outline a system which would be of sufficiently general application to be of real value; in fact, the system which may be adopted for recording information is of secondary importance, provided that some definite system is adopted and conscientiously followed.

Basic Design Segregated into Six Divisions

THE STEPS INVOLVED IN BASIC DESIGN are here for convenience segregated into six principal divisions or groups. These are noted below in their usual order and are later followed by a more detailed discussion of the considerations involved and their relationships to the design.

The steps covered by the first division have for their object the adoption, tentatively, of displacement and length in order to obtain a basis for carrying out the investigations which follow and which depend directly upon the size of the vessel.

The steps included in the second division relate principally to the vessel's vertical dimensions, having in view the location of the vertical position of her center of gravity.

The steps covered by the third division have for their object the selection of the beam in order that a proper metacentric height may be realized and a reasonable period of roll in service assured

The considerations dealt with in the first three divisions are of a tentative nature, and have place in design in order to form a basis for the investigations folowing.

On the assumption that the work done up to this point has resulted satisfactorily, the determination of the most efficient length is the next step and is covered in the fourth division.

The principal steps in the fifth division relate to form and weight, the object in view being the preparation of the vessel's body plan and the obtaining of her principal characteristics, including dimensions, coefficients, strength, scantlings, weights, stability, and power.

The sixth division covers a process of refinement, and includes such subjects as freeboard, tonnage, damaged stability, etc., which, while of secondary importance when compared with the considerations previously referred to, can not be ignored if satisfactory results are anticipated.

Classes of Ships

BEFORE TAKING UP THE DETAILED CONSIDERATION of the divisions above referred to, it is necessary to recognize the existence of two principal classes of ships as determined by the general purpose for which they are intended. They are:

(a) The merchant vessel, or profit earner.

(b) The various types of naval vessel, and pleasure craft.

There is another class, miscellaneous, including barges, tugs, car ferries, dredges, ice breakers, etc. The design of such vessels, though governed by the same fundamental considerations as all other types, involves experience of an especial nature. This discussion, therefore, while applicable in some particulars, is not intended to bear upon vessels of these types.

While the treatment of the first class is of primary importance in so far as the present discussion is concerned, there are certain features which can best be treated by reference to ships of the second class. Further, it has been possible to obtain valuable information in connection with the tests, and observations of the characteristics and performances of naval vessels of various classes, which while not available to any such extent for merchant vessels, applies with certain modifications to them. It is therefore intended to include the second class in the present discussion, in so far as such a course will aid in a satisfactory presentation of the subject.

The following is an outline of the items given especial

consideration in this discussion. They are listed in their proper order under the six divisions referred to above.

FIRST DIVISION—DISPLACEMENT AND LENGTH

1. Requirements or characteristics.
2. Cost.
3. Type.
4. Displacement.
5. Length.
6. Useful load.
7. Speed length ratio.
8. Displacement length coefficient.

SECOND DIVISION—DEPTH

1. Draft.
2. Depth.
3. Midship section coefficient and area.
4. Vertical position of center of gravity.

THIRD DIVISION—BEAM

1. Period of roll.
2. Radius of gyration.
3. Metacentric height.
4. Transverse metacenter.
5. Beam.
6. Metacenter beam charts.
7. Longitudinal coefficient.
8. Approximate power.

FOURTH DIVISION—OPTIMUM LENGTH

1. Trial ships and their selection.
2. Approximate power.
3. Strength.
4. Fuel.
5. Weights.
6. Curve of margins.
7. Costs.

FIFTH DIVISION—FORM AND WEIGHT

1. Body plan.
2. Preliminary displacement and other curves.
3. Strength calculation.
4. Inertia of section and selection of scantlings.
5. Careful estimates of weights, stability and power.
6. Appendages.

SIXTH DIVISION—CHECKING AND RECAPITULATION

1. Freeboard.
2. Tonnage.
3. Floodable length.
4. Damaged stability.
5. Checking.
6. History of design.
7. Practical example.

FIRST DIVISION

Requirements or Characteristics

OVER EMPHASIS OF SOME ONE REQUIREMENT has frequently resulted in the embodiment of objectionable features in many ships actually built and in service. The most successful ship will be that which most satisfactorily embodies the greatest proportion of the requirements imposed. Inasmuch as any ship involves a multitude of different considerations and partially antagonistic requirements, it is only practicable to give unbiased attention to the ship as a whole, with an accurate knowledge of all the requirements and of the importance of each requirement relative to that of all the others. In view of the foregoing, it will be apparent that before beginning any design a clear statement of all the requirements to be met is essential.

Cost

THE QUESTION OF COST in some one of its various forms may come up in such a manner as to require consideration at the time of deciding upon the characteristics. Such a condition may easily change the whole problem of design by placing limitations upon certain characteristics. In the present discussion it is assumed that such a condition does not exist, and that the consideration of cost may be taken up after the other possibilities of the design have been investigated.

Type

FOR DESCRIPTION AND SKETCHES of various types of vessel commonly met in both commercial and naval service, reference is suggested to *The Design and Construction of Ships,* by Sir John Harvard Biles, pages 51 to 81 inclusive. Reference to *The Naval Constructor,* by G. Simpson, pages 133 to 135 inclusive, will result in further information relative to merchant types.

In so far as steam merchant vessels are concerned, the main differences between the various types referred to consist in the character and size of deck structures and erections and the number, character, and disposition of the decks.

The choice of type will depend almost entirely upon the trade for which the vessel is to be designed, there being various conditions to which the different types referred to are especially adapted.

Location of the Machinery

THE FORE AND AFT LOCATION OF THE MACHINERY is a very important subject. Generally the machinery is placed either amidships or aft. In certain classes of service the conditions are such as to leave the designer no choice between the two locations. On the Great Lakes machinery aft is almost universal. For colliers and oil tankers intended mainly for Atlantic service the machinery is at the present time generally located aft. Such a location should, however, be adopted only after a careful study of conditions.

The following advantages may be claimed for machinery thus located:

(a) A practically constant immersion of the propeller under nearly all conditions of loading.

(b) A decrease in machinery weight due to shorter propeller shafting, short shaft alley, and less bulkheading.

(c) Simplification of the problems connected with alignment and support of propeller shafting.

(d) In the case of oil tankers the necessity of fitting but one pump room.

(e) Loading facilities.

The following advantages may be claimed for machinery located amidships:

(a) Decreased bending moment in hogging condition, particularly light.

(b) Obviation of the necessity of carrying large quan-

tities of ballast in the forward portion of the vessel when at sea without cargo.

(c) Decreased variation of trim under various conditions of loading.

(d) More satisfactory behavior of the ship in a seaway, due to the symmetrical arrangement of weights. This results in much more satisfactory steering qualities, particularly in light condition.

Displacement

THE SMALLEST DISPLACEMENT on which a vessel satisfactorily meets the requirements for which she is designed should, in general, be that selected. Other things being equal, small displacement means small dimensions, reasonable coefficients, small machinery plant, low fuel consumption, low running expenses, and small cost.

While the general trend is constantly toward a larger vessel, because of increased carrying efficiency, greater possible safety, higher sustained sea speed, etc.—docking facilities, channel depths, and cargo handling appliances at terminals, do at present and will probably continue to exercise a restraining effect upon this increase in size. The above statement is true, both of merchant and naval vessels, but it is not at all contradictory to the statement previously made, that the smallest displacement on which a vessel can satisfactorily meet the requirements for which she is designed should be that adopted.

There appears to be no method of arriving at the exact displacement of a proposed vessel without the investigation in detail of the conditions laid down for the individual case. The most nearly satisfactory methods are the following:

1. The useful load or dead weight coefficient.
2. The synthetic.
3. Normand's formula.

The first method is of especial value in connection with cargo carrying ships, wherein the dead weight can be closely approximated at an early stage of the design and where the percentage of dead weight to deep load displacement is rather accurately fixed, being for moderate sized cargo carriers having speeds of from 10 to 11 knots in the neighborhood of .7. For further information see "Useful Load."

The synthetic method lends itself most satisfactorily to estimates for vessels which are very dissimilar to ships previously constructed or which are the first of a class, and consists in making a series of weight allowonces for the various main divisions entering into displacement, concerning which fairly accurate information may be available, and taking their summation as the tentative displacement.

Normand's formula is used only where a type ship with weight data is available. This method consists essentially in estimating the weight effects of changes from a type ship and multiplying the algebraic sum of such effects by a constant, in order to obtain the increase (or decrease) in displacement as compared with the type. This constant has the values shown in Table 1 for several typical classes of ships:

Table 1—Constants for Normand's Formula

Merchant vessels—general cargo type	1.30 to 1.35
Tankers and colliers	1.30 to 1.40
Intermediate and fast liners	1.50 to 2.00
Battleships	1.70 to 1.80
Fast yachts and destroyers	2.40 to 2.50

Note.—For merchant vessels the displacement is in all cases the deep load. For naval vessels and fast yachts the displacement is that corresponding to a load of two-thirds stores, reserve feed and fuel.

Whenever a good vessel exists, the data for which are available, it will be found that time will be saved and results improved by adopting same as a basis for the new design. Either of the other methods may, however, be satisfactorily used for purposes of checking.

Length

THIS DIMENSION frequently is fixed in the characteristics laid down for the design, and the limit set by the result of a number of different considerations. When, however, no such limit exists, it is generally possible to select a tentative length which will be satisfactory for the purposes of preliminary investigation. This length should be so fixed as to obtain reasonable dimensions, coefficients and capacity.

There are two coefficients, or ratios, which should receive careful consideration at this point. These coefficients are, the speed length ratio and the displacement length coefficient. The speed length ratio, $\frac{V}{\sqrt{L}}$ is the speed constant for ships of similar form. The displacement length coefficient, $\Delta \div \left(\frac{L}{100}\right)^3$ is the displacement constant for ships of similar form. The length selected should be such as will give reasonable values to each of these coefficients, the type of ship being given due consideration.

When the designer has sufficiently investigated the relationship which should exist between suitable values of speed length ratio and displacement length coefficient for ships of the type and size contemplated, he will have little difficulty in selecting a reasonable length at this point, and the more elaborate investigation referred to under Division 4 may be abbreviated or entirely eliminated. For assistance in making this selection Table 2 is given. It should be noted, however, that the range of values is so wide as to make more detailed investigation desirable when such an expenditure of time is possible.

Table 2—Speed Length Ratio and Displacement Length Coefficient

Type.	Displacement in Tons.	$\frac{V}{\sqrt{L}}$	$\frac{\Delta}{\left(\frac{L}{100}\right)^3}$
Cargo vessels	5,000 to 20,000	.45 to .65	140 to 250
Fast cargo or cargo passenger	10,000 to 40,000	.65 to .80	100 to 170
Battleships	20,000 to 40,000	.85 to .93	140 to 155
Fast passenger ships	15,000 to 60,000	.80 to 1.05	65 to 115
Battle cruisers	20,000 to 40,000	1.00 to 1.20	55 to 75
Light cruisers and scouts	2,500 to 7,000	1.20 to 1.50	40 to 50
Destroyers and fast yachts.	up to 2,500	1.70 to 2.20	39 to 45

Useful Load

USEFUL LOAD is that portion of a vessel's designed displacement which is devoted more or less definitely to the object for which the vessel is intended.

In merchant vessels it includes cargo, fuel, stores, and water—both potable and reserve feed.

In naval vessels it includes protection proper, battery, ammunition, fuel, stores, and water—both potable and reserve feed.

The principal factor affecting the value of a vessel's useful load is speed. Great speed necessitates the assignment of a large portion of the displacement to machinery; hence, great speed means small useful load. Further, great speed places a limit upon the amount of displacement which may be adopted for a vessel of given type and length, and forces the selection of a form of hull which

is conducive to easy driving. A short, full ship is economical of hull weight and a long, fine vessel is expensive.

The range of values generally realized in practice will be seen by reference to Fig. 1, in which useful load includes cargo, stores, fresh water, complement, reserve feed water, fuel, battery, battery foundations, ammunition, and protective material serving no other purpose than that of protection.

Moreover, if such saving is to be accomplished at the expense of greatly increased hull weight it is evident that for slow speed cargo vessels, on account of the very small percentage of displacement allotted to machinery weights in comparison to hull weights the saving might be entirely canceled or possibly turned into a loss.

As previously explained, one of the first steps in the design of a ship is an approximation to the displacement upon

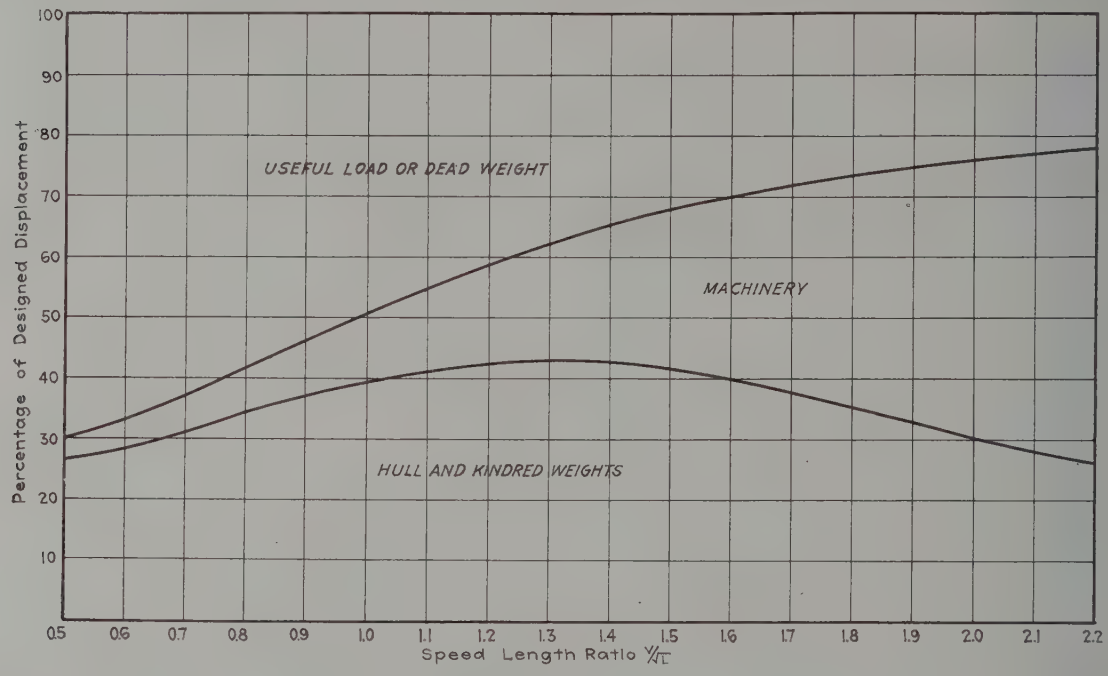


Fig. 1.—Percentages of Useful Load or Deadweight, Machinery and Hull, Plotted upon Speed Length Ratio

Hull includes besides the hull proper, fittings, equipment outfit, and designer's margin.

Machinery includes propelling machinery proper and related items, the weight being taken wet for convenience.

The results of analyses of numerous ships of varying types and sizes are plotted in Fig. 1. There may be considerable variation from the values shown, due to different causes, particularly perhaps to widely differing types of ships occurring in practically the same range of speed length ratio; for instance, tugs and fast Atlantic liners. Such variations do not, however, affect the truth of the general principles laid down above and illustrated by the figure. It will be noted that the value of the useful load decreases from about 70 per cent in vessels of the slowest types to 22 per cent or below in vessels of extreme speed; also that the hull group is subject to relatively less variation than either useful load or machinery, and that machinery in slow vessels, judged from the weight standpoint only, forms an almost negligible percentage.

The question of the size of machinery installation required, the fuel consumption permissible, the first cost of hull and machinery, etc., must receive careful consideration. In such consideration a proper conception of the relative values of the several items making up the above percentage curves is essential. Thus, while as a general principle the use of the smallest possible power plant is desirable from both the standpoint of economy of operation and first cost, the saving to be anticipated by such means is far greater in high than in low speed vessels.

which the conditions laid down can be met. The value of the ratio of useful load to load displacement follows certain general laws in practice, depending principally upon

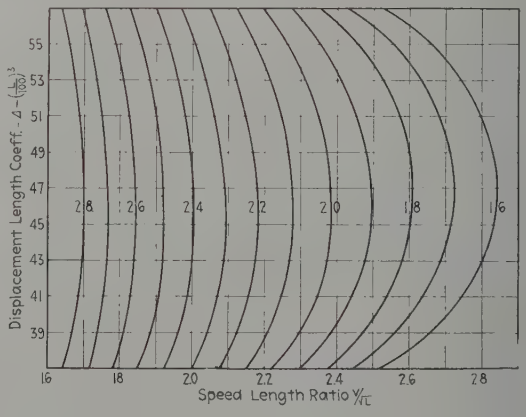


Fig. 2.—Percentages of Useful Load Plotted on Displacement Length Coefficient and Speed Length Ratio

the type, speed, and size of the ship contemplated. These characteristics being known it is possible to approximate very closely the displacement required at an early stage of

the design. Data arranged as shown in Fig. 2 and later figures are useful for this purpose.

The curves in Fig. 2 are largely based on modern destroyer practice and apply particularly to ships of from 500 to 1,500 tons designed displacement. For fast yachts of similar speeds one might obtain slightly larger values of useful load than those shown, provided careful attention were paid to the design and construction in all details.

It will be noted that the highest values of useful load correspond in general to values of displacement length coefficient lying between 44 and 47. In order to obtain the length of hull necessary for the accommodation of machinery, fuel, stores, personnel, etc., it will frequently be found necessary to decrease the above values slightly. In the vicinity of speed length ratios of 1.8 to 2.2 (where most of the modern destroyers lie), values of displacement length coefficient as low as 38 may be used without material loss in efficiency. The usual range is from 39 to 45.

It is not possible to fix the values of useful load for the various other classes of vessel so definitely as for destroyers and fast yachts. Some of the reasons for this are as follows:

In the case of nearly all naval vessels, with the exceptions of destroyers and gunboats, portions of the deck protection, longitudinal bulkhead protection, and sometimes side belt protection, form integral parts of the vessel's girder strength. It then becomes a difficult task to differentiate between ballistic and strength material.

In the case of both naval and merchant vessels the actual size and amount of displacement placed on a given length make the accurate assignment of values to the percentage of useful load difficult.

With the above statements in mind, however, the figures quoted in Table 3 may be used:

Table 3—Good Practice Values for the Ratio of Useful Load to Displacement

Type.	Displacement in Tons.	$\frac{V}{\sqrt{L}}$	Useful load / Displacement.
Cargo vessels	5,000 to 20,000	.45 to .65	.66 to .73
Fast cargo or cargo passenger	10,000 to 40,000	.65 to .80	.55 to .70
Battleships	20,000 to 40,000	.85 to .93	.53 to .59
Fast passenger ships	15,000 to 60,000	.80 to 1.05	.28 to .35
Battle cruisers	20,000 to 40,000	1.00 to 1.20	.40 to .45
Light cruisers and scouts.	2,500 to 7,000	1.20 to 1.50	.31 to .37
Destroyers and fast yachts.	up to 2,500	1.70 to 2.20	.22 to .32

Speed Length Ratio

IT IS IMPORTANT TO SELECT SUCH A LENGTH as will be suitable to the type of ship, the speed desired, and the displacement required. This point has been touched upon in connection with the selection of tentative length.

The length criterion, from the speed standpoint, is the speed length ratio or the speed divided by the square root of the length. For similar ships driven at corresponding speeds its value is constant independent of size. Durand defines "corresponding speeds" as follows: "Geometrical similarity for the two systems being assumed, corresponding speeds are those which will produce similar stream line or similar wave configurations."

It follows from the foregoing that ships of a given type, intended for the same service, and fitted with appropriate machinery for that service, may be expected to have values of speed length ratio lying within a fairly definite range. If in the process of design a length be adopted such as to throw the value of this ratio outside the usual range an abnormal ship will result and unless special and sufficient reasons therefor exist unsatisfactory performance in service may be anticipated. For example, $\frac{V}{\sqrt{L}} = 2$ is good practice for destroyers having light, fast running machinery, hulls of special design, and limited displacement. Such a value would be out of the question for a battle cruiser with machinery weighing two and a half times as much per horsepower and carrying heavy armor and armament, even though the actual speeds of the two vessels be nearly the same.

Table 4 represents present-day practice, the values given being based upon a study of several hundred merchant and naval vessels:

Table 4—Values of Speed Length Ratio for Various Classes of Ships

Type of Ship.	Usual Values of $\frac{V}{\sqrt{L}}$	Extreme Values of $\frac{V}{\sqrt{L}}$
Cargo vessels	.52 to .58	.45 to .65
Fast cargo or passenger vessels	.7 to .75	.65 to .80
Battleships	.88 to .90	.85 to .93
Fast passenger vessels	.85 to .95	.80 to 1.05
Battle cruisers	1.10	1.00 to 1.20
Light cruisers and scouts	1.30	1.20 to 1.50
Destroyers and fast yachts	1.90 to 2.05	1.70 to 2.20

Displacement Length Coefficient

THE DISPLACEMENT LENGTH COEFFICIENT is the ratio of a vessel's displacement, in tons, to 1/100 of its length in feet cubed. It is essentially a criterion of the amount of displacement placed upon a given length.

"When it comes to size we need a variable which does not change for similar models whatever the displacement. Since the displacement varies as the cube of linear dimensions, such a quantity would be Displacement ÷ (any quantity proportional to the cube of linear dimensions). As length is much more important in connection with resistance than beam or draft, a suitable quantity would be $\frac{\Delta}{L^3}$ This would usually be a very small fraction, however, and it is desirable to use a function which in practical cases assumes numerical values convenient for consideration and comparison. Such a function is $\Delta \div \left(\frac{L}{100}\right)^3$ called the displacement-length ratio or displacement-length coefficient. It is the displacement in tons of a vessel similar to the one under consideration and 100 feet long."—Taylor's "Speed and Power of Ships."

The values assigned to this coefficient in practice vary widely with differing types and sizes of vessel.

The lowest values, from 30 to 45 or 50 are associated with very fast yachts and destroyers in which power and speed are primary considerations.

The highest values are for tugs and gunboats, both types being short, deep vessels having speed length ratios of about 1. In these cases this coefficient may be from 250 to 300 or even more.

Small cargo vessels of full body have rather high values of this coefficient, lying between 200 and 250.

Battleships and large freight carriers of fair speed have values of 120 to 160.

Battle cruisers, large fast battleships, and liners of the largest size, are limited in draft by the depth of harbor channels and entrances to dry docks. This places a limit

on beam, on account of the necessity of avoiding excessive values of metacentric height, and forces the designer to obtain the required displacement by increased length. If in addition it is necessary to make high speed, the actual size of the machinery installation which is obtainable may force still greater length and finer lines.

It results from the foregoing that vessels of great displacement and high speed (though not necessarily high speed length ratio) have relatively low values of the displacement length coefficient. These values for such vessels at present in service lie between 70 and 100.

The values of the displacement length coefficient given above for the various classes of vessels are based upon the results of a careful investigation covering some fifty to seventy-five actual vessels for which accurate weights, power, characteristics, etc., were available. These vessels were made the basis for studies in which length and speed were maintained constant while displacement, beam, draft and depth were varied throughout a considerable range. The original relationship between these variants was modified only in so far as was necessary in order to obtain a reasonable ship. The weights were then carefully estimated for five vessels of a series and the resulting displacement and useful load noted. By plotting the value of the per cent of useful load on a base of displacement length coefficient it was then possible to find the most efficient vessel of the series from this standpoint. Fig. 3 shows the result of such an analysis of a modern destroyer.

It will be noted that values of displacement length ratio

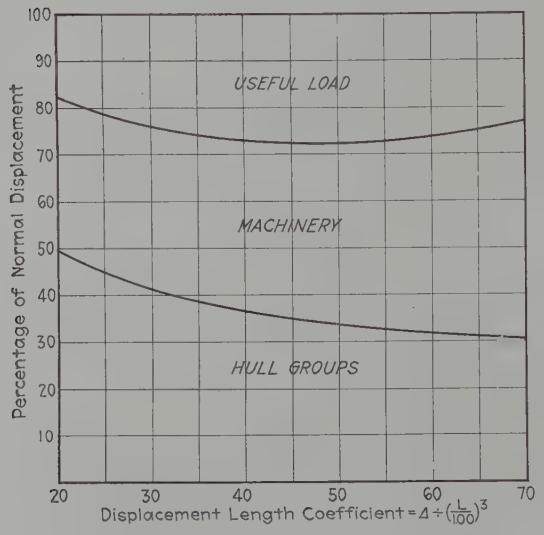


Fig. 3.—Variation in Percentage of Useful Load, Machinery and Hull, with Displacement Length Coefficient, for a Typical Destroyer

which in this study give the most efficient ship lie between 35 and 60. In practice the smallest length which will accommodate the machinery, personnel, magazines, etc., is generally selected in order to obtain a small turning circle and minimize the bending strains.

Fig. 4 represents the results of a similar analysis of a large naval collier. The differences between the value and variation of the displacement length coefficient in the case of the destroyer and the collier are of interest:

(a) The range of practical values of this coefficient in the case of the destroyer is distinctly limited, as above noted. In the case of the collier an indefinite increase up to a value of 200 results in a continuous increase in the value of the percentage of useful load.

(b) In the case of the destroyer the relative weight of the hull group decreases with the increase of the displacement length coefficient, while the machinery group weight relatively increases. In the case of the collier the relative weight of both hull and machinery groups decreases slowly with the increase of the value of the displacement length coefficient.

In view of the foregoing we can not fix the limiting value for cargo vessels as we can for destroyers so as to give a maximum useful load efficiency. The length of this particular vessel, however, was made such that it gave a value of displacement length coefficient of 146.

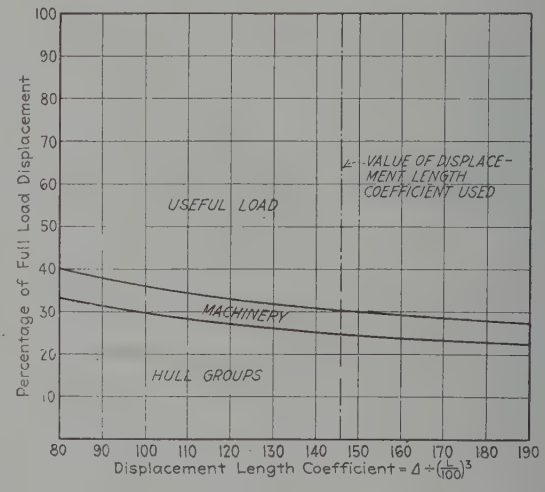
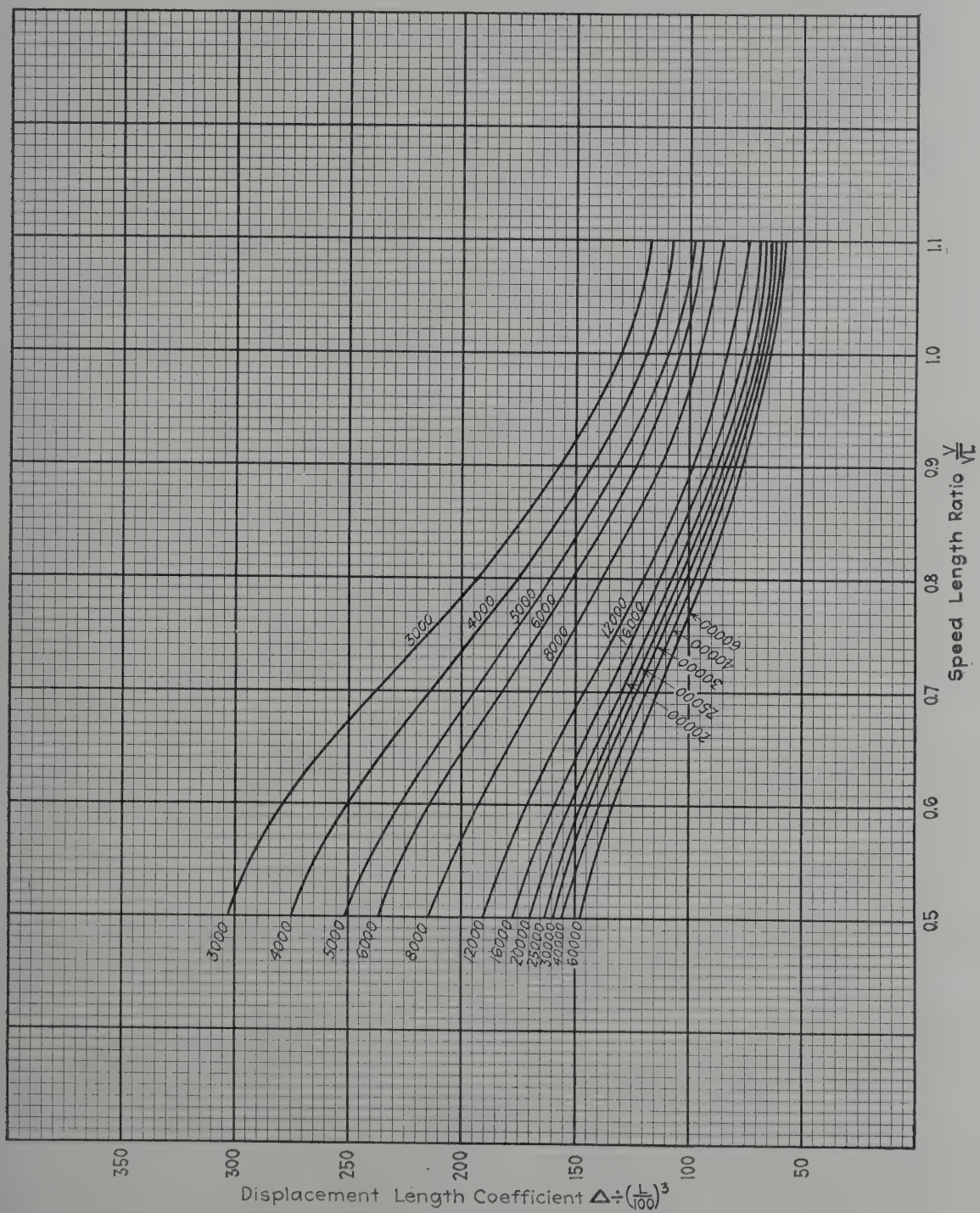


Fig. 4.—Variation in Percentage of Useful Load, Machinery and Hull, with Displacement Length Coefficient, for a Typical Collier

Inasmuch as the beam, draft, and coefficients of the actual ship were made as large as possible considering channel depths to be encountered in the ports of call contemplated, it was not considered advisable to shorten the ship further, but rather to accept this value of the displacement length ratio, 146, as representing about the best which could be expected in the case of a ship of this type and size.

The greatest value of this coefficient for purposes of basic design lies in its usefulness in the selection of dimensions. Given a knowledge of the displacement necessary and of the values of this coefficient which are appropriate for ships of certain sizes, types, and speed length ratio, it is possible at once to approximate the most desirable length very closely for those vessels in which speed and manoeuvering ability are the governing factors. Fig. 5 showing lines of constant displacement plotted upon speed length ratio and displacement length coefficient, represents good practice. The curves are not, however, applicable to heavily protected naval vessels, such as battleships, which on account of the great weights carried in high positions and the large value of the transverse radius of gyration due to the winging of weights, may be given very great beam without obtaining an excessive metacentric height.

Fig. 5—Curves of Constant Displacement
plotted upon
Displacement Length Coefficient and Speed Length Ratio



Thus relatively high values of displacement length coefficient may be satisfactorily used.

For a tabular statement of reasonable values of this coefficient for various classes of ship, see data under "Length."

Fig. 5 is furnished more on account of its value as illustrating the general law of variation for this coefficient than on account of the accuracy of the results shown. But the results are sufficiently close to those obtained in practice to warrant more than passing attention.

SECOND DIVISION

Draft

IT MAY BE LAID DOWN AS A GENERAL RULE that the greatest draft which it is possible to use gives the best result from the standpoint of all-round efficiency.

Among the principal reasons for this fact may be mentioned the following:

(a) Great draft is relatively inexpensive from the weight standpoint as compared with great length or beam.

(b) It tends toward an increase in the depth of the strength girder, which in turn makes for a lowering of the longitudinal stresses in the ship's structure.

(c) Maximum draft means maximum beam and (other things being equal) reasonable coefficients of form and reasonable values of dead weight efficiency, or useful load.

In spite of the foregoing, in designing ships for general service it is important to bear in mind the fact that the ports to which vessels drawing upwards of 25 or 26 feet in deep load condition have ready access are relatively limited in number when compared with those which are open to ships drawing several feet less.

Depth

THE VALUE ASSIGNED TO THIS DIMENSION will depend upon the draft selected and upon the freeboard required. This latter feature—viz., freeboard—will vary with length, character of sheer, type of deck erections, etc., in addition to the draft.

The rules of the Classification Society with which the projected vessel is to be classed will, in general, require scantlings such as to insure a section which will be satisfactory from the standpoint of girder strength. The ratio of length to depth proposed for the new ship may be compared, however, with similar ratios for ships in commission or with the provisions of classification societies, in order to avoid the possibility of adopting abnormal values. For the same reason the ratio of beam to depth should be examined in comparison with values adopted in practice.

In the case of ships designed to meet extreme conditions for which there is no type ship available, a rough strength approximation is highly desirable. For the purposes of such a calculation the bending moment may be derived by means of the well-known formula, $M = \frac{\Delta \times L}{C}$, in which Δ = displacement, L = length, and C is a constant the value of which depends primarily upon the longitudinal distribution of weights and buoyancy. Values of C for merchant vessels given in Table 5 will be found useful in this calculation:

Table 5—Constants for Longitudinal Strength Formula

Type.	Value of C.	
	Hogging.	Sagging.
Cargo vessels	25—29	18— 28
Passenger cargo vessels	22—29	40— 50
Battleships	30—35	55—100
Large, fast passenger ships	24—28	30— 35
Battle cruisers	27—33	40— 55
Scouts	25—35	40— 50
*Destroyers	22—28	16— 24
**Destroyers	19—25	23— 31

*Coal burners, fuel stowed amidships.

**Oil burners, fuel stowed in deep tanks at ends of machinery spaces.

In order to further simplify this approximation to the vessel's strength it is possible to base the inertia of section upon the material in the principal strength decks and bottoms, only allowing for the effect of side plating and vertical members by means of a percentage. This is not advocated in general, as it introduces an additional element of uncertainty.

Reference is also suggested to a paper by W. S. Abell entitled "Some Questions in Connection with the Work of the Load Line Committee." This paper was read before the Institution of Naval Architects April 12, 1916. Both the paper itself and the discussions thereof are considered of value to those interested in the strength of merchant ships.

Midship Section Coefficient and Area

THE BLOCK COEFFICIENT divided by the midship section coefficient is the prismatic coefficient. Inasmuch as the longitudinal distribution of the displacement of a ship is quite largely dependent upon the area of its greatest or midship section, it is apparent that the fixing of the area of the midship section is of considerable importance.

If it were practicable to design from the standpoint of the lowest possible resistance to driving, only the largest areas of midship section would be desirable for slow ships. This statement is supported by the findings of both Admiral D. W. Taylor and G. S. Baker. Limitations to draft and consideration of stability usually affect the area given.

For large vessels the above limitations make necessary the use of very high values of midship section coefficient, in order to obtain the lowest possible longitudinal coefficient. For oil tankers and slow cargo vessels generally, .96 to .98 represent common values, although the figure is sometimes as high as .99, and in the case of so-called simplified form vessels with no radius at the bilge and no rise of floor, a value of 1.0 has been successfully used.

In extreme cases it is possible to use a value of midship section coefficient slightly greater than unity where it is essential to obtain large area without excessive metacentric height. For small vessels of low displacement, in order to provide satisfactory seagoing qualities and to make possible the holding of the head of the ship up against wind and waves, it is customary to give as great a draft as practicable and to use considerable rise of floor associated with slack bilges. This has resulted, in destroyer practice, in using values of midship section coefficient as low as .65.

The values given in Table 6 are used in good practice for the different types of vessel enumerated:

Table 6—Midship Section Coefficients

Oil tankers and cargo carriers	.96 to .99
Fast cargo or cargo passenger	.94 to .98
Battleships	.98 to .99
Fast passenger vessels	.95 to .97
Battle cruisers	.95 to 1.03
Light cruisers and scouts	.90 to .95
Destroyers and fast yachts	.65 to .90

Admiral Taylor, in "The Speed and Power of Ships," gives data which indicate that between values of beam to draft ratio running from 2.6 to about 3.4, values of midship section coefficient lying between .8 and .95 may be expected to give most satisfactory results from the standpoint of wetted surface. This in itself would appear to indicate that values much in excess of .95 could not be satisfactorily used for slow cargo vessels in which the frictional resistance may amount to from 80 to 85 per cent of the total resistance, except that practice seems to indicate that adoption of the greater coefficient referred to above, with the resulting increase in cargo capacity and decrease in longitudinal coefficient is of more value than the relatively small saving in frictional horsepower to be expected from the use of a smaller midship section coefficient.

In the case of vessels in which the provision and location of longitudinal strength members is of great importance, a flat-floored midship section is of considerable advantage, inasmuch as it makes possible the location of the shell plating and longitudials at a maximum distance below the vessel's neutral axis.

Mr. Baker states that great care must be exercised in the design of sections where the parallel middle body is worked into the entrance and run, in order to avoid the formation of eddies.

For vessels of the slow cargo type Mr. Baker gives a formula and diagram for determining the optimum value of midship section area for low wave making, the displacement and speed being given. See "Engineering," March 7, 1919, page 307.

For further information in this connection, reference is suggested to "Speed and Power of Ships" (D. W. Taylor), pages 95, 97, and 104; and "Ship Form Resistance and Screw Propulsion" (G. S. Baker), sections 43, 44, 45, 47, 49 and 51.

For vessels of high speed length ratio it is not practicable to adopt high values of midship section coefficient. Some of the reasons for this are the following:

Relatively full ended forms, high longitudinal coefficients, and therefore low midship section coefficients, are desirable from the driving standpoint.

Considerable draft and rise of floor, especially forward, are advantageous for light, fast vessels intended to operate in a seaway, in order to avoid pounding, and from the standpoints of girder strength and behavior in a seaway. Admiral Taylor in "Speed and Power of Ships," page 96, writes, "For vessels of usual types and of speeds in knots no greater than twice the square root of the length in feet, the naval architect may vary widely midship section fullness without material beneficial or prejudicial effect upon speed"; also, "It should be most carefully borne in mind that the above applies to the shape and coefficient of a midship section of a given area, not to the area of the section."

For slow speed vessels the middle body or midship portion is placed somewhat forward relative to M.P. resulting in a ratio of run to entrance of about 1.1 to 1.2. The principal reasons for this difference in length between the fore and after body are to be found in the fact that the tendency to produce eddies along the after body is materially reduced by the use of the finer lines, and as a result the efficiency of the propeller is increased. For further information in detail it is suggested that reference be made to G. S. Baker's "Ship Form Resistance and Screw Propulsion," page 93, and Naval Constructor McEntee's paper read before the Society of Naval Architects and Marine Engineers in November, 1918.

For fast vessels the location of the area of greatest section is not very clearly defined, excellent results having been obtained by locating this section at a very considerable distance aft of the mid-perpendicular and practically as good results being obtained with the section located at the mid-perpendicular. In the case of extremely high-speed vessels having values of the speed length ratio in excess of 2, it is customary to immerse the transom deeply so that a positive area of considerable size is obtained at the after perpendicular. It would appear that this results in increasing the vessel's effective length without the addition of increased wetted surface, so that while the section of maximum area is located considerably aft of the mid point of the vessel's actual length, it is not generally placed aft of the mid point of the virtual or effective length which the ship would have were it not for the terminating of the form at the transom.

Vertical Position of the Center of Gravity

IN VIEW OF THE IMPORTANCE OF THE METACENTRIC HEIGHT, the necessity for obtaining an accurate idea of the vertical position of the center of gravity at an early stage of the design will be appreciated. In so far as the geometrical features of the vessel are concerned, the principal items affecting the vertical position of the center of gravity are:

Depth of hull, rise of floor, type of sheer line, type of keel contour.

From the standpoint of the location of weight the principal items to be considered are, the position of the machinery, the position of heavy decks and superstructures; in naval vessels, the position of guns, ammunition, armor, etc.; in merchant vessels, the location of cargo; and in all vessels the location of fuel, reserve feed, etc. In connection with this latter item especial attention is invited to the necessity of making proper allowance for the effect of free surface in case water or fuel oil is carried in wide, shallow tanks. It has been found in practice that where the depth of a tank is approximately equal to its width in the athwartship direction, the effect of free surface is practically negligible unless the particular problem in hand makes necessary a very small metacentric height, in which case careful, detailed estimates are necessary.

A careful study of numerous vessels of varying types and classes has been made, and the results shown in Table 7. The values given are in nearly all cases based on carefully conducted inclining experiments for several vessels of a given class or type. For vessels of the merchant type the loading to which the figures given correspond is what is ordinarily termed deep load; namely, with full cargo, fuel, stores, etc.; for strictly naval vessels a trial loading corresponding to full ammunition and two-thirds full supply of fuel, stores and water is used.

For the naval vessels just referred to the height of the c. g. in full load condition varies but slightly (probably not

Table 7—For Estimating Vertical Position of Center of Gravity

Type.	Approx. value of mid. sec. coeff.	Ratio of V. C. G. Above Base to Depth of Ship to Strength Deck. Light Condition. Average.	Light Condition. Range.	Designed Condition. Average.	Designed Condition. Range.	Structure Above Strength Deck Sheer Line.
Colliers	.97	.70	.67-.72	.58	.56-.60	Forecastle and poop.
Oil tankers	.97	.63	.62-.65	.51	.50-.53	Forecastle and poop.
General cargo	.96	.64	.62-.68	.56	.54-.58	Forecastle, bridge house and poop.
Cargo passenger	.96	.68	.66-.70	.61	.58-.64	Various.
Naval auxiliaries and tenders	.90	.63	.59-.67	.55	.51-.57	Various.
Modern battleships	.98	.73	.72-.74	.67	.66-.68	Flush deck.
		.735	.72-.75	.68	.67-.70	Forecastle.
		.745	.73-.76	.72	.70-.74	Upper deck half length.
Fast passenger ships	.95	...	.....	.57	.55-.60	Superstructure amidships.
Modern destroyers	.65-.67	.625	.61-.64	.58	.565-.60	Forecastle ¼ length.
	.75	.615	.605-.635	.57	.56-.59	Forecastle ¼ length.
	.75	.64	.63-.65	.595	.59-.60	Flush deck.
Power driven yachts	.80-.90	...	.....	.58	.56-.60	.....

See also data given by Simpson in "The Naval Constructor."

more than 2%) from its position in the designed or trial condition.

In the design of a vessel it should be borne in mind that she may go to sea, or at any rate be at sea, under a variety of conditions of loading. A cargo vessel, for example, upon nearing the end of a voyage may have very little fuel on board, or it may be necessary to go from port to port practically light. If the fuel or the cargo be so located in the vessel that either is quite a distance from the center of gravity of the ship light, a marked variation in the value of the metacentric height of the vessel may be anticipated. Somewhat similar variations will occur in all ships. It is accordingly customary to estimate the value of the metacentric height for several conditions of loading. Among the conditions most commonly used are the following:

(a) Ship light with no cargo, stores, fuel, water or coal on board.

(b) Ship completely loaded with full supply of cargo, stores, fuel and water on board.

(c) Conditions intermediate between (a) and (b), as may be considered desirable.

It is desirable in order to obtain a satisfactory value of the metacentric height in all conditions, to design a vessel so that the vertical position of center of gravity will be maintained throughout the various conditions of loading at an approximately constant distance below the corresponding position of the transverse metacenter. It is not always possible to attain such a result. This is especially the case in full cargo vessels subject to great variations in draft. The height of metacenter at the lower drafts in such vessels is usually very great, and it is only by filling all top-side ballast tanks or by adopting other similar means of raising the effective center of gravity of the vessel that it is possible to obtain a small enough value of metacentric height to give a ship reasonable seagoing characteristics. Reference to the metacentric charts will illustrate this point further. It will be noted that in the case of vessels having a beam to draft ratio of from 2 to 3, the height of the metacenter above base is approximately constant. When, however, the value of this ratio materially exceeds 3, the height of the metacenter increases very rapidly. Inasmuch as a 20,000-ton cargo carrier having a beam of 65 feet might at some times be at sea with a draft of 16 feet, thus giving a ratio of beam to draft of something over 4; it will readily be recognized that the difficulty of reducing her metacentric height to a reasonable figure will under such circumstances be considerable.

As has been referred to elsewhere, it is very undesirable from a seagoing standpoint to design a vessel with a center of gravity materially above the load waterline. An extreme case of such a design may be instanced: This vessel had a height of center of gravity above the waterline equal to about half her draft. She had a reasonable metacentric height in all conditions, it being practically constant until deep load was reached, where it increased considerably over its value in the lighter conditions. The range of stability and righting arm were fairly satisfactory in all conditions excepting the light load, in which case a very small righting arm and a comparatively small range were realized. In a seaway, however, this boat was notably uneasy and disconcerting in its behavior. It is believed that this was the result of a center of gravity so high that the lines of action of waves meeting the vessel fell in nearly all instances well below it, thus in every case having a marked tendency to displace the vessel from her perpendicular position in spite of the fact that her moderate metacentric height and relatively large radius of gyration should have made a comfortable and satisfactory sea boat.

In connection with the subject discussed in the preceding paragraph, attention is invited to the fact that in nearly all ships, regardless of type, the center of gravity lies within a moderate distance of the vessel's waterline, so that it is not often that the difficulties just described are experienced.

THIRD DIVISION

Period of Roll

SHIPS HAVE TWO PRINCIPAL KINDS OF OSCILLATION, termed respectively, rolling and pitching. (Heaving is sometimes mentioned in this connection, but is relatively unimportant.) Rolling is applied to motion in the transverse direction, and pitching to motion longitudinally. The more important of these two kinds of oscillation is rolling, because upon this characteristic depends the comfort of the personnel, the safety of the ship in a sea, and the character of the transverse strains which she experiences. Moreover, the arc through which a vessel may be expected to roll is greatly in excess of the arc through which she may be expected to pitch. In the case of naval vessels the good or bad qualities of the vessel as a gun platform are largely dependent upon her period of roll.

If the time in seconds of a single unresisted oscillation be denoted by T, the metacentric height in feet by GM, and the radius of gyration in feet about a longitudinal axis through the center of gravity in feet by K, then the

law governing their relationship may be expressed in the form,—

$$T = .554\sqrt{\frac{K^2}{GM}}$$

This expression may be used in arriving at a still-water period of oscillation for a proposed vessel. Knowing the period which it is desired to obtain, it is customary at an early stage in the vessel's design to so associate the values of metacentric height, beam and under-water form as to give a satisfactory value for the period of roll. In making this approximation it is not customary to calculate the value of the radius of gyration, but to use a value based upon vessels of known characteristics and performance. The expression referred to above assumes unresisted rolling. For actual vessels under ordinary conditions of service the period will not be materially affected by resistances, such as bilge keels, docking keels, plate edges, etc.

The resistances experienced are of three different characteristics; namely, wave-making, frictional, and positive. The wave-making is due to the change of form in the vicinity of the vessel's water-line. The frictional is due to the passage of the vessel's skin through the water, and the positive is due to the direct opposition of plane surface such as bilge and docking keels, shaft bossing, deadwood, etc. All these resistances combine to decrease the amplitude of roll, but do not have a material effect upon the period.

Forced rolling among waves may, however, result in very different periods from those obtained in still-water conditions.

In the design of a vessel it is seldom possible for the naval architect to exercise control over the location of the principal items of weight, in so far as the relationship to the longitudinal axis through the vessel's center of gravity is concerned. The location of such weights is largely determined by the vessel's general type; thus, in the case of a battleship we have an exaggerated instance of the winging of weights on account of the location of the main armor belt placed at the vessel's extreme beam, the placing of turrets, main battery guns, barbettes, conning tower, etc., at great heights, and the carriage of fuel or reserve feed water in the vessel's wings. In the case of a destroyer or the ordinary merchant vessel, such a winging of weights is not practicable.

It results, accordingly, that the principal means by which a designer may regulate the period of roll is by the changing of the value of the metacentric height. An increase in the radius of gyration or a decrease in the metacentric height will result in an increased period of roll, while decreases in the radius of gyration or increases in the metacentric height will tend to decrease the period of roll. The table (see radius of gyration), which is based upon numerous reports for actual ships, indicates satisfactory values for the period of roll.

Radius of Gyration

ONE OF THE TWO FACTORS vitally affecting the period of roll is the radius of gyration. Its value is so largely dependent upon the type and beam of the ship as to be practically beyond the control of the designer. Nevertheless, the winging of weights wherever possible is of assistance in increasing its value and so increasing the period of roll.

While, as above stated, the value of the radius of gyration is not readily controllable, a fairly definite knowledge of its probable value for various types and sizes of ship is possible, and is of considerable importance.

Table 8 has been prepared in order to show the relationships existing between the several factors affecting the periods of roll of representative types and sizes of ship:

Table 8—Factors Affecting the Period of Roll

Type	Displacement, tons.	Beam, feet.	Draft, feet.	Radius of Gyration, feet.	Approx. Value G.M. Designed Condition, feet.	*Period of Roll, Secs.
Tankers, colliers, and miscellaneous cargo vessels...	5,000-20,000	40- 65	19-28	13-25	2.0-3.0	10-14
Naval auxiliaries	5,000-12,000	40- 60	20-26	13-23	2.5-3.5	9-12
Modern battleships	20,000-40,000	85-105	25-33	28-37	4.5-7.0	13-16
Fast passenger vessels ...	15,000-60,000	60-100	25-40	20-38	2.0-4.0	15-18
Destroyers ...	500- 2,500	25- 37	7-12	9-13	2.0-2.5	7- 9
Yachts, power driven	75- 1,000	15- 30	4-11	5-10	1.5-2.0	4.5-8

*This is a double oscillation and is equal to 2T as used in the formula for unresisted rolling.

Metacentric Height

THE CHARACTER OF A VESSEL'S METACENTRIC HEIGHT determines into which of the following conditions of equilibrium she falls:

(a) Negative metacentric height, when the vertical center of gravity is above the metacenter, results in unstable equilibrium. The ship will heel until the lines of action of gravity and buoyancy coincide, when stable equilibrium is established; or failing this, will continue to heel until capsizing takes place.

(b) Zero metacentric height, when the vertical center of gravity is coincident with the metacenter, results in neutral equilibrium. In this condition the ship tends to remain in the position occupied until moved therefrom by an external force.

(c) Positive metacentric height, when the vertical center of gravity is below the metacenter, results in stable equilibrium. The ship will then tend to return to its vertical position whenever forced therefrom by the action of some external force.

Theoretically a ship should be so designed that her metacentric height remains at approximately a constant value independent of loading. This is frequently not possible. A cargo vessel of ordinary design will usually have a position of metacenter at her lower drafts such as to entail an excessive metacentric height, except where ballast can be carried at a great height as in topside tanks. This is due to the fact that the value of the inertia of water plane does not decrease materially at lower drafts for vessels of the cargo type, while the displacement becomes relatively very small.

On the contrary, a war vessel frequently will have a relatively small metacentric height when light, but an entirely satisfactory one when partially or fully loaded. This difference is partially explained by the different proportions adopted for the war vessel, her beam to draft ratio being usually in excess of 3 as compared with 2 to 2½ in the cargo vessel. This change in proportions throws the war vessel on to that part of the curve of metacenters where large variations in draft produce slight changes in the height of the metacenter. Further, the difference in draft between the light and deep load is much less in the war than in the cargo vessel, because so large a portion of the useful load of the war vessel is made up of protection, guns, etc., which are fixed. Thus the change in

draft between light and deep load may be 15 to 20 feet for the cargo vessel as against 6 or 7 for a battleship of similar displacement.

Allowance for the Addition of Top Weights

IN CONSIDERING THE VALUE to be assigned to the metacentric height at an early stage in the design, the decrease to be anticipated during design development and later must be allowed for.

During the development of the design and subsequent to the fixing of the dimensions, numerous additions of features not originally contemplated frequently take place. These additions usually result in increased top weight, raising the center of gravity of the vessel and decreasing the metacentric height.

During the service of a ship weights are seldom added to her underbody or bottom. But the life of the vessel is largely lived on her upper decks and bridges, and the need for additional weight of various kinds frequently develops in this vicinity. Accordingly the greater part of the weights added during the vessel's life are high weights and, as pointed out in the preceding paragraph, such additions tend to raise the center of gravity while in most cases decreasing the height of metacenter due to increased displacement. This tendency is not so marked in merchant as in naval practice. In naval practice, as the result of changes during the vessel's design and building, from .3 ft. to .5 ft, of metacentric height is frequently lost. During a period of ten or a dozen years of actual service a half foot more may be lost, so that a decrease of 12 inches from the designed metacentric height of the vessel is sometimes experienced, even where great attention is paid both to details of design and construction.

Due consideration being given to possibilities such as the foregoing, a value of metacentric height such that a satisfactory period of roll may be assured is to be selected. The realizing of a proper value for this feature is perhaps the most important single consideration in the basic design of any ship. In its selection, both the actual size and type of vessel have considerable weight. Thus a 40,000-ton battleship with its great radius of gyration (due to its great beam and winging of weights) may be satisfactorily given nearly twice the metacentric height of a 40,000-ton merchant passenger ship.

The foregoing assumes normal conditions of service. In the event of damage, particularly severe and sudden damage such as to permit an inrush of water in large quantities, a small metacentric height may prove insufficient to safeguard a vessel during its initial heel. After this stage is safely passed and the ship assumes a state of equilibrium under the new conditions it will frequently be found that the resulting metacentric height is as great or greater than that which existed in the undamaged condition.

The considerations involved in a study of damaged stability are touched upon more in detail elsewhere. It is only necessary at this point to emphasize the importance of fixing the value of the metacentric height so as to meet the requirements of the ship when damaged as well as when intact.

For reasonable values of the metacentric height for various types and sizes of ship, see table given under "Radius of Gyration."

Transverse Metacenter

THE DISTANCE between the center of gravity and the transverse metacenter of a vessel—namely, the metacentric height—exercises a most important influence upon the vessel's behavior when among waves. It is, therefore, essential that the position of the metacenter be known as accurately and at as early a stage in the design as is practicable.

It is, of course, possible to obtain the desired height of metacenter by the adoption of any one of several combinations of water-line, beam and block coefficient. The type of ship contemplated will, however, in most cases, restrict the shape of water-line and value of coefficients within comparatively narrow limits. While this statement is in general true, there frequently arise problems in design which render necessary a departure from values which under ordinary circumstances would be considered good practice. For example, the adoption of a full ended water-line for a vessel which is to carry very heavy end weights would be advisable on account of the deep pitch which might be expected when a vessel with very fine ends is running into a head sea. Such a consideration is sometimes lost sight of in the desire for forms of low resistance.

Good practice has also fixed with a fair degree of certainty desirable values of sectional coefficients for given types of load water plane and curves of sectional area. As referred to in the previous paragraph, it is possible to vary such coefficients through quite a wide range. Such variations, however, may have a noticeable effect, both upon the vessel's driving qualities and her behavior in a seaway. Very full U-shaped sections forward, giving high sectional coefficients associated with fine angles of entrance, in some cases decrease resistance markedly but they tend to produce a wet ship. As a further example, broad water-lines aft with high values of the sectional coefficient are generally conducive to low resistance at high speeds, but may result in pounding and bad steering unless great care is exercised in the design.

It has accordingly been found advantageous to adopt a system of standard curves of sectional areas and load water planes, associated with suitable values of longitudinal coefficient. Functions for such curves may be found herein under the proper headings. They are based upon the area of the midship section or upon the maximum half breadth, as the case may be, so that, these features being fixed, it is possible to read off suitable values for areas of sections or water plane half breadths. While it is not suggested that sectional area curves and load water-lines, which would in certain cases be superior to the standard curves submitted, can not be laid down, nevertheless the standard curves have been prepared as a result of much investigation and comparison of actual performances. They represent good practice and may wisely be adopted without material change, unless accurate information of especial application to the case in hand is available.

Whether or not these curves are adopted in toto for the final design, they form an excellent basis for the preliminary body plan and for investigations of the comparative weight, power, strength, etc., of alternative designs.

The particular value of the proposed curves of sectional area consists in the accurate basis which they provide for promptly laying down sectional area curves of a desired displacement and reasonable shape and at the same time giving a known value of the longitudinal coefficient.

The curves of load water-lines are furnished with two objects in view. They afford a means of laying down at once a fair load water-line of known area which represents good practice as to shape and is associated with a reasonable value of the longitudinal coefficient. Their

greatest value, however, is found in the basis they provide for the derivation of metacenter, beam and midship section coefficient curves shown on the metacentric charts following. These metacenter beam curves make it possible to select the proper beam at once without referring to formulae or calculations based upon a type ship. This is especially important when it becomes necessary to design ships of widely varying types or when questions of stability involve changes in the location of weights on ships in process of design. They are also of value for estimating purposes in connection with completed ships, where the usual displacement sheet with metacentric curves is not available.

In order to render the curves as flexible as possible the values of the relation, $l \times \frac{m}{p}$ and of the factor k, have been entered on each of the sheets so that the basis for the sheet itself is immediately known.

Accuracy of Metacenter Beam Charts

WHERE THE STANDARD WATER-LINES are closely adhered to the metacentric beam curves may be expected to give results which are accurate within less than one per cent, or almost as close as can be expected from the best detailed calculations. These results are much more accurate than the estimated height of the ship's center of gravity at even an advanced stage of the vessel's design.

The curve sheets have been prepared in such a way as to apply to the three classes of ship; namely, those designed for low speed, those designed for moderate speed, and those intended for high speed. In the case of the low and moderate speed charts, which include vessels of all types with the exception of destroyers, torpedo boats and fast yachts, the ordinary ship-shape form with V or U sections has been assumed and the curve of sectional area so drawn as to be O at A.P. and F.P. These curves are divided into two sets; one for ships of lower speeds having parallel middle body, the length of middle body used being such as is sanctioned by good practice and by the investigations of Admiral Taylor and Mr. Baker; the other for ships of moderate speeds has been given no parallel middle body. In the case of the charts for the high speed vessels a certain amount of area has been given at AP. It is recognized that this area may be obtained either by a very wide water-line and small immersion of transom, or by a comparatively narrow water-line associated with a V-shaped transom and deep immersion. The type of water-line selected, as well as the type of sectional area curve, are considered to be in accordance with good practice and are, in fact, based upon models which have shown good results under test.

Beam

THE PRINCIPAL INFLUENCE which a vessel's beam exerts is upon her resistance and stability. The resistance is largely influenced through the value of the area of the midship section, which affects directly the value of the longitudinal coefficient. It is a common error to associate high resistance with vessels having great beam. That this is an erroneous idea has been frequently proven by model tests made for various classes of ships and at various model basins. The value of the beam to draft ratio may be varied through quite a wide range without materially affecting the resistance of a vessel. It will, in fact, be found advantageous from the standpoint of driving to use as large a beam as is practicable, consistent with satisfactory stability qualities, in order to obtain the fine ends so necessary in slow and moderate speed vessels.

The beam is the principal factor by which a vessel's height of metacenter, and therefore her behavior among waves, is regulated. It is practicable to vary the beam and the water plane coefficient through a limited range and hold the height of metacenter constant, but for an ordinary type of vessel in which a given height of metacenter is desirable, the appropriate beam is fixed by practice within comparatively definite limits.

In determining the metacentric height desirable for a given type of ship the relationship of a vessel's freeboard to her beam should receive consideration, it being noted that the range of stability is more directly influenced by the freeboard given to a vessel than by the beam. For example, a monitor having a metacentric height of 12 or 13 feet, a beam of 50 feet, and very small freeboard, may have a maximum righting arm of 3 or 4 feet, but a range of no more than 50° or 60°, whereas a vessel of similar beam and but 2 or 3 feet metacentric height, but having a freeboard of 15 or 20 feet, may have a maximum righting arm of about 3 feet and a range of 80° to 90°.

Metacenter Beam Charts

THE PROBLEM of determining the most desirable dimensions and coefficients for a proposed ship to meet any given set of conditions is made difficult because a change in one characteristic generally calls for changes in others. For example, the required speed being given, a change in length requires a change in power plant, which in turn requires a change in the amount of fuel to be carried. The weight of hull also is affected. At the same time the load water-line is changed and this may affect the metacentric height, which would call for a change in beam, etc. The problem is generally solved by the trial and error method, but any system which can be introduced whereby one or more characteristics are made independent of the others tends to simplify the solution.

It is generally recognized that with other characteristics given, the beam is determined by the height of metacenter required. The method here proposed and the charts which are appended enable the designer to choose in the preliminary stage of design that beam which in connection with the draft and midship section coefficient selected will give exactly the height of metacenter desired. The length and longitudinal coefficient adopted (the displacement being constant) will have no effect upon the height of metacenter so long as this system is followed. The charts also enable one to determine the effect which contemplated changes in midship section coefficient or beam will have upon the metacenter.

In the following demonstration,

L = *Length of ship on L. W. L.*
B = *Beam amidship on L. W. L.*
H = *Mean draft.*
l = *Longitudinal coefficient.*
m = *Midship section coefficient.*
p = *Water plane coefficient.*
I = *Moment of inertia of L. W. L.*
ρ = *Radius of gyration of L. W. L.*
W = *Area of L. W. L.*
V = *Volume of displacement.*
K = *A factor hereafter described as the "Moment of Inertia Factor."*
M = *Height of metacenter above base.*
CB = *Height of center of buoyancy above base.*
BM = *Distance from c. b. to the metacenter.*

By Normand's formula,

$$CB = H - \frac{1}{3}\left(\frac{H}{2} + \frac{V}{W}\right) \quad \ldots\ldots(1)$$

and by common consent

$$BM = \frac{I}{V} \quad \ldots\ldots(2)$$

Then $$M = \frac{I}{V} + H - \frac{1}{3}\left(\frac{H}{2} + \frac{V}{W}\right) \quad \ldots\ldots(3)$$

but $$I = \rho^2 W = \rho^2 pLB \quad \ldots\ldots(4)$$

$$V = lmLBH \quad \ldots\ldots(5)$$

and $$W = pLB \quad \ldots\ldots(6)$$

whence by substitution and simplification (3) becomes,

$$M = \frac{\rho^2 p}{lm}\frac{1}{H} + \frac{5H}{6} - \frac{lm}{3p}H \quad \ldots\ldots(7)$$

Now ρ, the radius of gyration, is a linear quantity, and for a given water plane may be expressed as $\sqrt{K}B$. If, then, the given water plane be expanded either in breadth only or in both breadth and length, the new beam becoming B_1, then the radius of gyration of the expanded plane is $\sqrt{K}B_1$. In other words, $\sqrt{K}$ is constant for a type plane regardless of the size to which it may be expanded. In equation (7), therefore, substitute KB^2 for ρ^2 and we get,

$$M = \frac{Kp}{lm}\frac{B^2}{H} + \frac{5H}{6} - \frac{lm}{3p}H \quad \ldots\ldots(8)$$

This is the general equation upon which the Metacentric Beam Charts are based. The first term of the second member comes from the expression $\frac{I}{V}$, and is absolutely accurate mathematically. The last two terms come from the Normand formula, and the accuracy of the equation therefore depends upon the accuracy of the Normand formula. To determine the degree of accuracy to be expected from this formula, some sixty-four ships of all sizes and types were investigated. The centers of buoyancy of these ships were computed by formula and the results compared with the results from detailed calculations. The average error for the Normand formula was found to be slightly under seven one-thousandths of a foot, amounting to six one-hundredths of one per cent. Individual errors were in most cases less than one-tenth of a foot, but in a few cases ran as high as two-tenths. One ship showed an error of forty-five one-hundredths of a foot, about three and one-half per cent, but for the same ship this error if applied to the height of metacenter above base would have amounted to only one and four-tenths per cent. This ship was, however, of eccentric design, with a beam to draft ratio of over three. The results of this study warrant the statement that for ships of ordinary design equation (8) will be found to be true, with an error of rarely more than one-half of one per cent.

Values of the inertia factor K were then investigated. Figure No. 6 shows the results of this study. Ships of many types, sizes and speeds were investigated. Each circle in the figure indicates the values of K and p for some particular ship. The figure indicates that for at least most ships designed in accordance with present-day practice, the water planes have values of K lying between the limits .0833 p and (.0833p + .006).

The significance of the value of K may here be noted. Planes with pointed ends and hollow entrance and runs with pronounced shoulders have high values of K, while planes fine amidship with U-shaped ends or with round or broad sterns have low values of K.

If a means is to be found for the ready evaluation of equation (8), K must be a known quantity. For this purpose certain standard water planes were established. The values of K for the standard water planes chosen are indicated in the figure.

For these standard water planes, then, a certain definite value of K is associated with any value of water plane coefficient chosen as suitable for a design in hand. If now p can be made a function of the longitudinal coefficient *l*, then one choice will determine all three, *l*, K and p. The possibilities in this direction have been investigated. One writer states that $\frac{l}{p}$ should equal .9. The present investigation, however, indicates that this is in accordance with good practice only over a limited range of *l*. Fig. No. 7 indicates the findings of this study, each circle again indicating a ship. Apparently the naval architect is here given considerable latitude for the exercise of his own judgment. It may be well to note the peculiarities of some of these ships lying somewhat outside the belt of general practice. 39, 40, and 41 are destroyers with fine water-lines; 5 and 64 are high-speed ships with broad sterns; 31, 33 and 55 are monitors. The standard water-lines here established are associated with longitudinal coefficients as indicated.

Having thus associated the standard water-lines with certain longitudinal coefficients, it becomes necessary, or at least seems desirable, similarly to establish standard series of sectional area curves, such that the two will work harmoniously together. This has been done.

We now return to equation (8)—

$$M = \left(\frac{Kp}{l}\right)\frac{1}{m}\frac{B^2}{H} + \frac{5H}{6} - \left(\frac{l}{3p}\right)mH$$

It may now be noted that so long as the standard planes and curves are adhered to, the bracketed portions of the equation are immediately fixed as soon as the longitudinal coefficient is chosen. This in itself simplifies the treatment of the equation, but it is further simplified by the fact that the standard water planes were intentionally so selected and so related to the longitudinal coefficients as to keep M constant for all values of *l* throughout each series. That is to say, if certain values of beam, draft and midship-section coefficient are chosen the height of metacenter will be fixed and will be the same for any value of longitudinal coefficient if the standard water plane associated with that *l* is adhered to. Putting it another way, the standard water-lines were so drawn as to make the height of metacenter independent of the length of ship.

Charts Furnished for High, Medium and Slow Speed Vessels

METACENTER-BEAM CHARTS have accordingly been prepared for each of three standard series. One series is for fast vessels with broad sterns, one series for ships of intermediate speed with longitudinal coefficients varying from .54 to .68 without parallel middle body. The third series covers slower ships with parallel middle body, and varying in longitudinal coefficient from .635 to .78. Each series is accompanied by several sheets, a sheet corresponding to a given midship section coefficient. On each sheet will be found a series of curves, a curve corresponding to a given beam.

To use the charts, select the series suitable to the type of ship under consideration and enter the proper sheet as determined by the midship section coefficient chosen. For any given draft and for any desired height of metacenter above base (the base line being taken at the under side of flat plate keel amidship), the proper beam may be se-

lected at the intersection of the ordinate from the desired M and the abscissa from the given H.

It will be found that for ships designed in close adherence to the standard curves, the charts will give results which are accurate within one per cent except for extreme ratios of beam to draft, where the error may be slightly greater for ships toward the extremities of the series. Moderate deviation from the standard planes will not materially affect the result.

cient." A low value for the longitudinal coefficient indicates a fine ended vessel with a relatively large area of midship section, while a high value indicates a full ended ship with a relatively small area of midship section. It is, of course, possible to obtain quite a variation in the shape of the curve of sectional areas without any alteration in the area of the midship or greatest section, while at the same time maintaining displacement and length constant. A discussion of this would entail comment on parallel

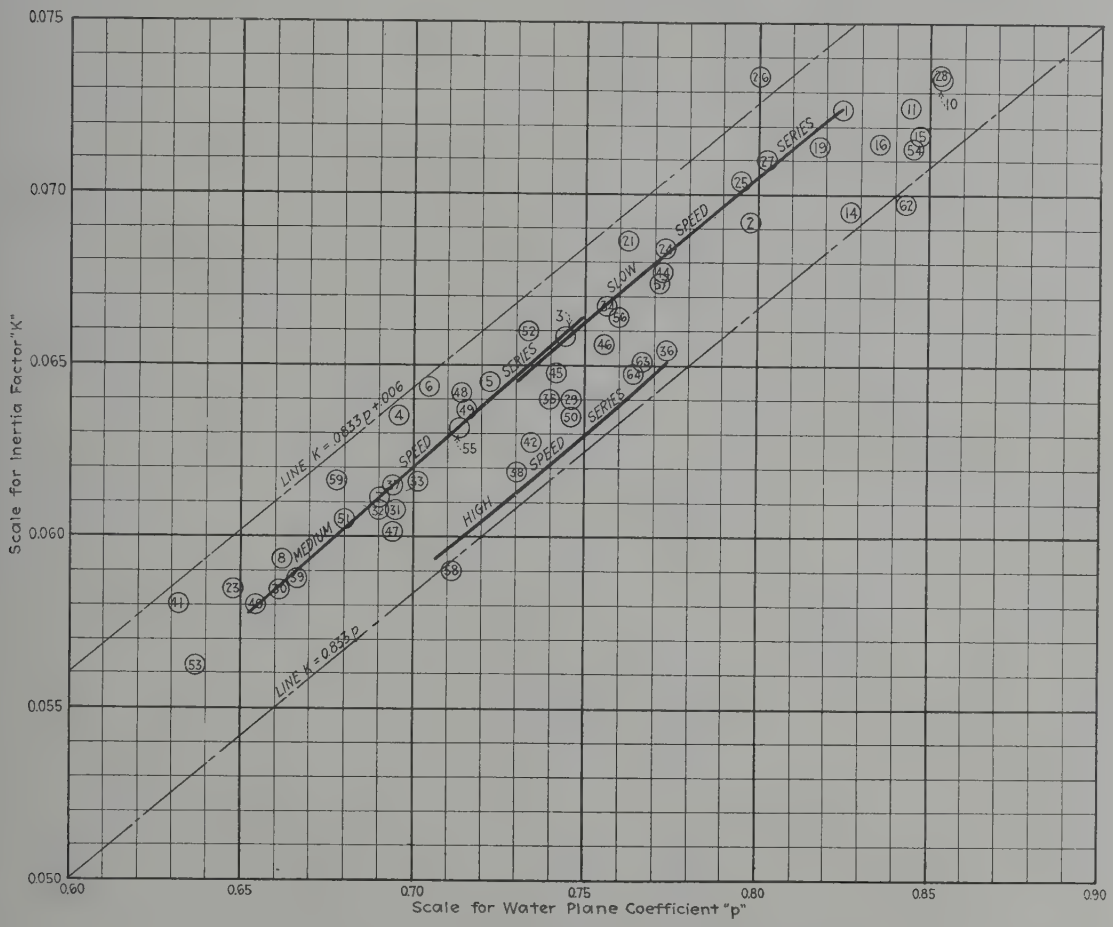


Fig. 6.—Chart Showing Relationship Between Water Plane Coefficient and Inertia Factor for Standard Series and for Various Ships

For ships in no wise based upon the standard curves, the charts are still of value. Each sheet is a graphic solution of equation (8) for certain values of $\left(\frac{Kp}{lm}\right)$ and $\left(\frac{lm}{3p}\right)$. For any ship K can be estimated from figure No. 6, and with l, m and p known, the above expressions can be calculated. The corresponding chart can then be entered in the usual manner. By interpolation between charts a close approximation can be made to the height of M for any ship of ordinary design.

Longitudinal Coefficient

THIS COEFFICIENT is indicative of the longitudinal distribution of a ship's displacement, and therefore is termed with especial propriety the "longitudinal coefficient." A low value for the longitudinal coefficient indicates a fine ended vessel with a relatively large area of midship section, while a high value indicates a full ended ship with a relatively small area of midship section. It is, of course, possible to obtain quite a variation in the shape of the curve of sectional areas without any alteration in the area of the midship or greatest section, while at the same time maintaining displacement and length constant. A discussion of this would entail comment on parallel middle body, angles of entrance, etc., and other features bordering more on details of form than is here justified.

The value of the longitudinal coefficient has a very important effect upon resistance at all speeds. Its influence is most important perhaps at the higher speeds, where wave-making is more prominent. At low speeds the frictional resistance, which is affected but slightly by variation in the value of the longitudinal coefficient, displacement and length being constant, constitutes from 75 to 85 per cent of the total resistance. At moderate speeds the wave-making or residual resistance assumes importance and hence the ends, which at these speeds are largely responsible for wave making, should be fine. At high speeds, however, where the residual resistance may constitute 50 per cent or more of the total resistance, the whole forebody of the ship is engaged in wave making and a smaller midship section, with relatively full ends, is advantageous.

This should not be carried to an extreme, however, the maximum value which may wisely be given to fast ships being about .65 or .66. (Ships having speed length ratios in excess of 2.25 or 2.50 are not considered in this discussion.)

Experiments carried out by such investigators as Taylor, Sadler, Froude, and Baker, indicate very definitely the best values of this coefficient from the driving standpoint only. In the design of vessels for actual service, however, it is necessary to take into consideration factors other than those making for satisfactory driving qualities. The other factors involved are more or less antagonistic and must be assigned proper relative importance in order that the resulting design may constitute a satisfactory compromise. For example, a 400-foot cargo vessel will have a machinery installation, the weight of which may be about 4 or 5 per cent of the load displacement of the ship. Such a vessel in accordance with present practice will have a longitudinal coefficient of about .78. Stability and channel depths will have dictated the vessel's beam and draft while its midship section will be as full as practicable for obvious reasons. If it were desired now to decrease the above value of the longitudinal coefficient by 10 per cent other conditions remaining unchanged,

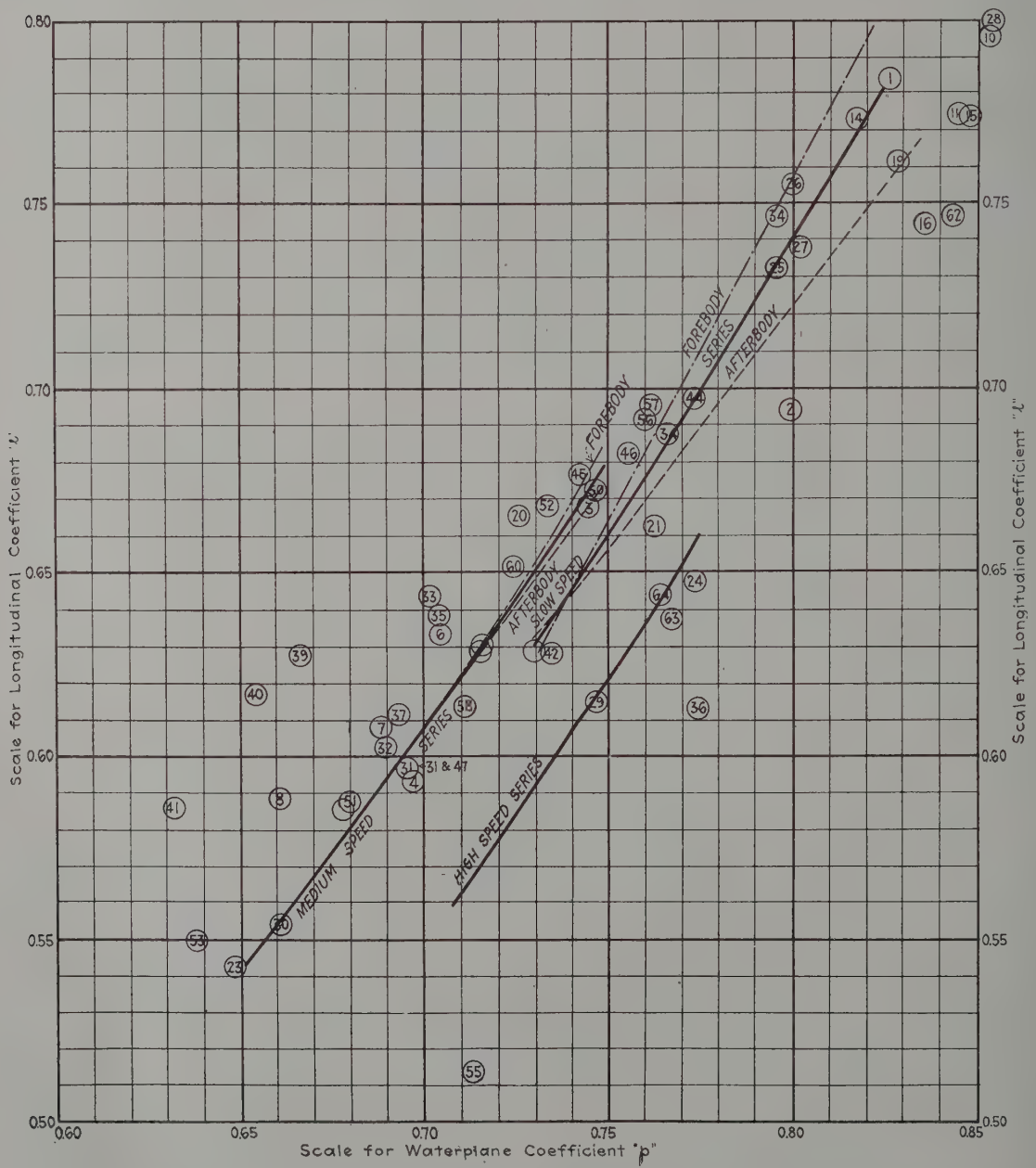
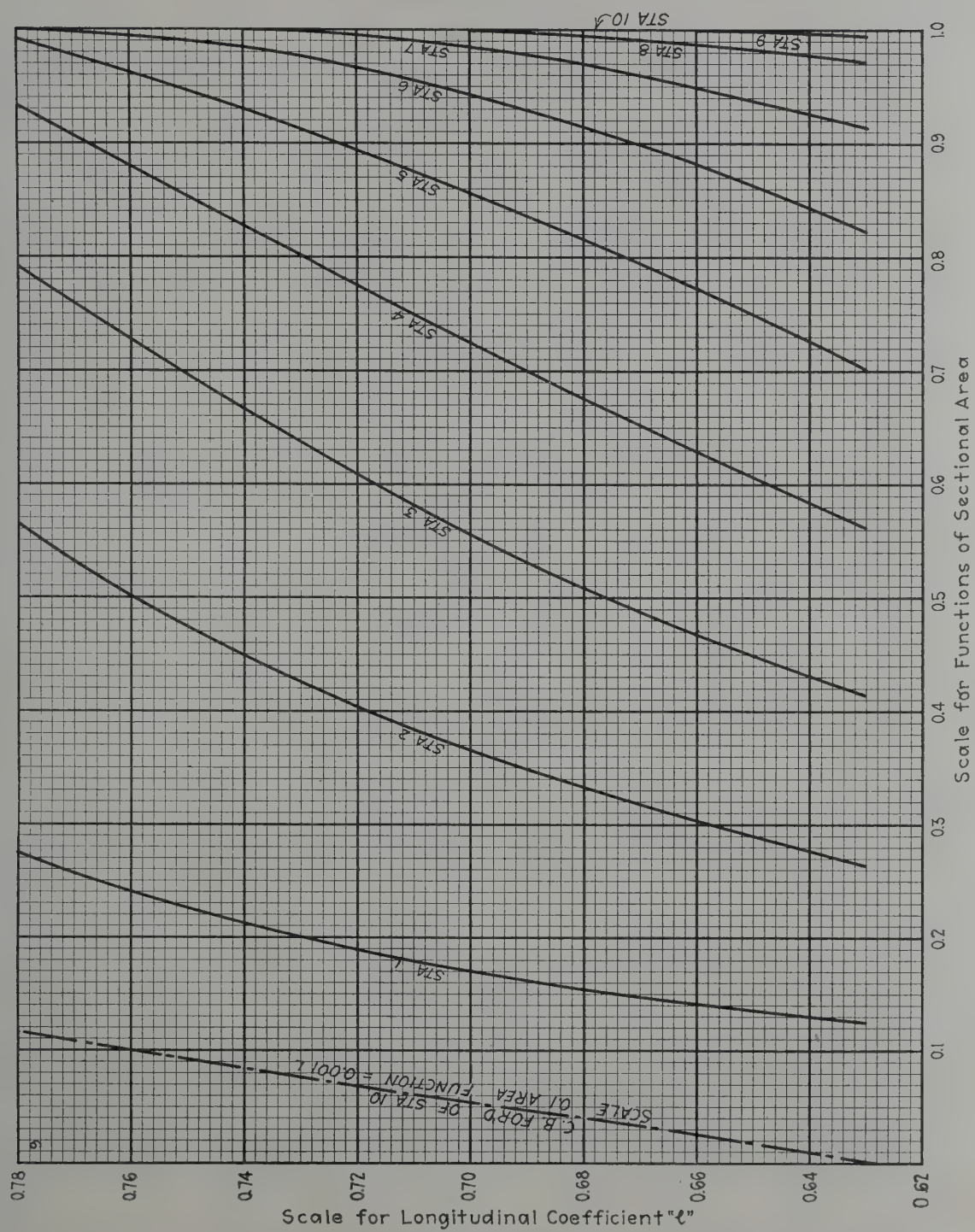


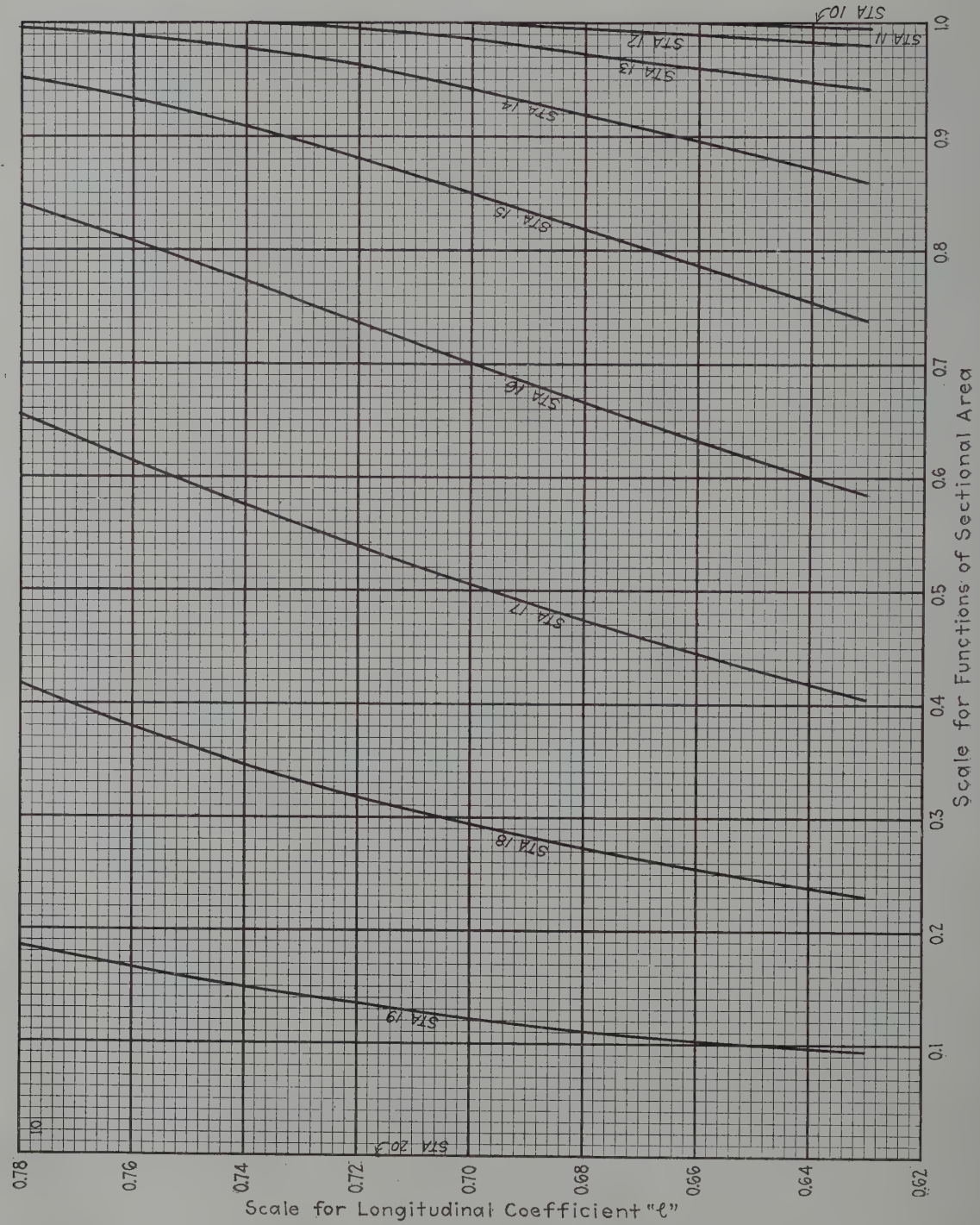
Fig. 7.—Chart Showing Relationship Between Longitudinal and Water Plane Coefficients for Standard Series and for Various Ships

Fig. 8—Functions for Sectional Area Curves
for
Slow Speed Vessels



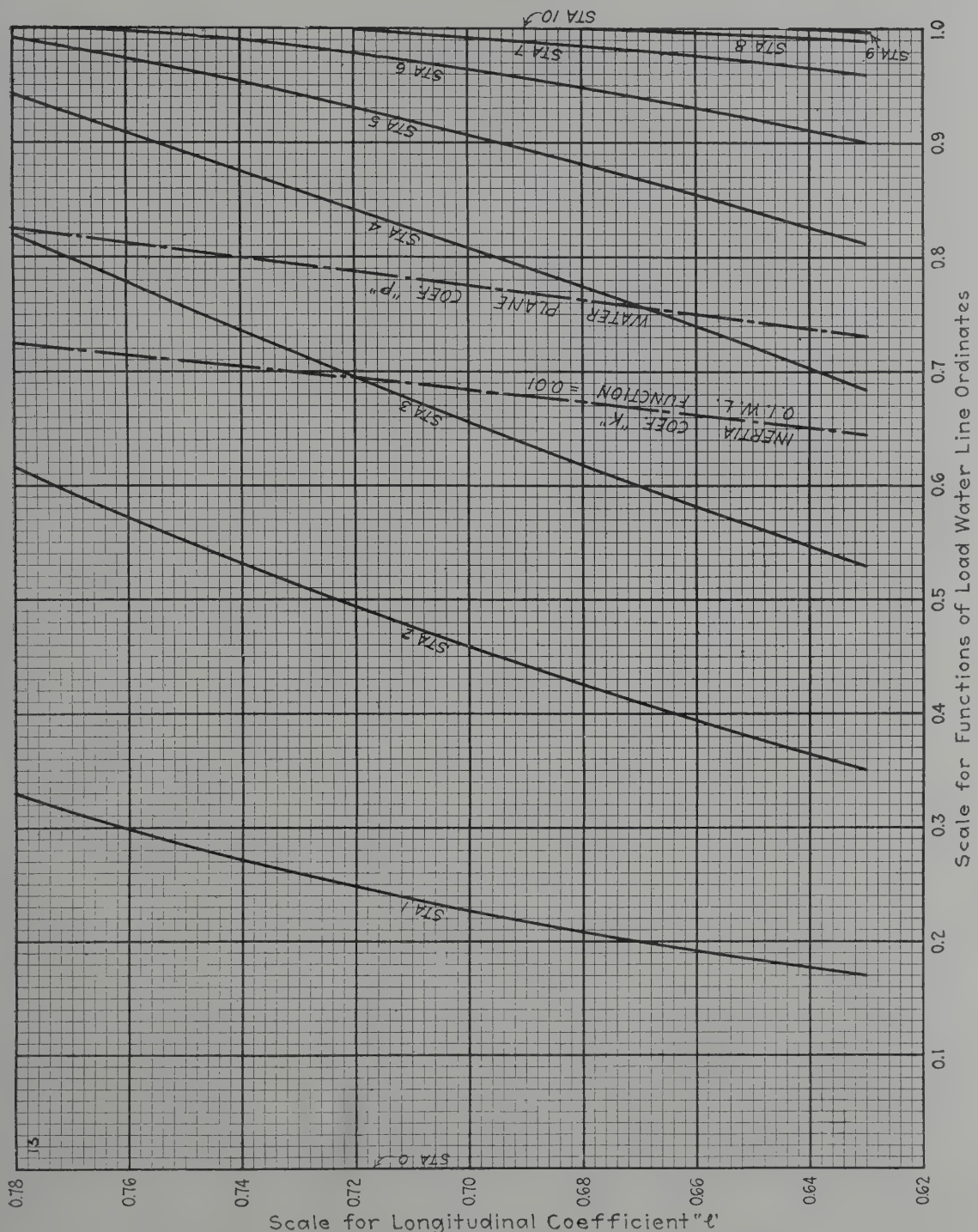
Fore Body

Fig. 9—Functions for Sectional Area Curves
for
Slow Speed Vessels



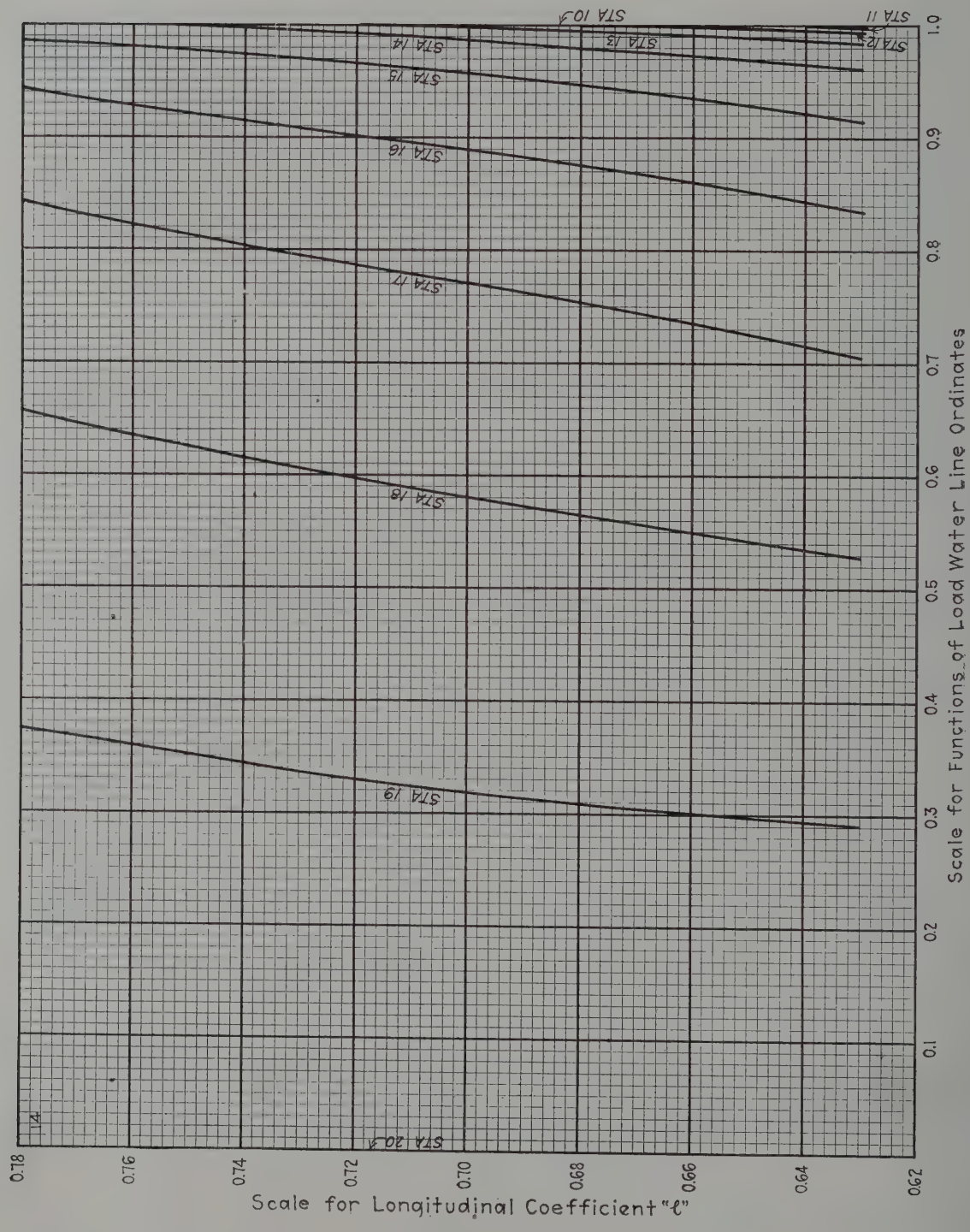
After Body

Fig. 10—Functions for Load Water Lines
for
Slow Speed Vessels



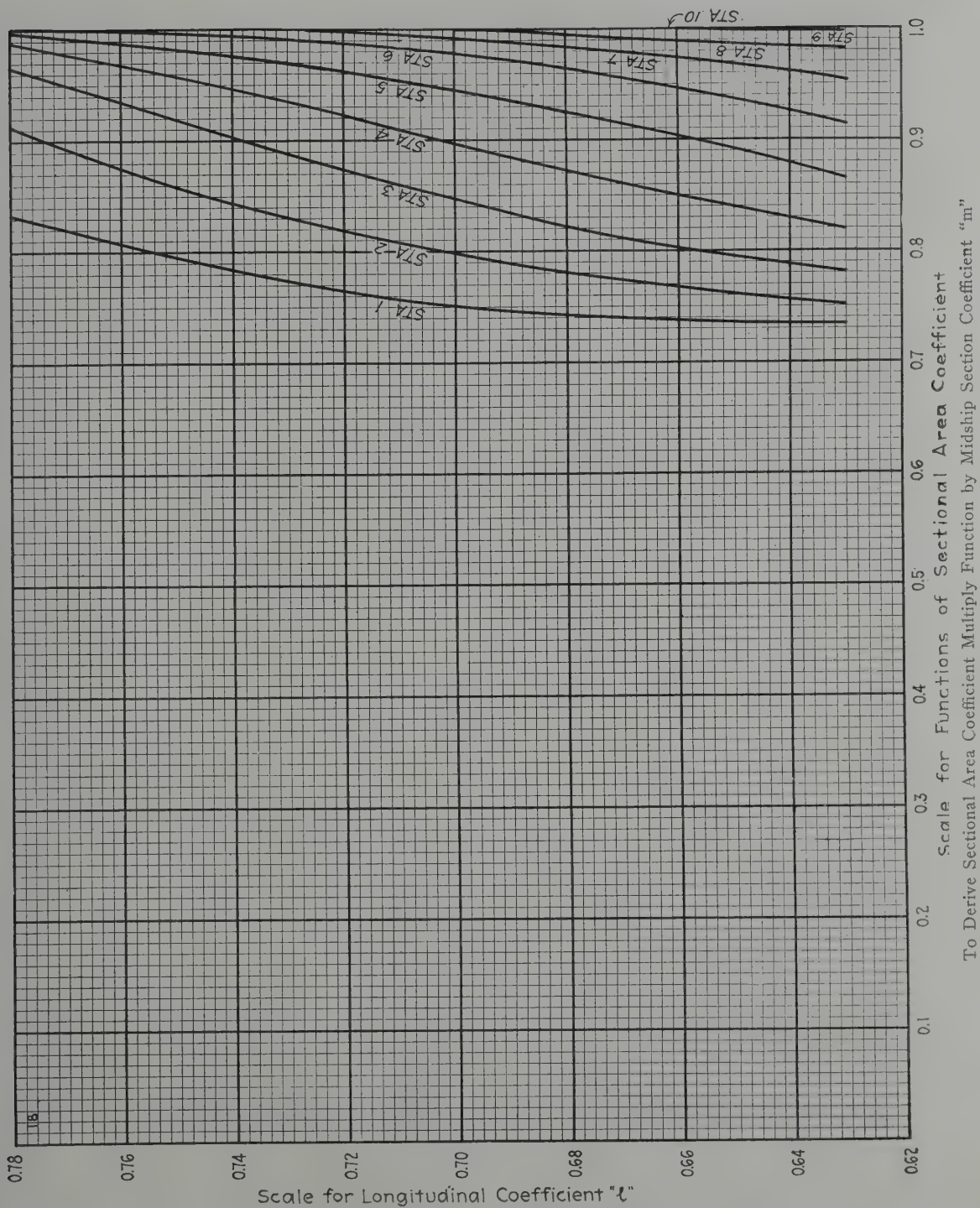
Fore Body

Fig. 11—Functions for Load Water Lines
for
Slow Speed Vessels



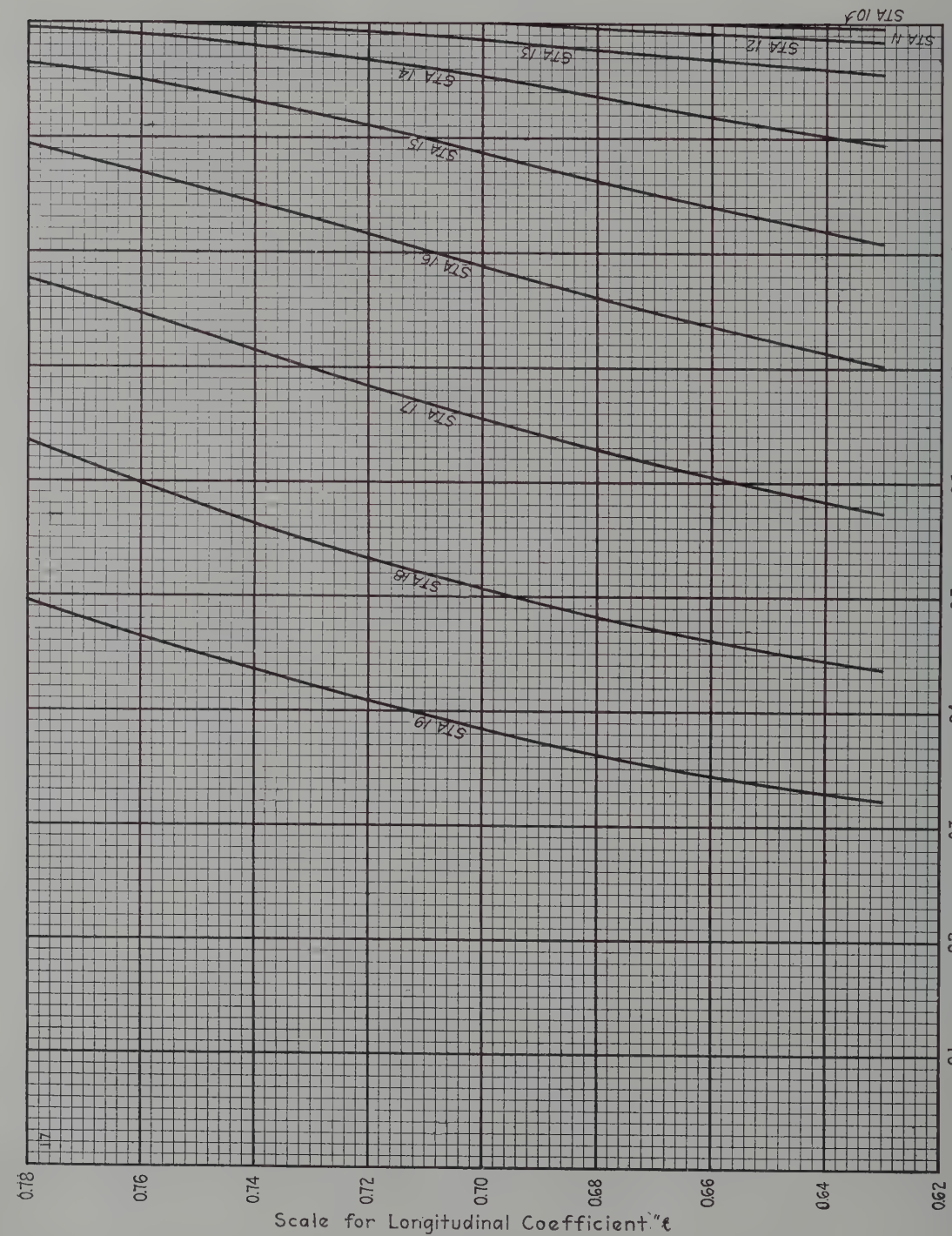
After Body

Fig. 12—Functions for Sectional Coefficient Curves
for
Slow Speed Vessels



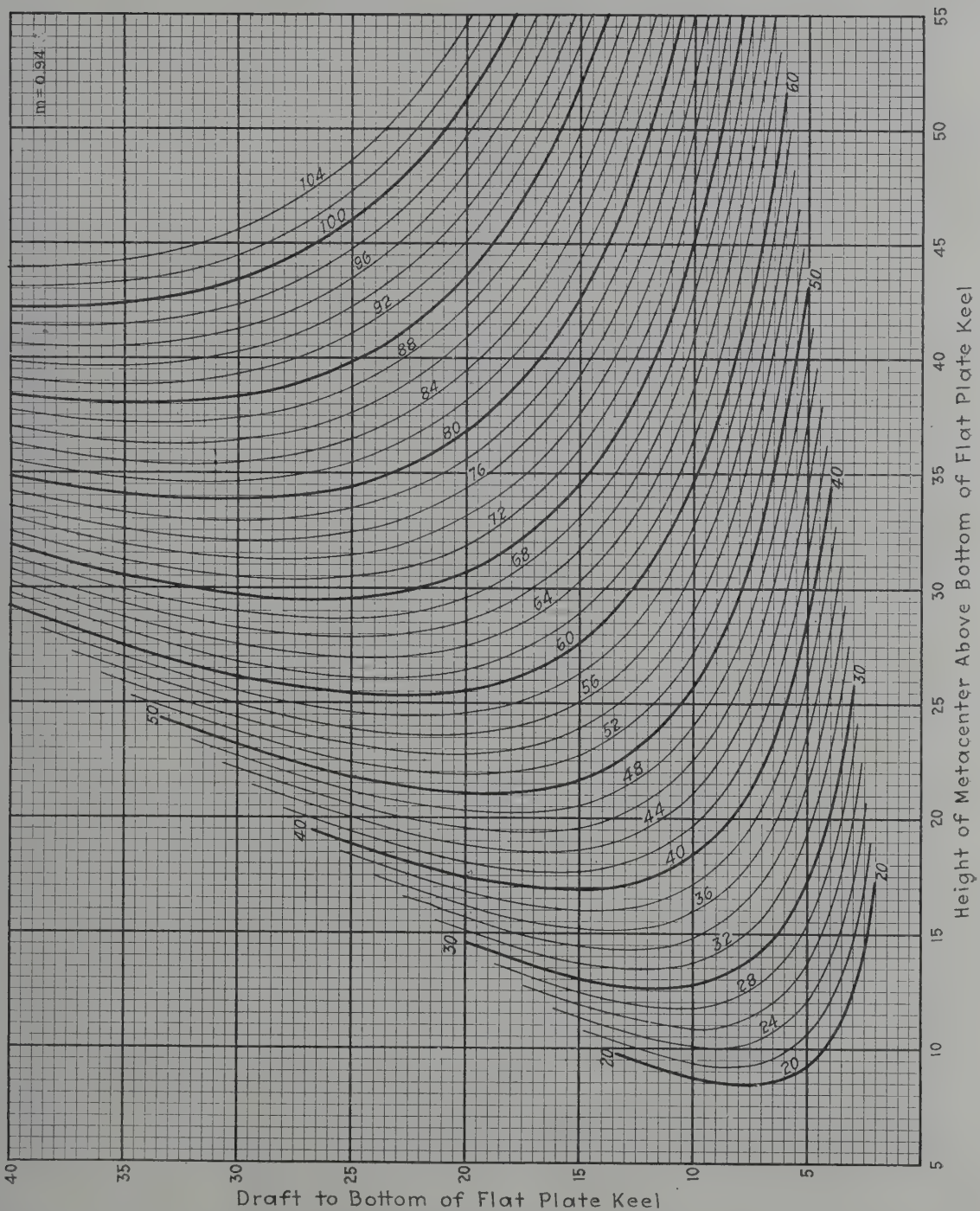
Fore Body

Fig. 13—Functions for Sectional Coefficient Curves
for
Slow Speed Vessels



After Body

Fig. 14—Metacenter Beam Chart
for
Slow Speed Vessels

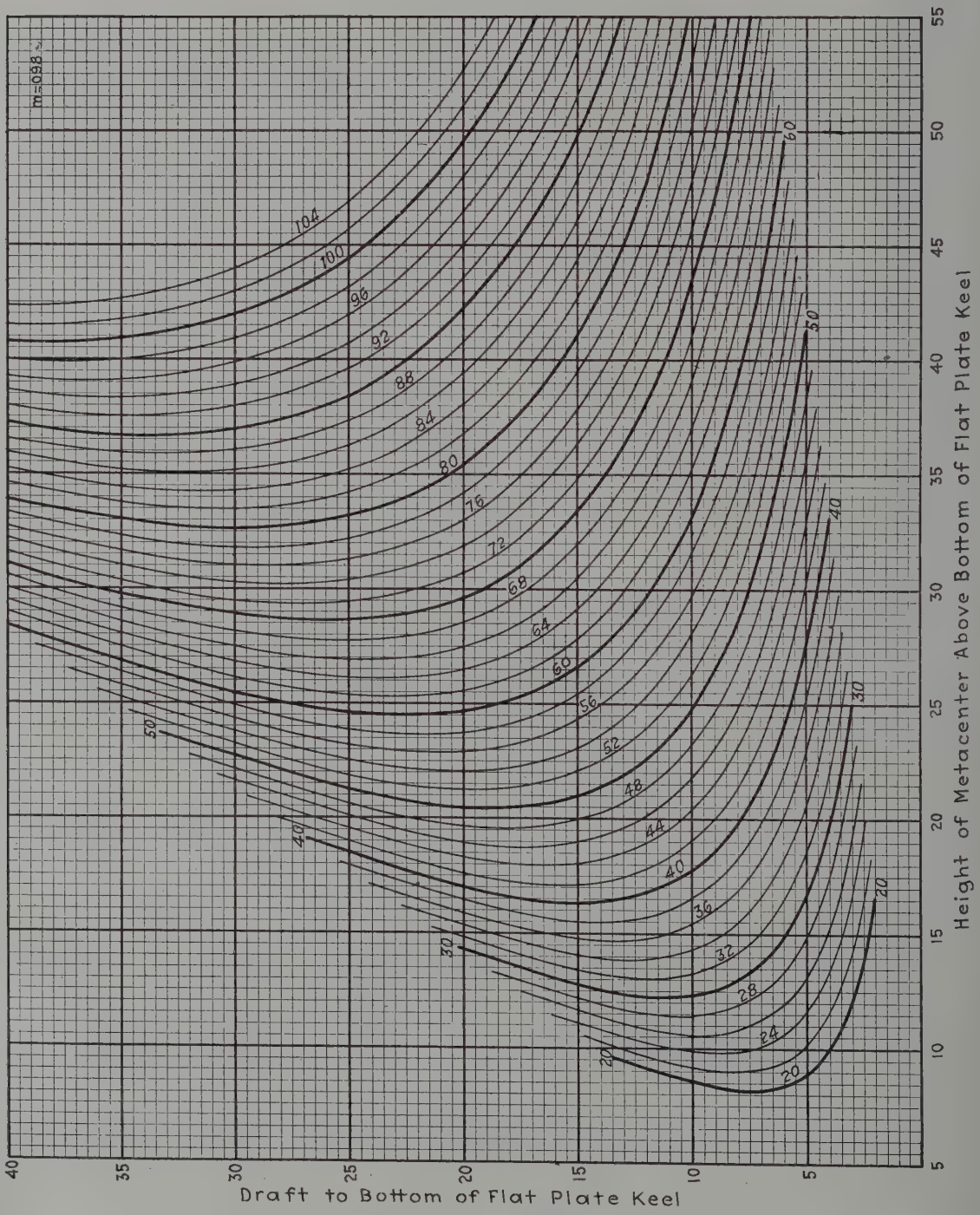


For Midship Section Coefficient = 0.94

Notes.—For any given draft and for any desired height of metacenter above the base line, the proper beam may be selected at the intersection of the ordinate from the desired M and the abscissa from the given draft.

$$\frac{kp}{lm} = 0.08063 \quad — \quad \frac{lm}{3p} = 0.2838$$

Fig. 15—Metacenter Beam Chart
for
Slow Speed Vessels

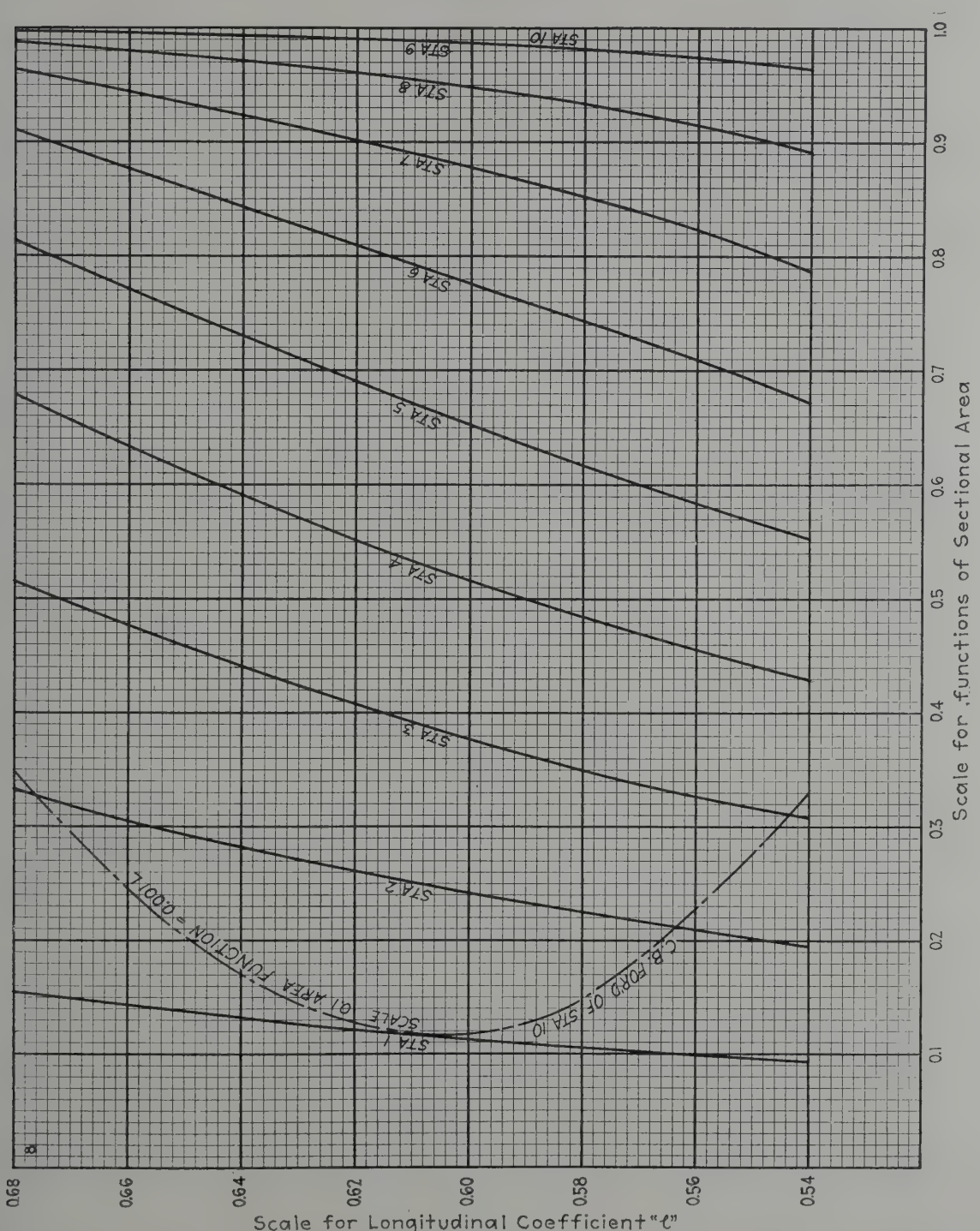


For Midship Section Coefficient = 0.98

Notes.—For any given draft and for any desired height of metacenter above the base line, the proper beam may be selected at the intersection of the ordinate from the desired M and the abscissa from the given draft.

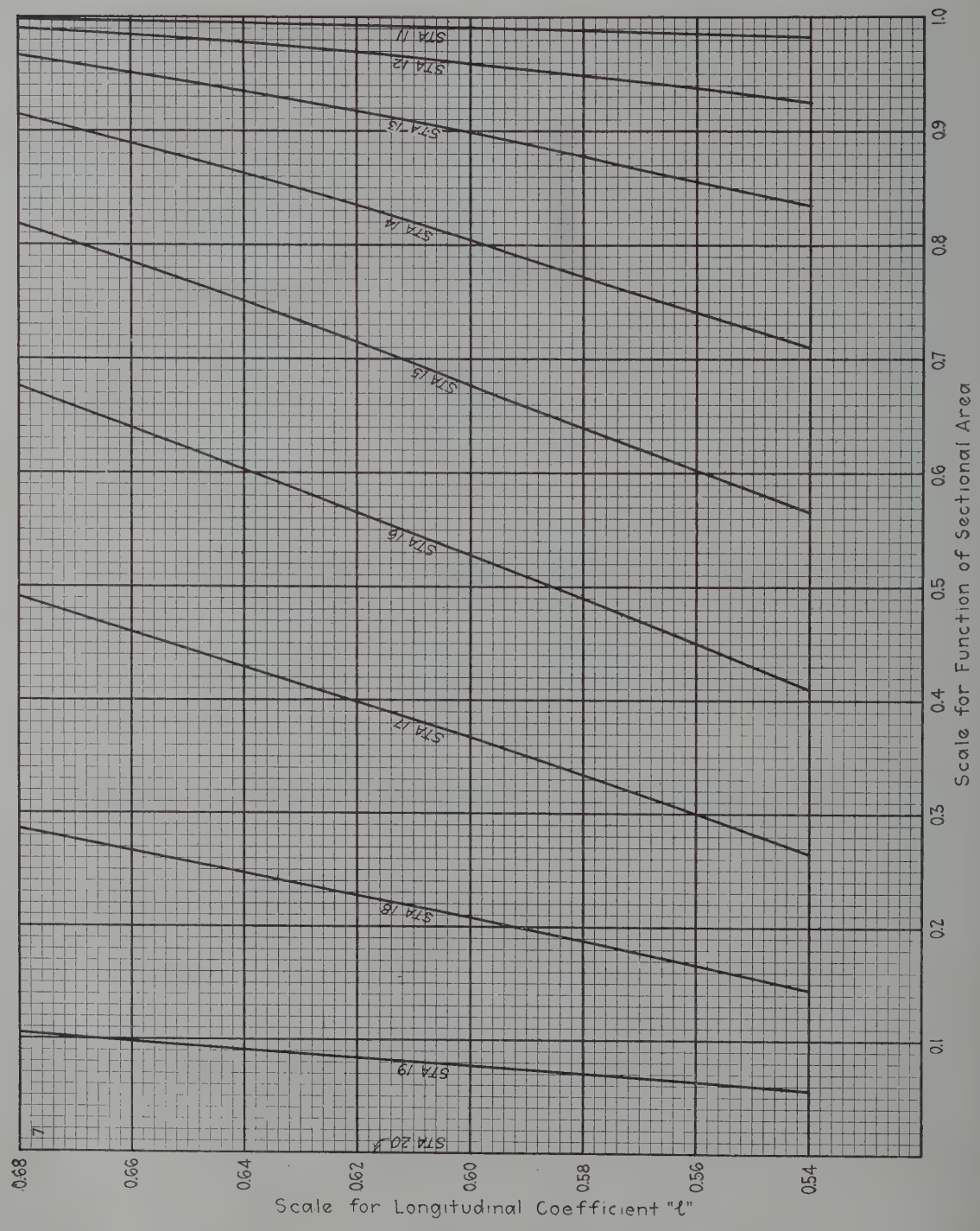
$$\frac{kp}{lm} = 0.07737 \quad \frac{lm}{3p} = 0.2955$$

Fig. 16—Functions for Sectional Area Curves
for
Medium Speed Vessels



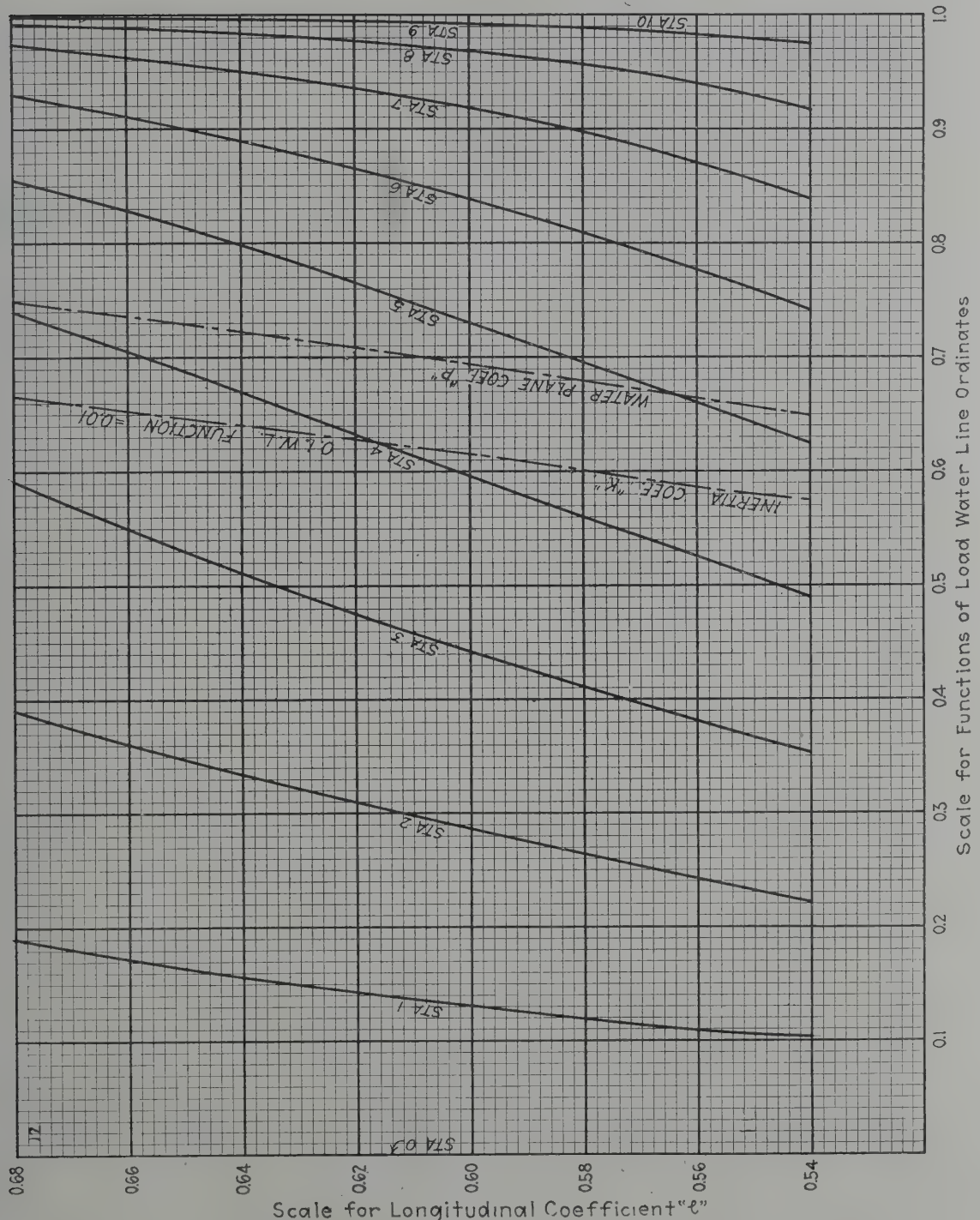
Fore Body

Fig. 17—Functions for Sectional Area Curves
for
Medium Speed Vessels



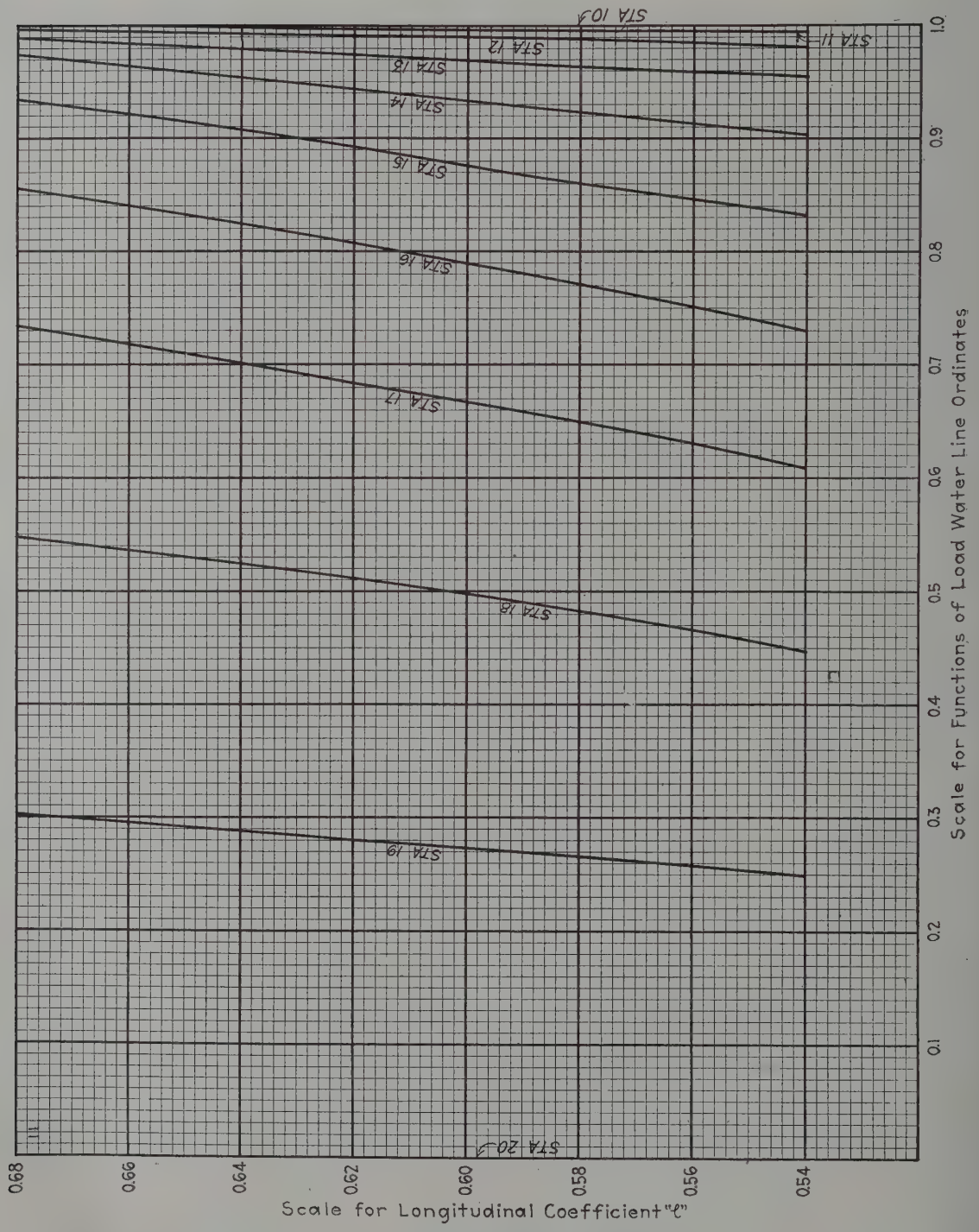
After Body

Fig. 18—Functions for Load Water Lines
for
Medium Speed Vessels



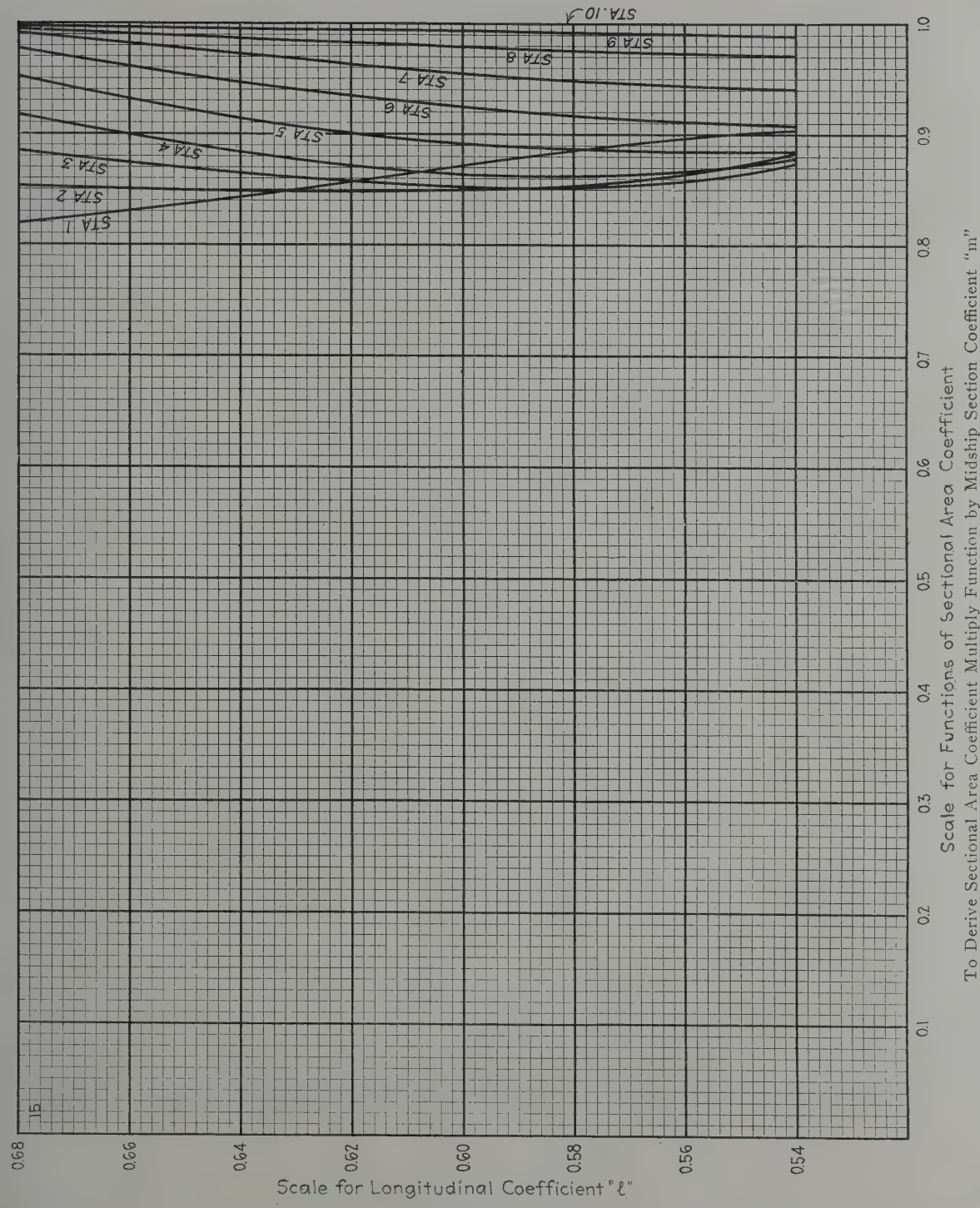
Fore Body

Fig. 19—Functions for Load Water Lines
for
Medium Speed Vessels



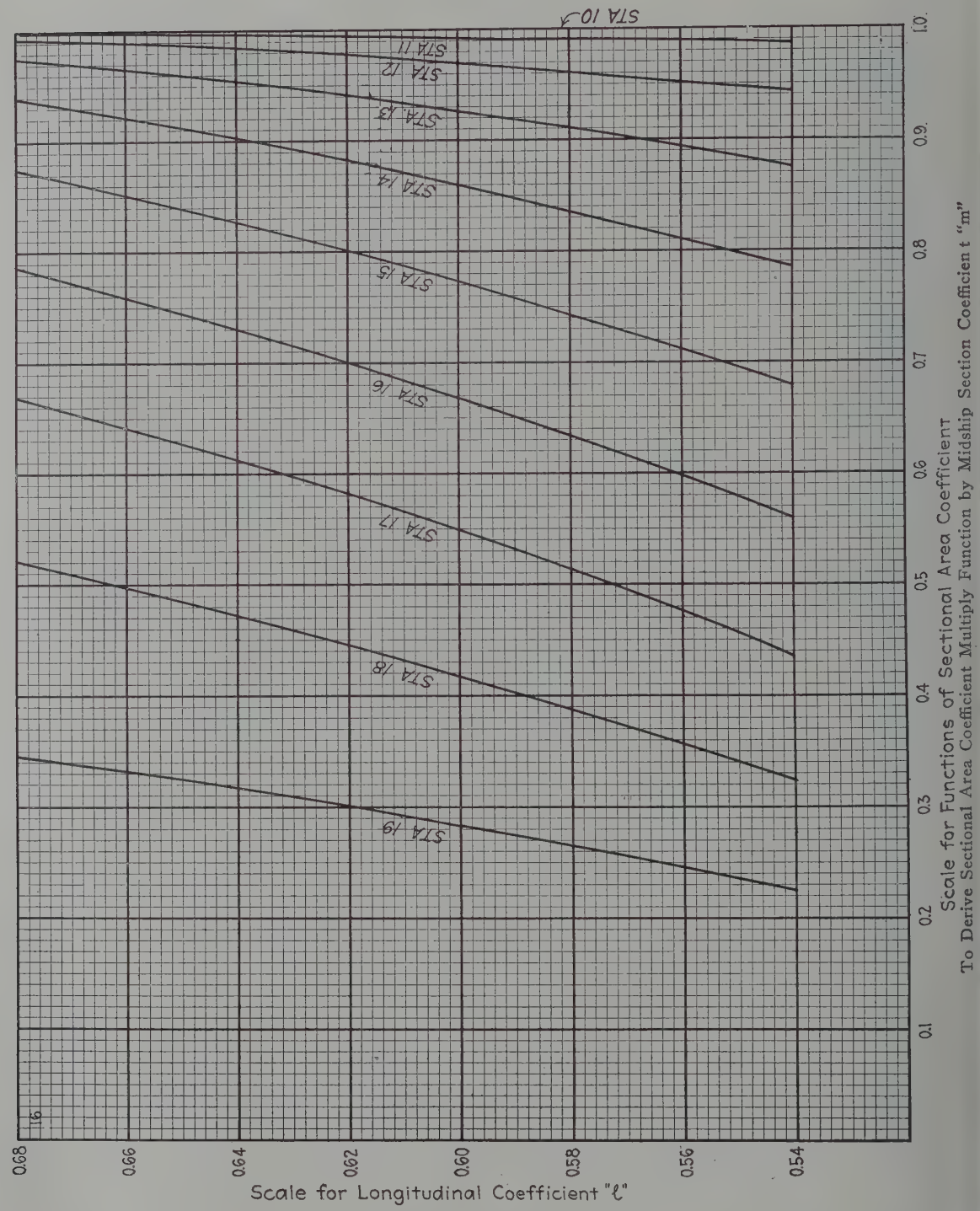
After Body

Fig. 20—Functions for Sectional Coefficient Curves
for
Medium Speed Vessels



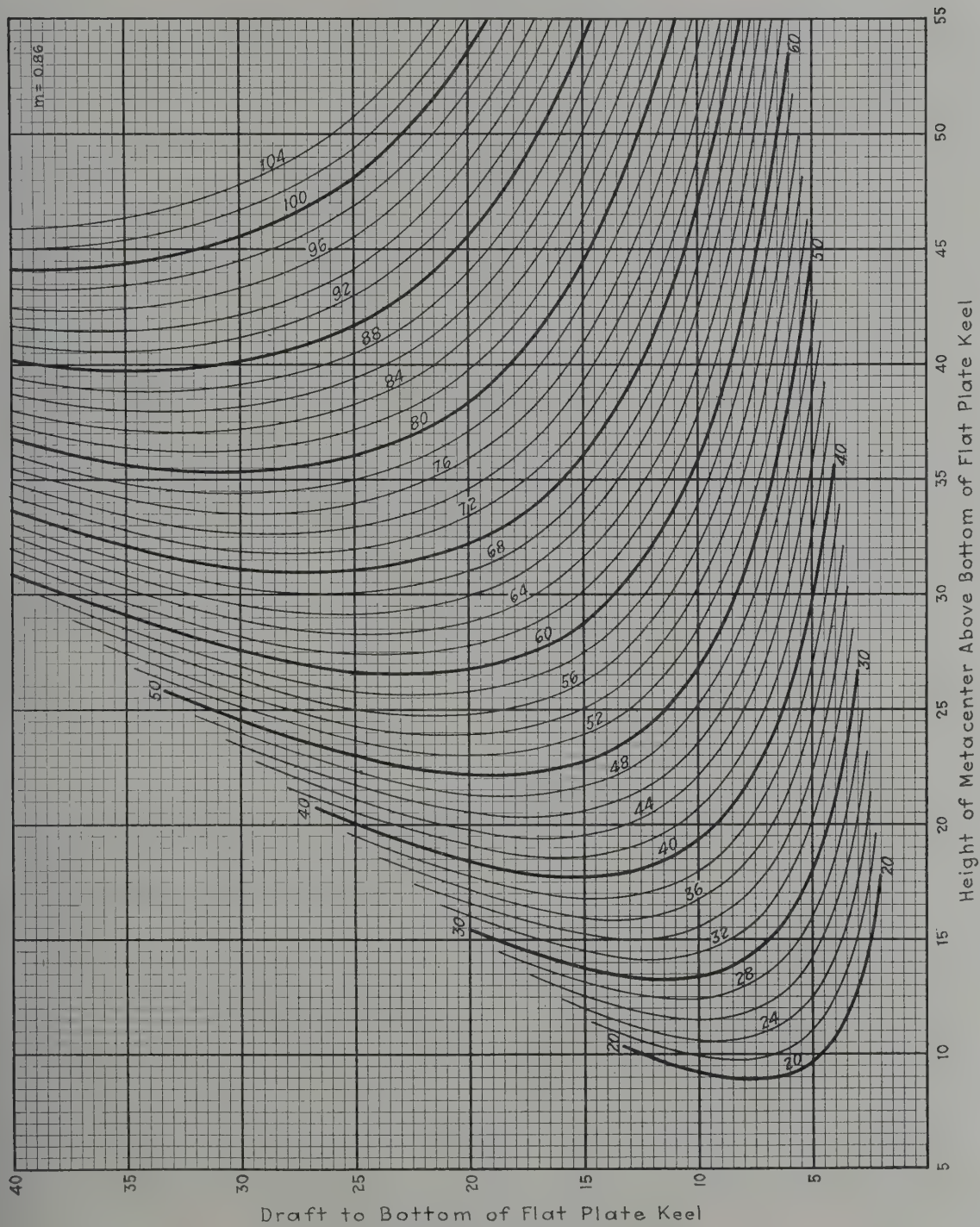
Fore Body

Fig. 21—Functions for Sectional Coefficient Curves
for
Medium Speed Vessels



After Body

Fig. 22—Metacenter Beam Chart
for
Medium Speed Vessels

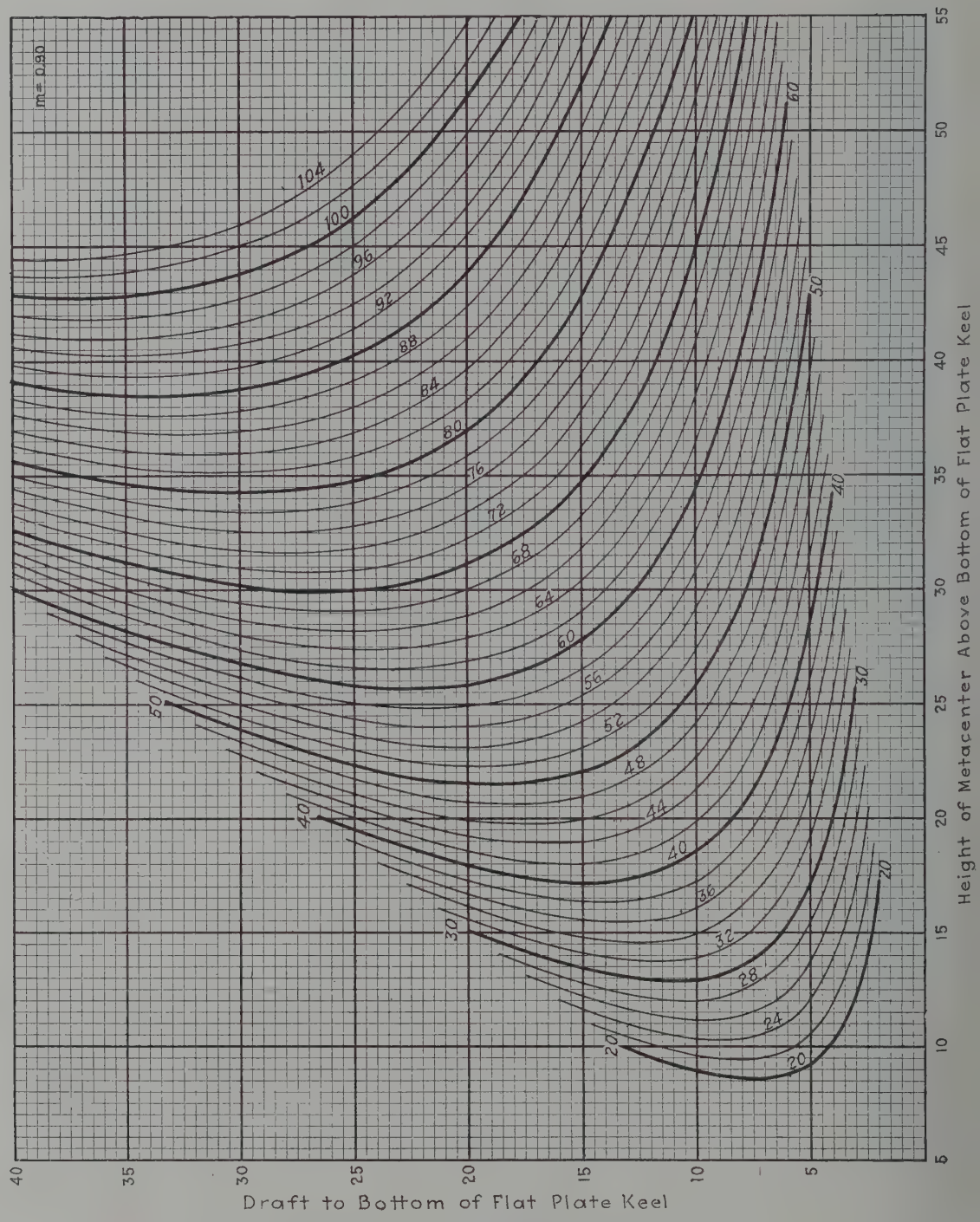


For Midship Section Coefficient = 0.86

Notes—For any given draft and for any desired height of metacenter above the base line, the proper beam may be selected at the intersection of the ordinate from the desired M and the abscissa from the given draft.

$$\frac{kp}{lm} = 0.0834 \qquad \frac{lm}{3p} = 0.2491$$

Fig. 23—Metacenter Beam Chart
for
Medium Speed Vessels

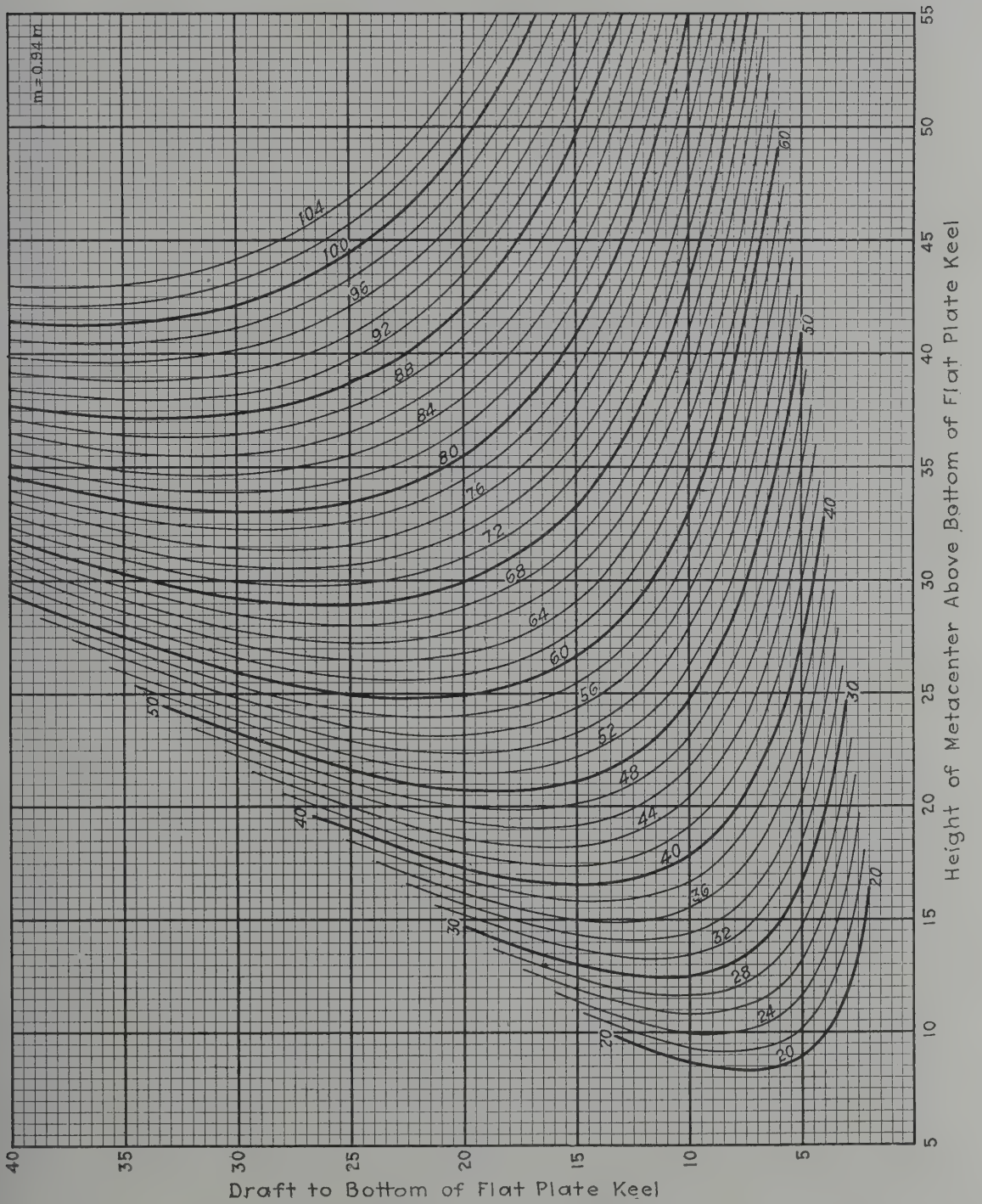


For Midship Section Coefficient = 0.90

Notes—For any given draft and for any desired height of metacenter above the base line, the proper beam may be selected at the intersection of the ordinate from the desired M and the abscissa from the given draft.

$$\frac{kp}{lm} = 0.07965 \qquad \frac{lm}{3p} = 0.2607$$

Fig. 24—Metacenter Beam Chart
for
Medium Speed Vessels

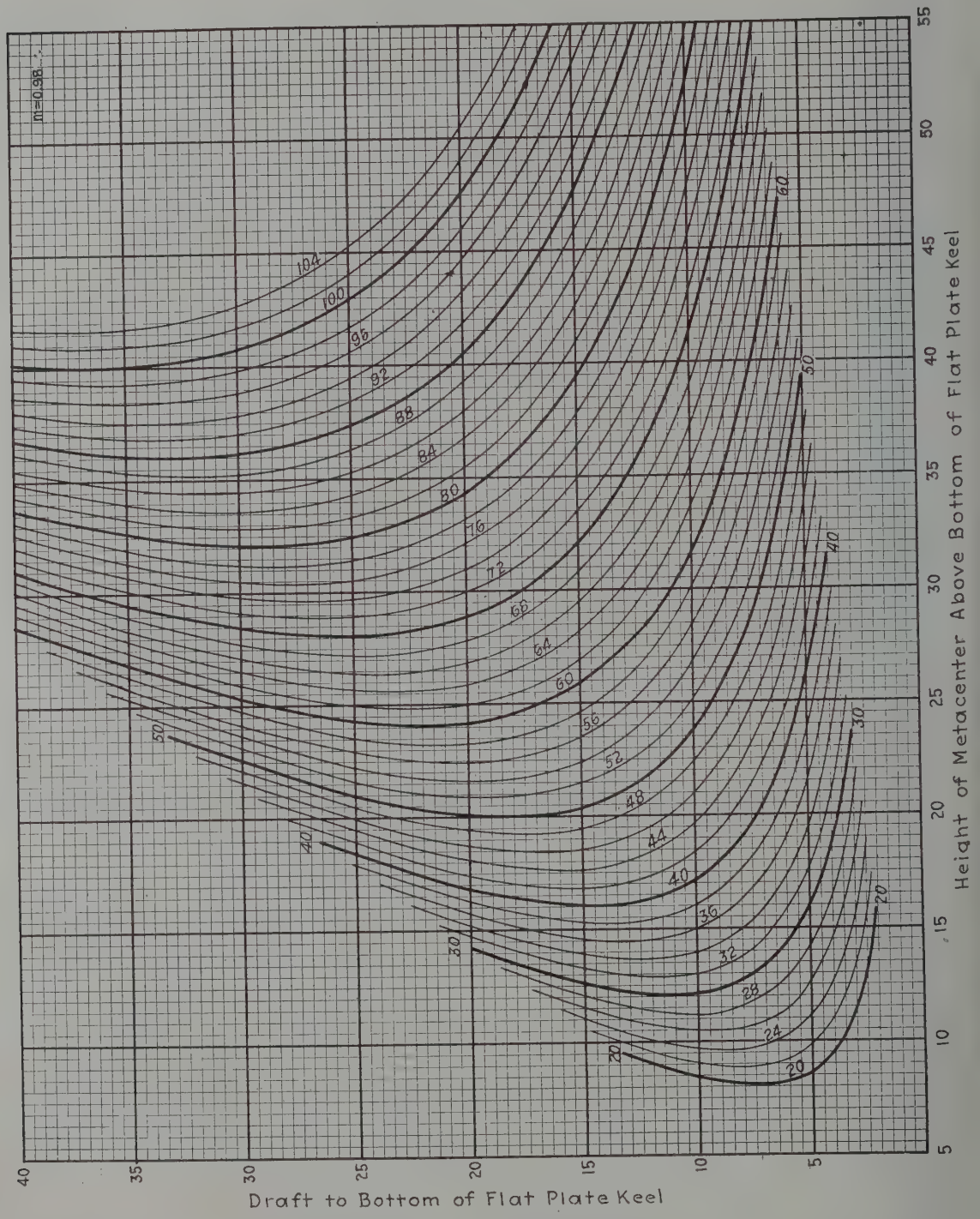


For Midship Section Coefficient = 0.94

Notes—For any given draft and for any desired height of metacenter above the base line, the proper beam may be selected at the intersection of the ordinate from the desired M and the abscissa from the given draft.

$$\frac{kp}{lm} = 0.0763 \qquad \frac{lm}{3p} = 0.2725$$

Fig. 25—Metacenter Beam Chart
for
Medium Speed Vessels

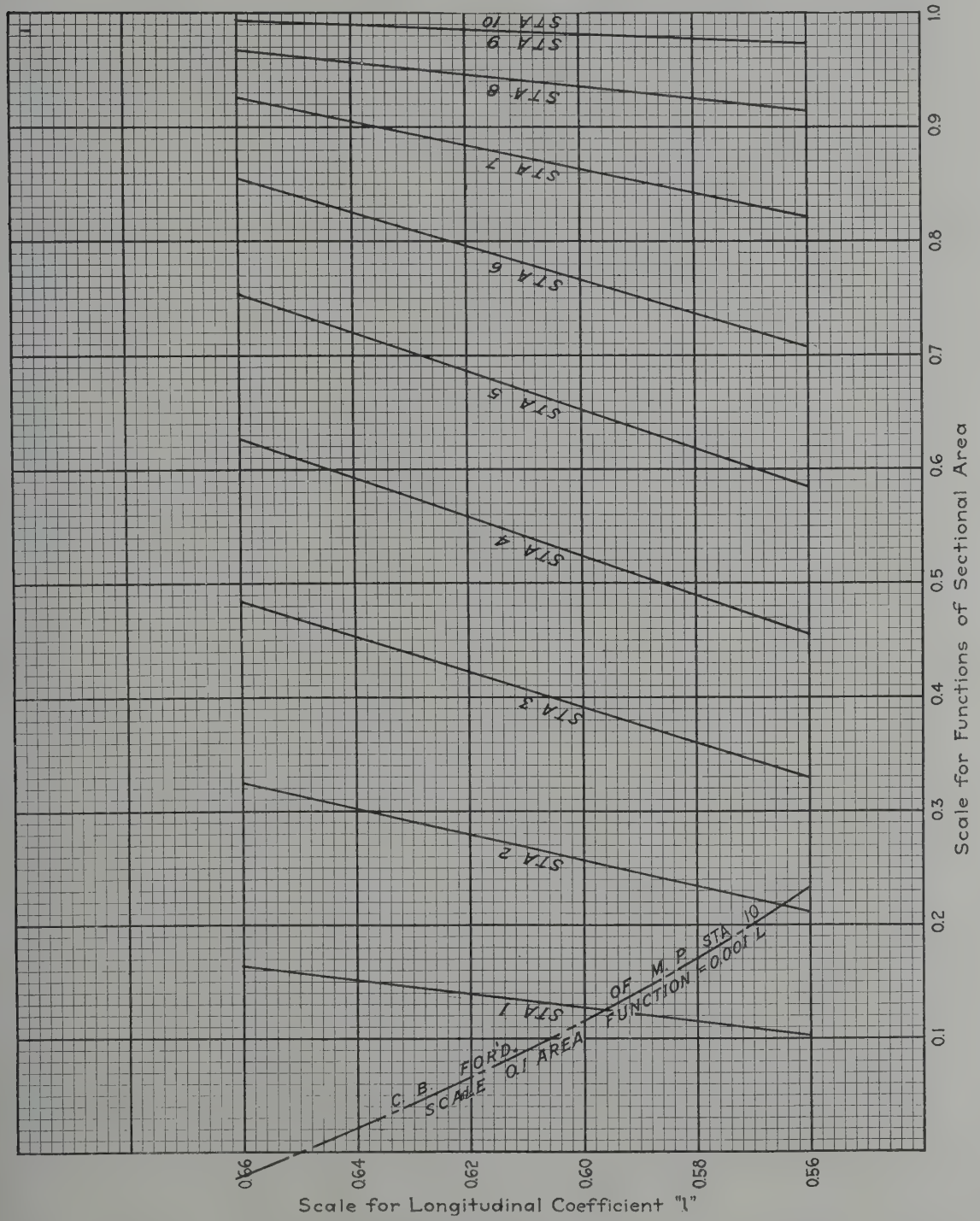


For Midship Section Coefficient = 0.98

Notes—For any given draft and for any desired height of metacenter above the base line, the proper beam may be selected at the intersection of the ordinate from the desired M and the abscissa from the given draft.

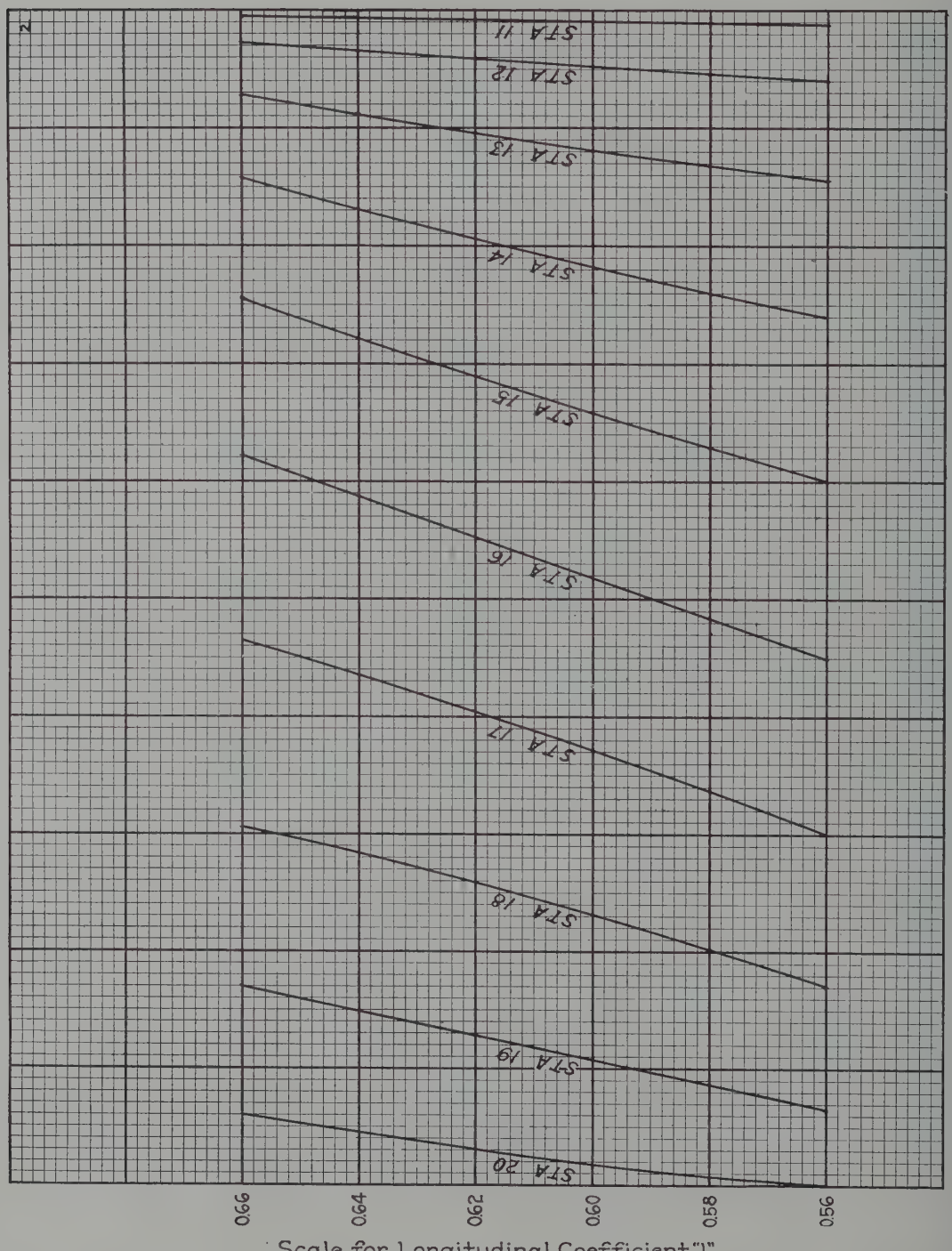
$$\frac{kp}{lm} = 0.0732 \qquad \frac{lm}{3p} = 0.2840$$

Fig. 26—Functions for Sectional Area Curves
for
High Speed Vessels



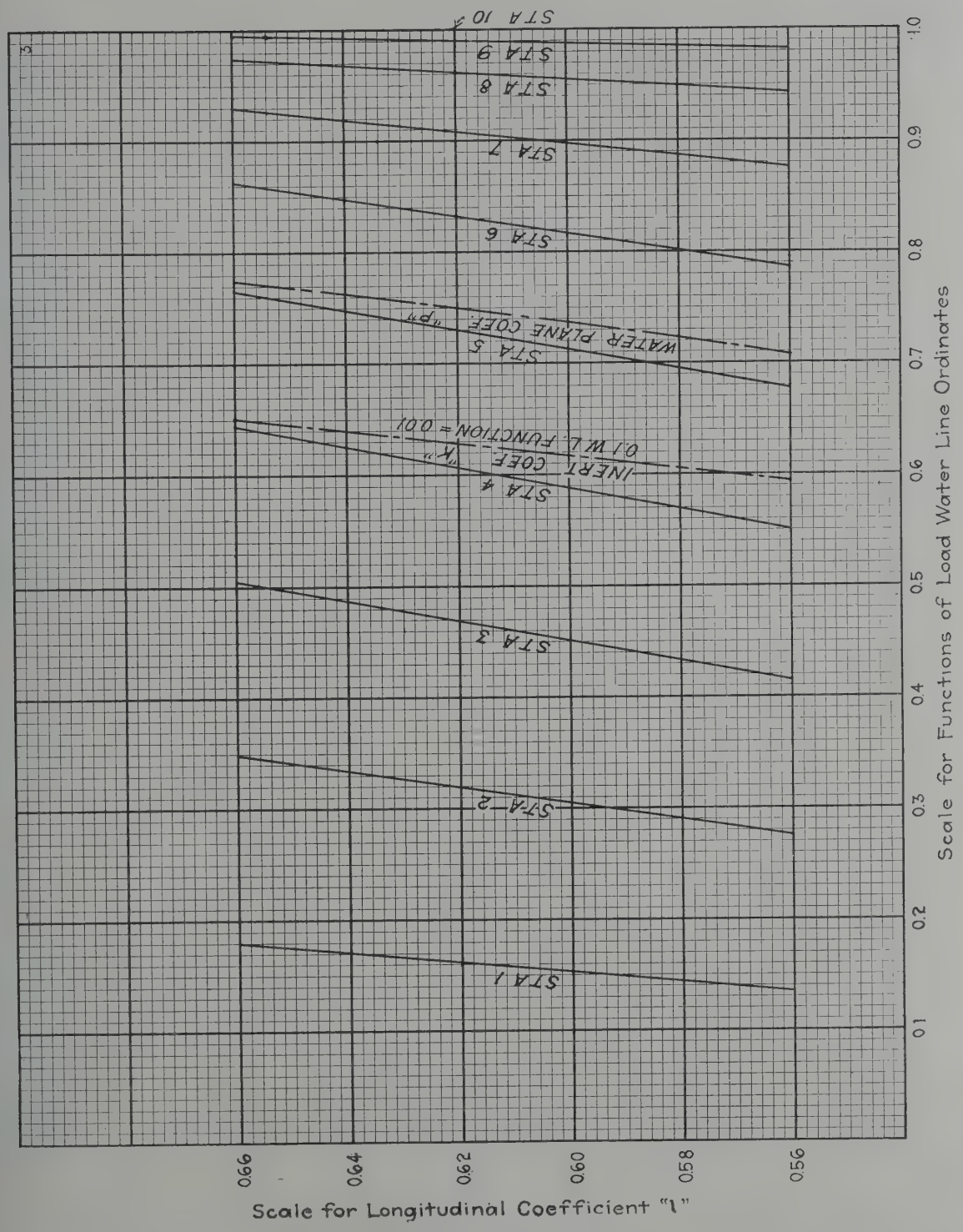
Fore Body

Fig. 27—Functions for Sectional Area Curves
for
High Speed Vessels



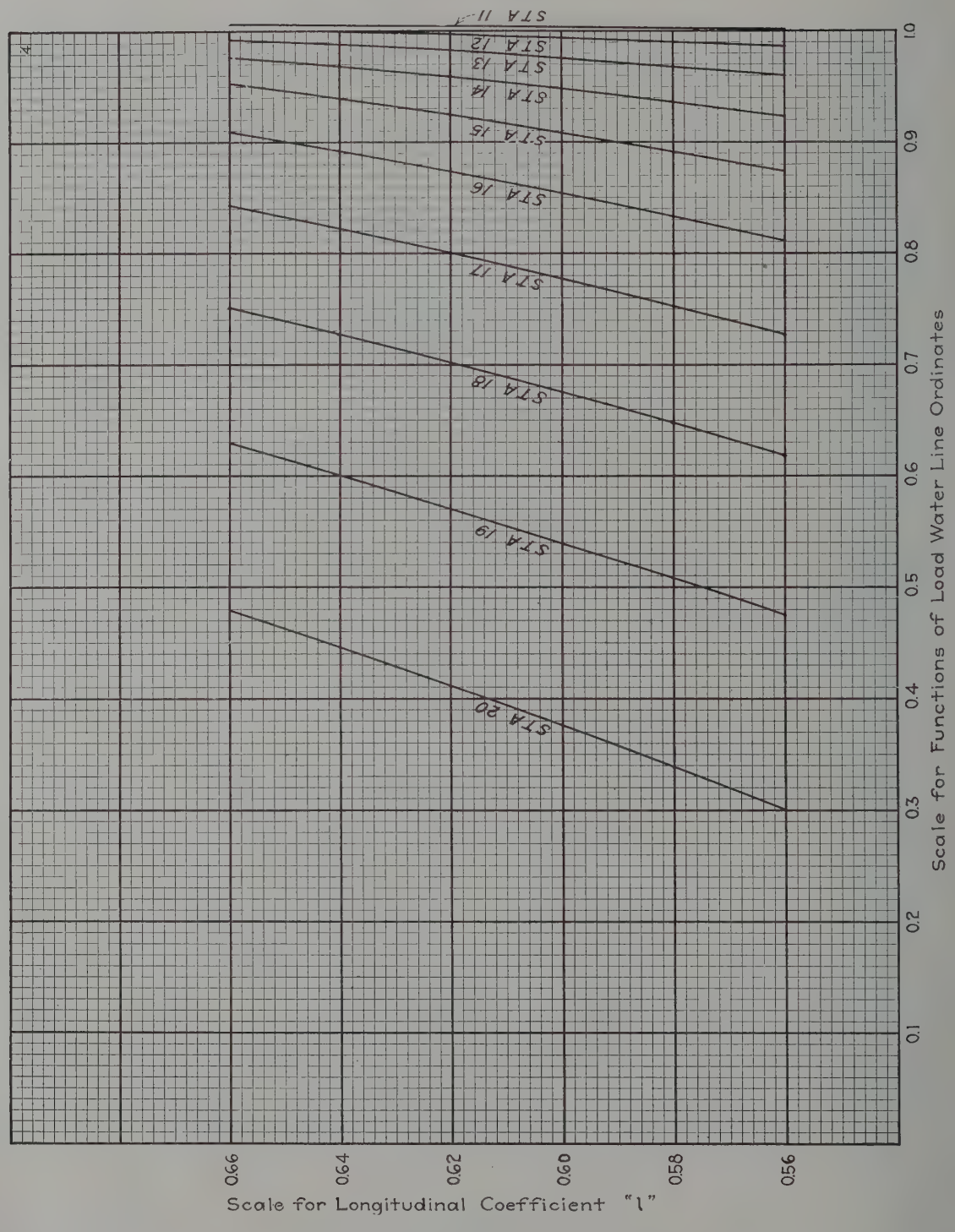
After Body

Fig. 28—Functions for Load Water Lines
for
High Speed Vessels



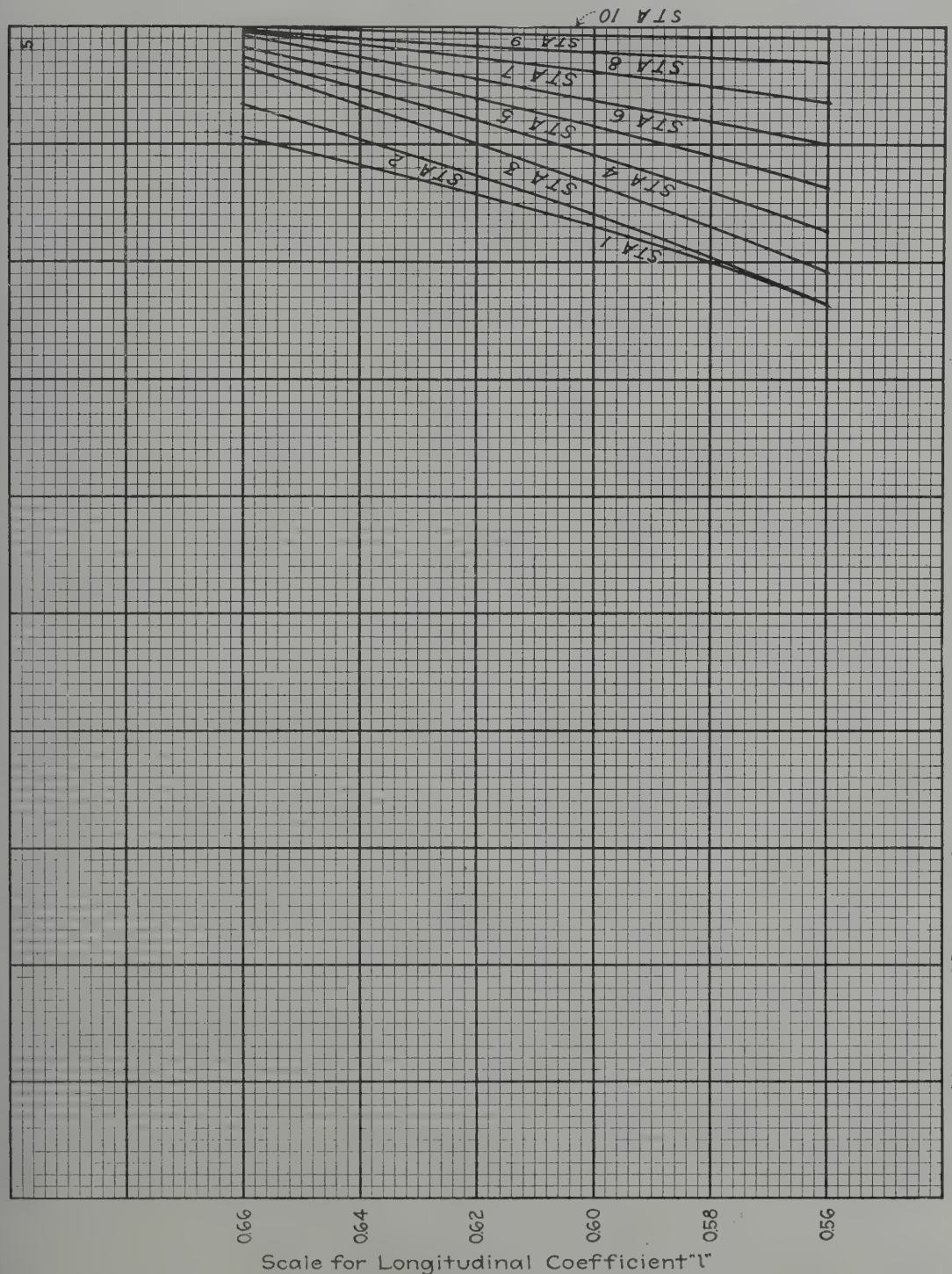
Fore Body

Fig. 29—Functions for Load Water Lines
for
High Speed Vessels



After Body

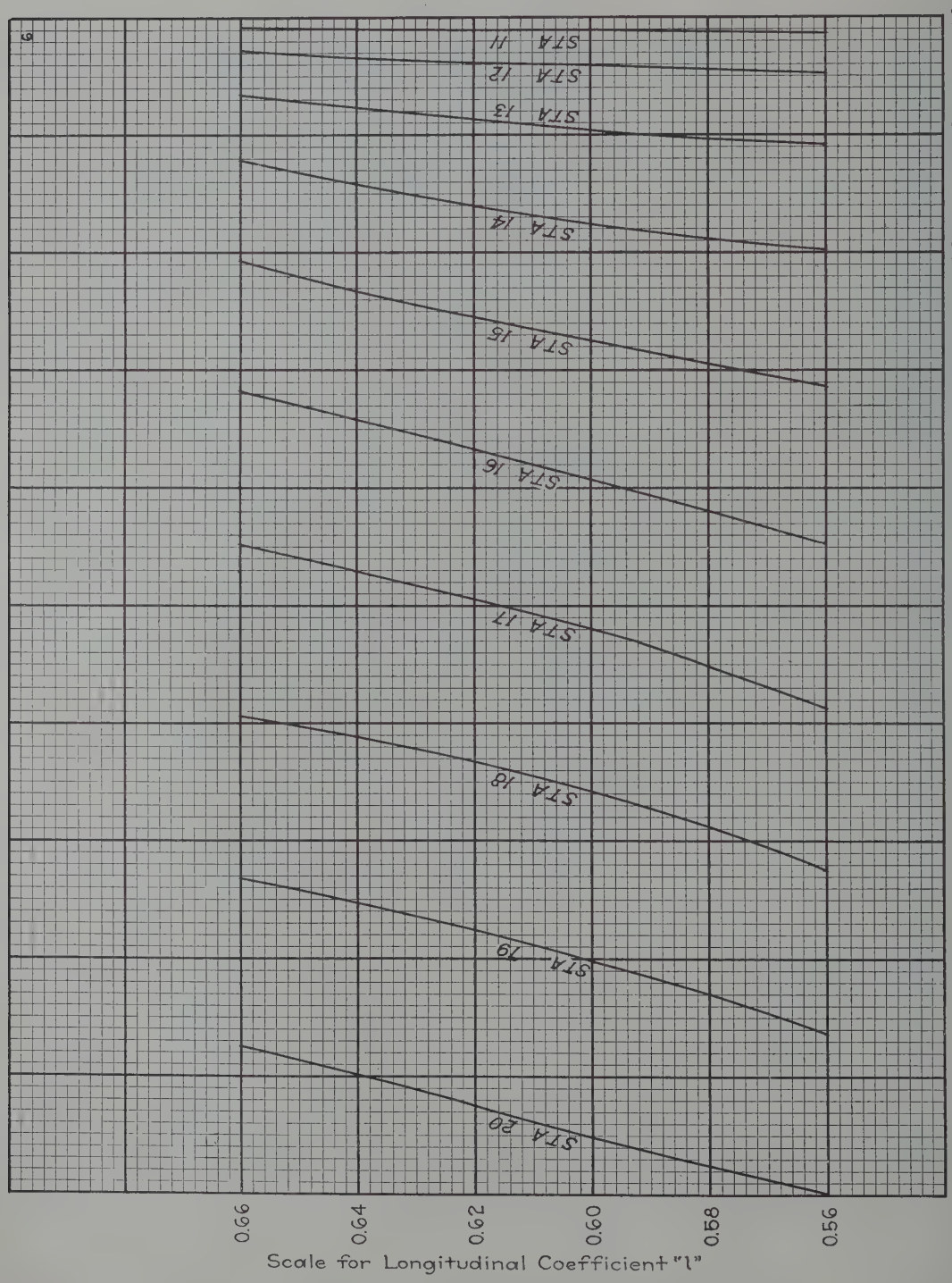
Fig. 30—Functions for Sectional Coefficient Curves
for
High Speed Vessels



To Derive Sectional Area Coefficient Multiply Function by Midship Section Coefficient "m"

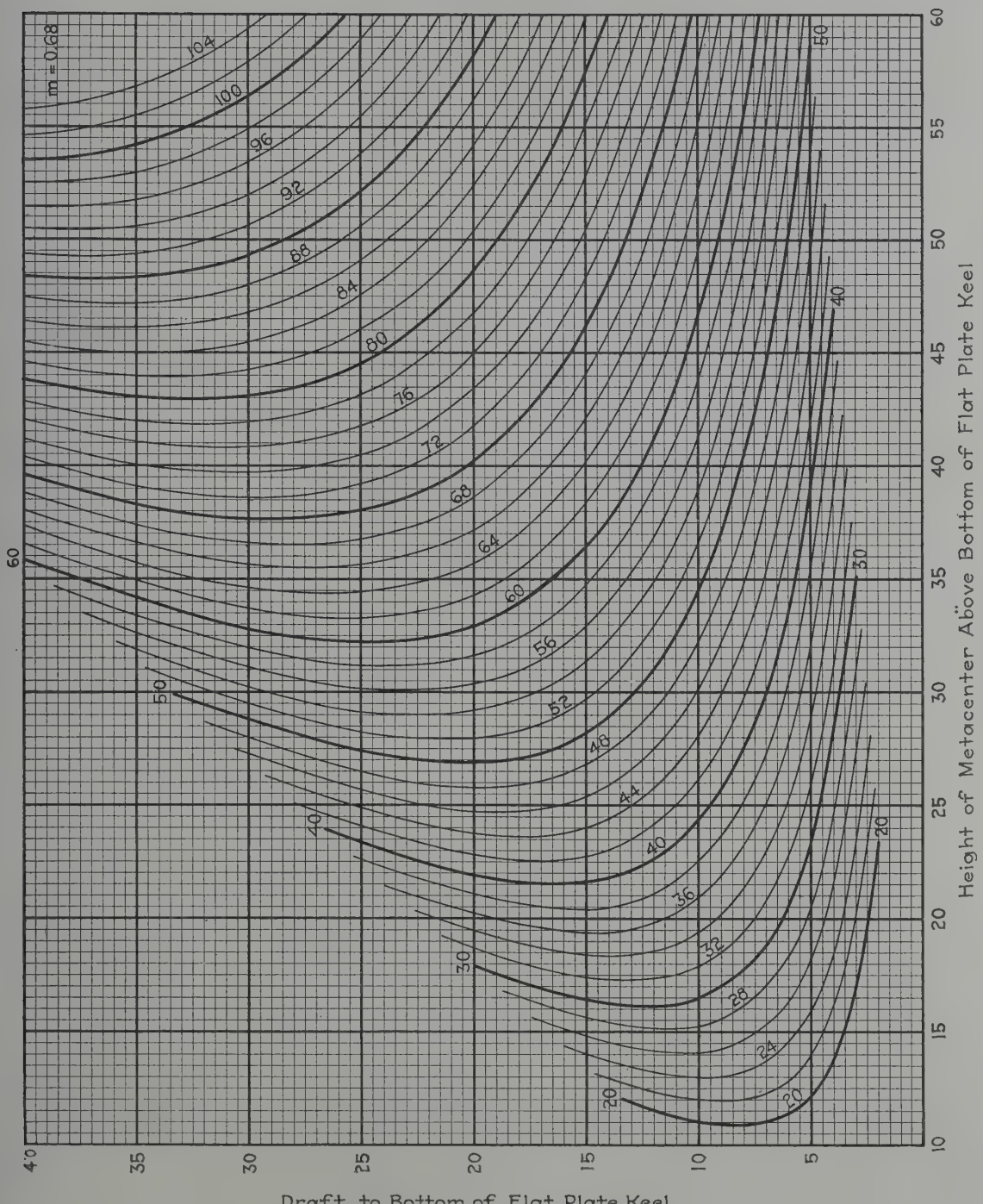
Fore Body

Fig. 31—Functions for Sectional Coefficient Curves
for
High Speed Vessels



After Body

Fig. 32—Metacenter Beam Chart
for
High Speed Vessels

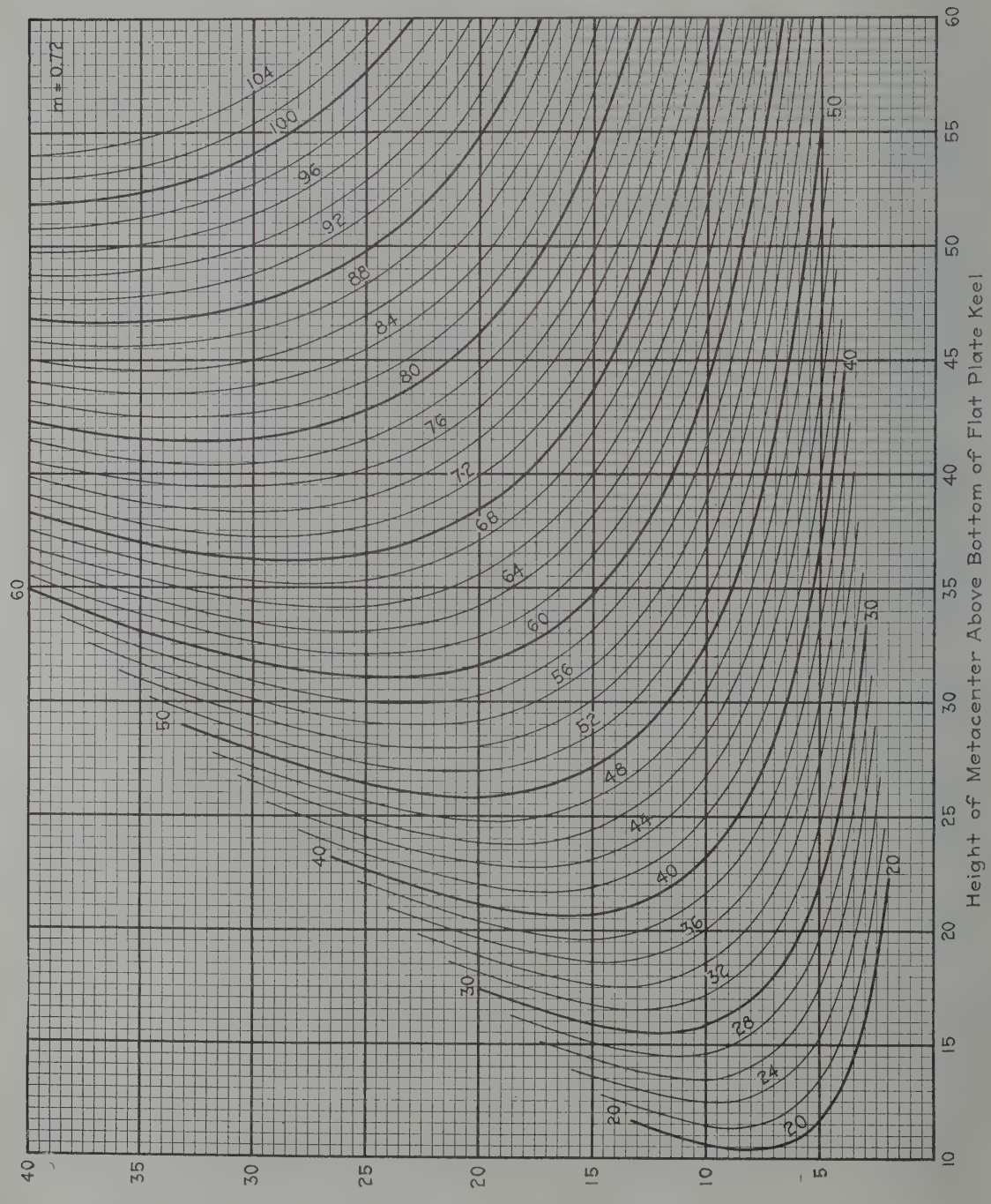


For Midship Section Coefficient = 0.68

Notes—For any given draft and for any desired height of metacenter above the base line, the proper beam may be selected at the intersection of the ordinate from the desired M and the abscissa from the given draft.

$$\frac{kp}{lm} = 0.1112 \qquad \frac{lm}{3p} = 0.1860$$

Fig. 33—Metacenter Beam Chart
for
High Speed Vessels

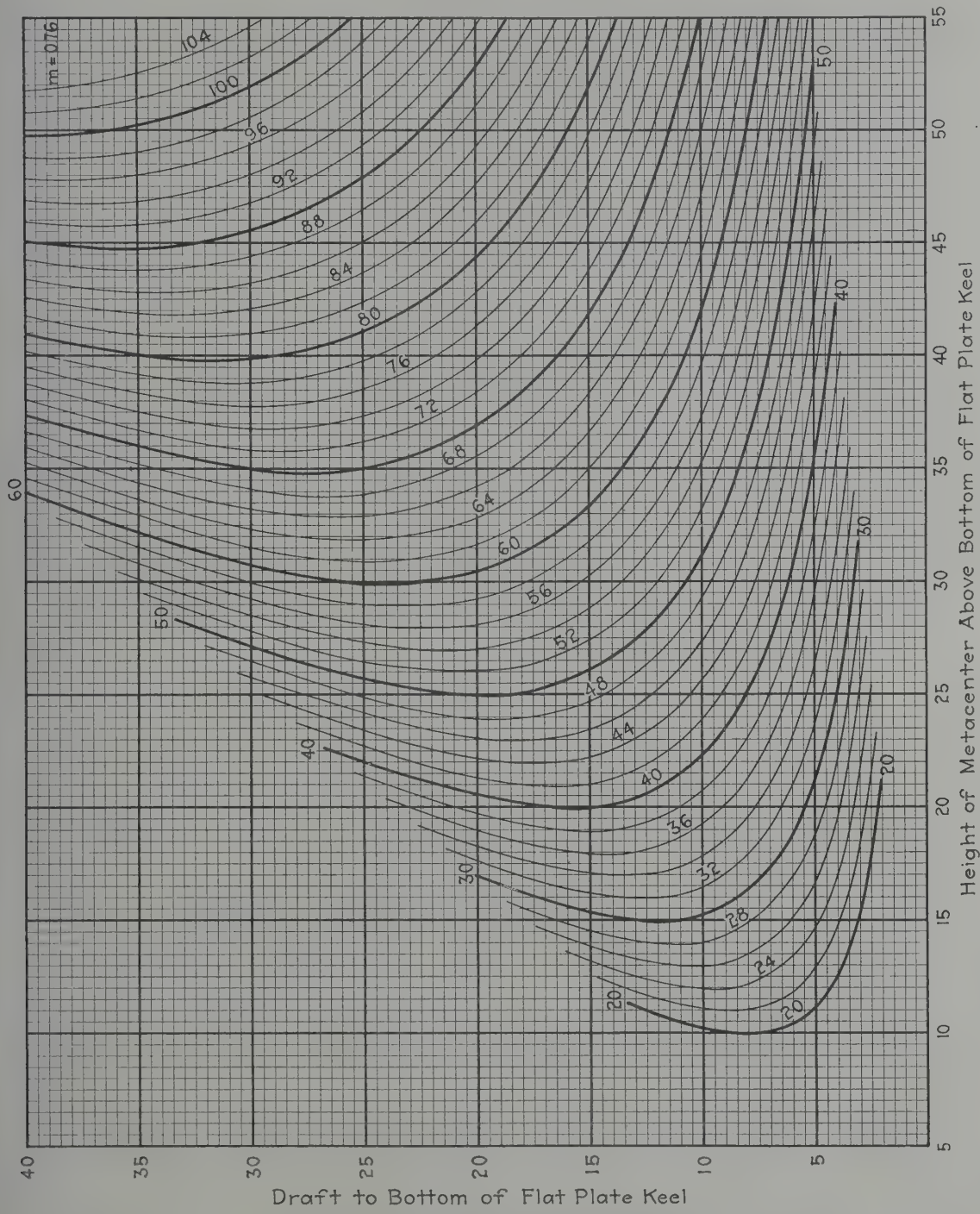


For Midship Section Coefficient = 0.72

Notes—For any given draft and for any desired height of metacenter above the base line, the proper beam may be selected at the intersection of the ordinate from the desired M and the abscissa from the given draft.

$$\frac{kp}{lm} = 0.1050 \qquad \frac{lm}{3p} = 0.1970$$

Fig. 34—Metacenter Beam Chart
for
High Speed Vessels

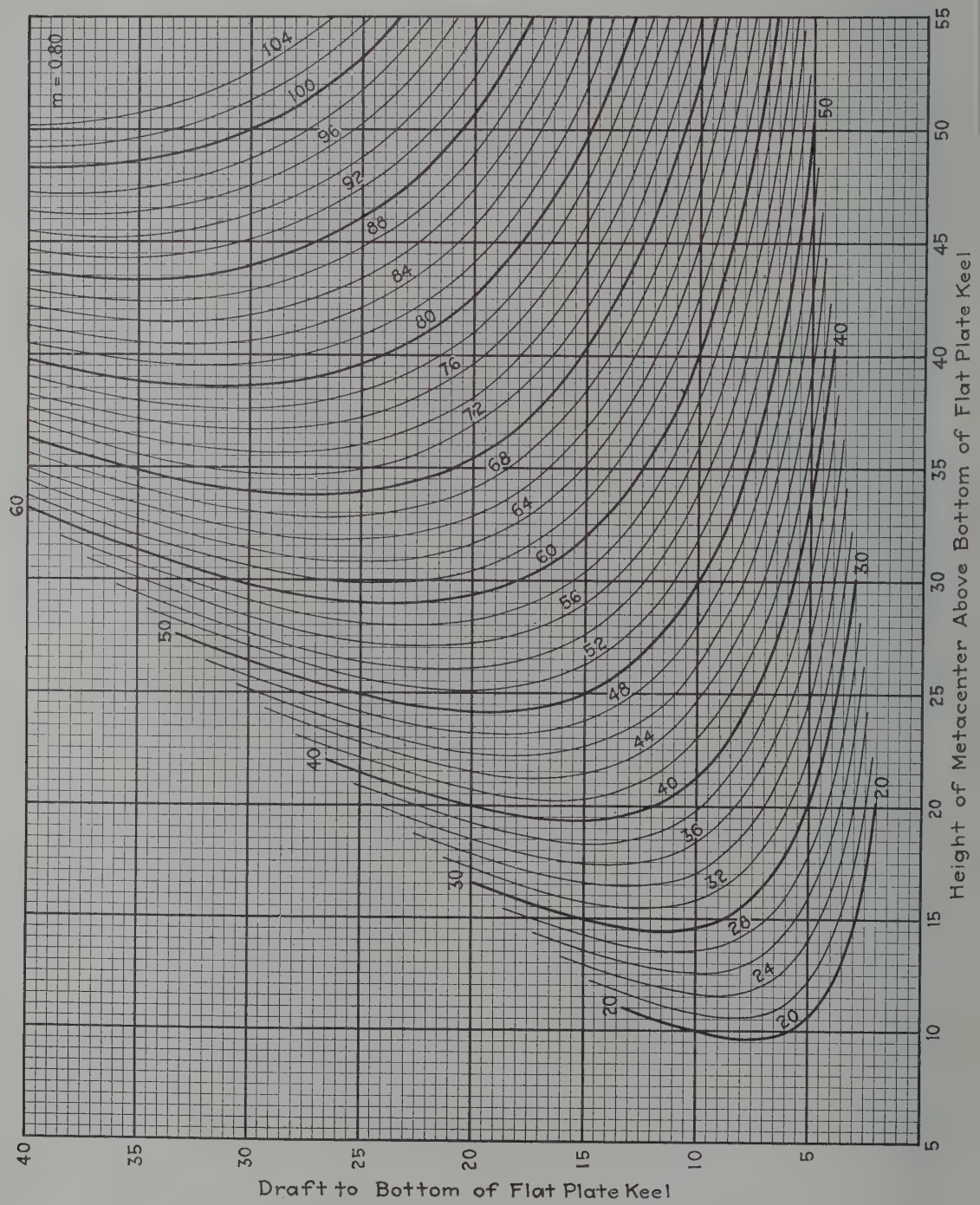


For Midship Section Coefficient = 0.76

Notes—For any given draft and for any desired height of metacenter above the base line, the proper beam may be selected at the intersection of the ordinate from the desired M and the abscissa from the given draft.

$$\frac{kp}{lm} = 0.0996 \qquad \frac{lm}{3p} = 0.2080$$

Fig. 35—Metacenter Beam Chart
for
High Speed Vessels

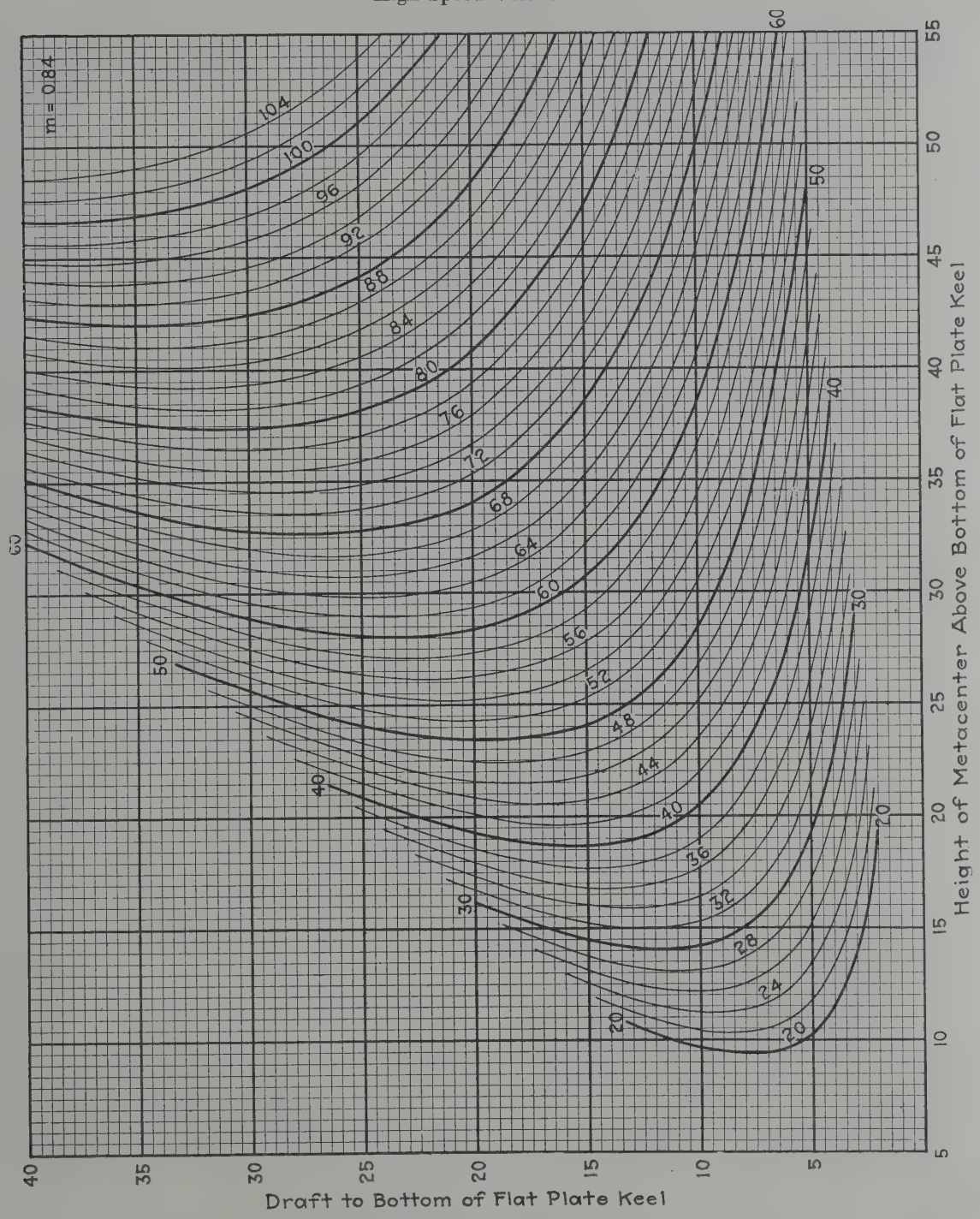


For Midship Section Coefficient = 0.80

Notes—For any given draft and for any desired height of metacenter above the base line, the proper beam may be selected at the intersection of the ordinate from the desired M and the abscissa from the given draft.

$$\frac{kp}{lm} = 0.0946 \qquad \frac{lm}{3p} = 0.2187$$

Fig. 36—Metacenter Beam Chart
for
High Speed Vessels

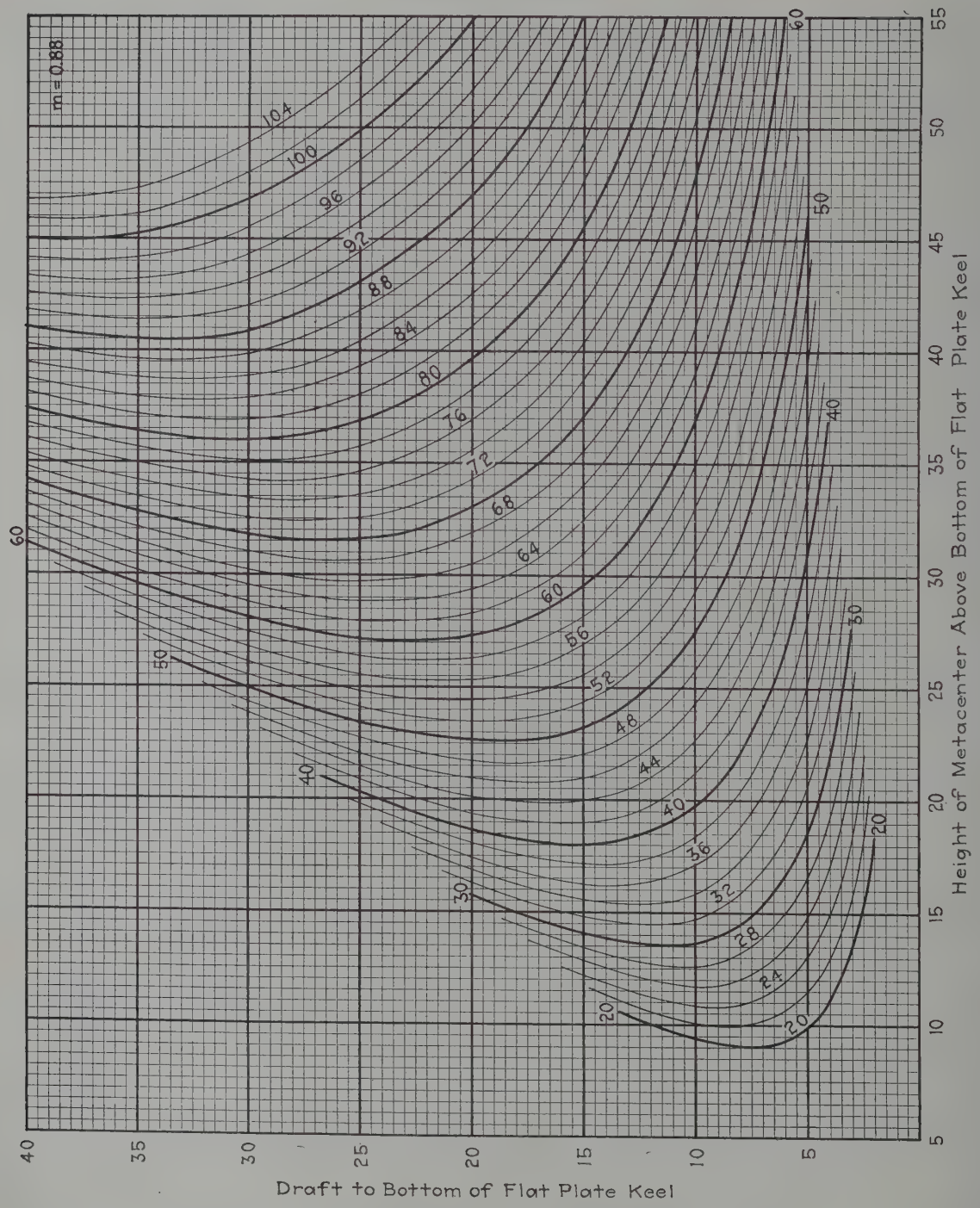


For Midship Section Coefficient = 0.84

Notes—For any given draft and for any desired height of metacenter above the base line, the proper beam may be selected at the intersection of the ordinate from the desired M and the abscissa from the given draft

$$\frac{kp}{lm} = 0.09005 \qquad \frac{lm}{3p} = 0.2295$$

Fig. 37—Metacenter Beam Chart
for
High Speed Vessels

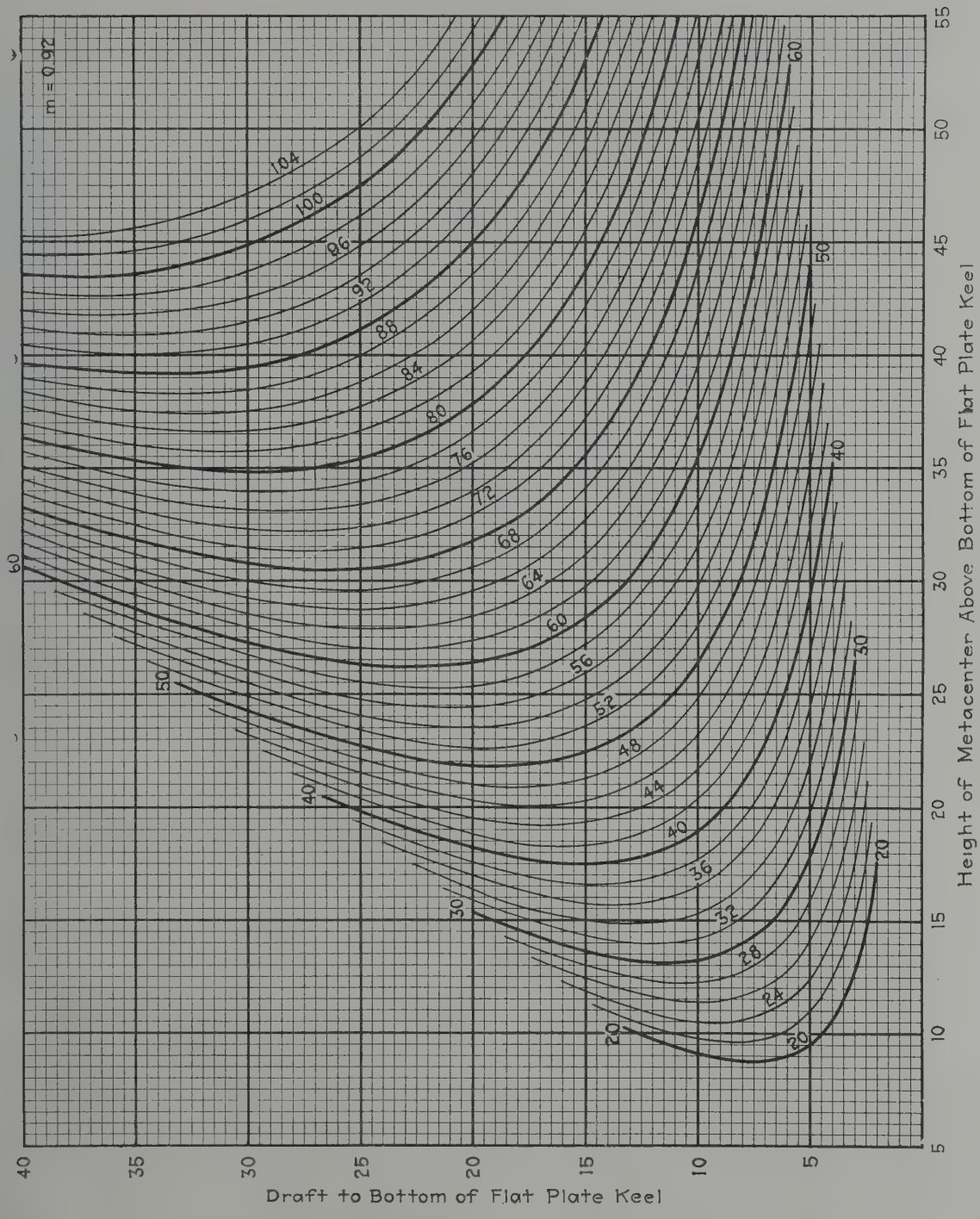


For Midship Section Coefficient = 0.88

Notes—For any given draft and for any desired height of metacenter above the base line, the proper beam may be selected at the intersection of the ordinate from the desired M and the abscissa from the given draft.

$$\frac{kp}{lm} = 0.086 \qquad \frac{lm}{3p} = 0.2408$$

Fig. 38—Metacenter Beam Chart
for
High Speed Vessels

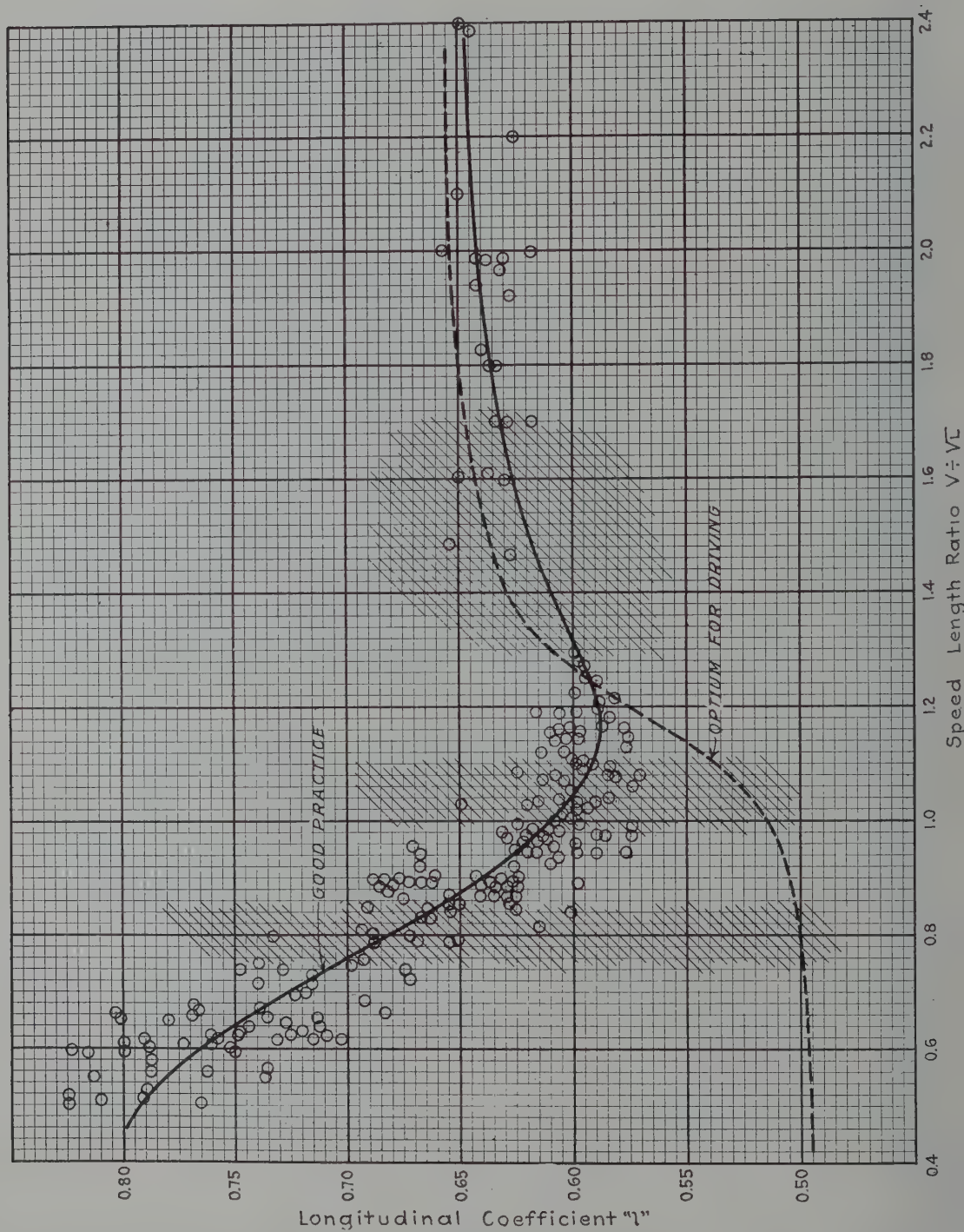


For Midship Section Coefficient = 0.92

Notes—For any given draft and for any desired height of metacenter above the base line, the proper beam may be selected at the intersection of the ordinate from the desired M and the abscissa from the given draft.

$$\frac{kp}{lm} = 0.08225 \qquad \frac{lm}{3p} = 0.2515$$

Fig. 39—Curves Showing
Variation of Longitudinal Coefficient
Plotted on Speed Length Ratio



in the interest of easier driving it would be necessary to add about 44 feet to the vessel's original length. Such a large increase in length would involve increases in hull weight and first cost which might easily outweigh the saving in size and cost of machinery installation plus any saving in fuel consumption which might be realized by the change. If, however, it were possible to increase the beam without obtaining too stiff a ship the reduction in longitudinal coefficient would be obtained without so great an increase in length. Under these conditions such a decrease in this coefficient might be desirable. In the case of a high-speed vessel of the destroyer type, however, the power demands are so great as to merit and receive first consideration.

It is worthy of note, however, that the appropriate values of longitudinal coefficient for this class of ship, viz., destroyers, are such as conduce to both easy driving, at the speeds contemplated, and lightness of hull in much greater degree than is the case with vessels of the type designed for somewhat lower speeds.

Longitudinal Coefficient Chart

Two curves are shown on Fig. 39. One curve shows optimum values for the longitudinal coefficient for varying values of the speed length ratio. This curve is based upon Taylor's investigations (the dotted line). The other curve (solid line) indicates values sanctioned by good practice. This curve is based upon a careful study of a large number of ships. The values actually used for some of these vessels are shown in the figure by small circles.

Inasmuch as the value assigned to the longitudinal coefficient is of such importance as affecting driving characteristics and as this coefficient is intimately connected with the length adopted it has been considered desirable to show on the sheet just described the localities in which "humps" in resistance curves occur. These localities are indicated by the shaded portions and correspond roughly to values of $\frac{V}{\sqrt{L}} = .75$ to .85, 1 to 1.10 and 1.30 to 1.70.

For comments on the importance of these humps see quotation from Admiral Taylor under definition of "humps."

In fixing the values for low speed vessels having speed length ratios of .45 to .70, special weight has been given to coefficients selected for cargo vessels recently designed by competent naval architects and to published comment from authoritative sources. For vessels of higher speed a large number of studies have been made. These studies have, in each case, included careful estimates of weight, power, strength, and stability for four or five ships, all designed to meet the same requirements, but varying in length and longitudinal coefficient. The studies have covered thoroughly the values corresponding to speed length ratios from .8 to .95, from 1.15 to 1.3, from 1.4 to 1.6 and from 1.7 to 2.1. Moreover, the characteristics of many vessels in service whose coefficients lie within the limits noted have been examined and given proper weight in connection with the above studies. It will, therefore, be apparent that the location of the curve has been logically determined for all ordinary cases.

In comparing the two curves it will be noted that though widely separated at lower speeds, they approach each other closely at speed length ratios greater than 1.2. This is in general accord with statements previously made relative to merchant ships and vessels of the destroyer type.

It is held by some designers that for slow cargo vessels the value of the longitudinal coefficient can be indefinitely increased, thus obtaining augmented cargo capacity. This might seem warranted in view of the results just cited. Careful investigation based on actual records of performance indicates that as between two vessels closely similar in other respects, an excessively full ship will lose sufficient time during an average season on account of the retarding effect of head seas to more than offset the smaller cargo capacity of a somewhat finer vessel. This, taken together with the fact that resistance increases rapidly for values of longitudinal coefficient above .8 even in slow vessels, indicates that from .78 to .8 is about the maximum value which may satisfactorily be assigned to the longitudinal coefficient for seagoing vessels.

The values given in Table 9 have been found satisfactory for the classes of ship enumerated and agree closely with Fig. 39.

Table 9—Variation of Longitudinal Coefficient with Speed Length Ratio for Various Types of Ships

Class.	$\frac{V}{\sqrt{L}}$	Longitudinal Coefficient.
Slow cargo vessels	.45 to .55	.78 to .80
Fast cargo vessels	.55 to .65	.745 to .78
Passenger cargo vessels	.65 to .80	.68 to .745
Battleships	.85 to .93	.625 to .66
Fast passenger vessels	.80 to 1.05	.60 to .68
Battle cruisers	1.00 to 1.20	.56 to .61
Scouts and light cruisers	1.20 to 1.50	.59 to .62
Destroyers and fast yachts	1.70 to 2.20	.63 to .645

While the values assigned represent general practice, it is entirely possible that circumstances governing in an individual case may render other values highly desirable.

In the case of long vessels of large displacement and relatively slow speed, slightly higher values than those suggested may be used with satisfactory results.

In the case of vessels of great size and very great speed, such as modern battle cruisers or a 30-knot Atlantic liner, it might be necessary on account of the enormous power required and the space necessary for the machinery installation to adopt a value of the coefficient which would be lower and therefore somewhat more favorable to the driving qualities than those shown. Such a change would of course involve increased length and hull weight, but would reduce machinery weights and fuel consumption.

In the case of light, high-speed vessels, should there be a restriction placed upon fuel consumption at a speed materially lower than the maximum speed, it would be desirable to reduce the value of the longitudinal coefficient indicated.

The coefficients suggested for higher speed vessels have been largely determined, in view of the smallest possible displacement and the most satisfactory maneuvering qualities. In case first cost should be of vital importance on account of the high price per ton of machinery as compared with the price per ton of hull, it would be necessary to favor the driving qualities more than has been done in the tables shown. This would result in longer and heavier hulls and somewhat increased displacement. The machinery installation would be of decreased power, however, and in view of the fact that machinery costs several times as much per ton as does hull, a noticeable saving in first cost might be expected. Moreover, if maneuvering ability were not especially important the added length of hull with the resulting increase in space for stores, quarters, etc., might be considered advantageous.

Approximate Power

Methods

In case the results of model experiments upon vessels of closely similar form and coefficients are available the designer will naturally base his power approximations directly upon them, making such allowances or corrections as his judgment dictates.

Frequently, however, such data as the above are not readily available. Then it is necessary to resort to such published information as best meets the conditions obtaining.

Taylor's Series

The publication of Admiral D. W. Taylor's "Speed and Power of Ships" makes it possible to estimate with facility and considerable accuracy the power required for a given ship, without reference to model results for a similar vessel.

Value and Limitations of Taylor's Standard Series

The curves published in this book have been found of especial value for ships in which wave-making forms a relatively large proportion of the total resistance. This would naturally be the case, inasmuch as the forms upon which Admiral Taylor's work is based were forms applicable particularly to intermediate and higher speed types rather than to the slow, full cargo vessel.

Furthermore, Admiral Taylor's contour curves for residuary resistance are not carried below values of speed length ratio of .6. Hence, wherever it is necessary to deal with slower vessels by means of Admiral Taylor's data, extrapolation must be resorted to. This introduces the possibility of error. Nevertheless, on account of the advantages which this method of studying and comparing the effects of changes in form and coefficients offers, it has been adopted as the basis for the following work. The foregoing should receive due weight when considering any comparisons between model tank results and the results of Admiral Taylor's standard series when applied to slow cargo carriers.

Wave Making the Resistance Criterion

Inasmuch as the wetted surface is directly responsible for the amount of skin friction encountered in any ship, and inasmuch, further, as this portion of the resistance makes up as much as 75 or 80 per cent of the total resistance for slow full vessels, it will be apparent that the amount of wetted surface must receive attention in all power studies relating to vessels of the cargo-carrying type. It should be noted, however, that it is possible to vary the form of the vessel quite widely without materially affecting the area of wetted surface, and therefore the value of the frictional resistance. This being the case, for purposes of comparing one form with another the wave-making resistance even in the case of full cargo vessels becomes the principal criterion. For this reason, and for reasons referred to later, the data published by Admiral Taylor have not been strictly followed in the curves here proposed for approximating the power of slow merchant vessels.

Table 10 shows the relative values of the two principal resistance components found in practice for several principal classes of ship varying widely in size and in speed:

Table 10—Principal Resistance Components

Type.	Percentage of Frictional Resistance.	Percentage of Residual Resistance.
Destroyer	41	59
Scout	50	50
Battle Cruiser	59	41
Battleship	63	37
Troop Transport	69	31
Fleet Oiler	70	30
Cargo Vessel	75	25

The figures in Table 10 correspond to the designed maximum speeds in each case.

Range Covered by Taylor's Standard Series

Admiral Taylor's curves were based upon experiments made with a model of conventional shape, with moderate U-shaped sections forward, and the usual V-shaped sections aft. They covered a range of speed length ratio between .6 and 2.0 and a range of displacement length coefficient between 30 and 160. Parallel middle body, for the reasons referred to above, is not contemplated, nor is a large amount of displacement for a given length. The curves, therefore, as has been previously pointed out, apply particularly to ships of medium and high speeds. For these ships, provided reasonable coefficients and fair forms are selected, the average error is very small, especially for the upper ranges of speed. This fact is well illustrated by Fig. 40, showing the results of model basin experiments compared with the estimated values as derived from Taylor's standard curves.

Comparison of Typical Forms of Underbody with the Standard Series

Curve B represents a high-speed vessel of the destroyer type, with an underbody form similar in general to the parent form used for Taylor's standard series. It will be noted that the line of actual performance does not depart at any point far from the standard, excepting at the lowest speeds.

Curve C represents a destroyer type having, as in case B, a straight keel parallel to the surface of the water for about 80 per cent of the vessel's length, but having sections which gradually flatten as the stern is reached. This type has positive area at the after perpendicular equal to approximately 4 per cent of the midship section area. The buttock lines of this type are easy and flat, having a tendency to droop rather than to increase their inclination at the extreme stern. It will be noted that this type shows a noticeable saving over the standard series throughout most of its length. This is probably due to the great effective length which is obtained by the considerable immersion of transom without the addition of wetted surface.

Curve D represents a fast transport type, having an ordinary ship-shape form but no parallel middle body.

Curve E. represents a fast cargo vessel. This, like curve D, tends to depart from Taylor's series, at the lower speeds.

It should be noted here that the difference between model experiments and the standard series occurring above a speed length ratio of .6 is relatively small and becomes serious only below this point in a range reached by extrapolation from Taylor's series.

It is believed that one of the principal reasons for this deviation lies in the fact that the parallel middle body—in the case of E about 40 per cent of the vessel's length—

Fig. 40—Curves of Performance
of
Typical Vessels as Compared with the Standard Series

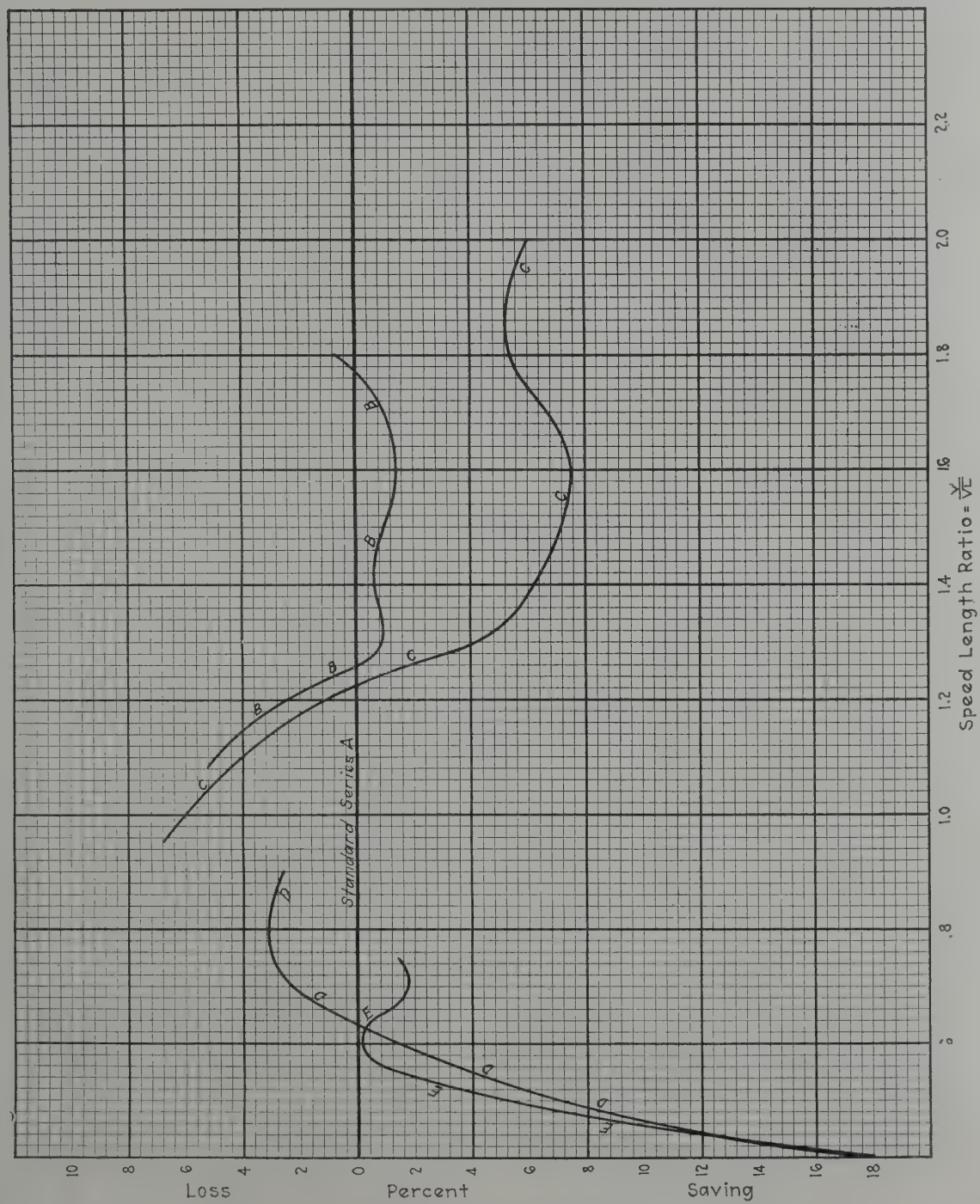
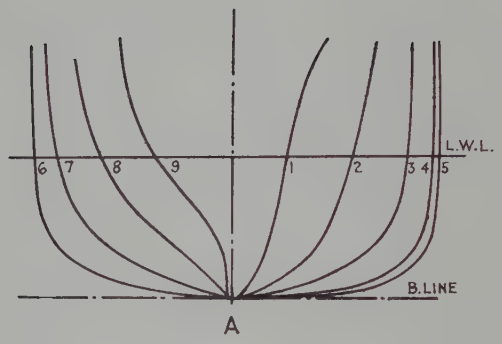
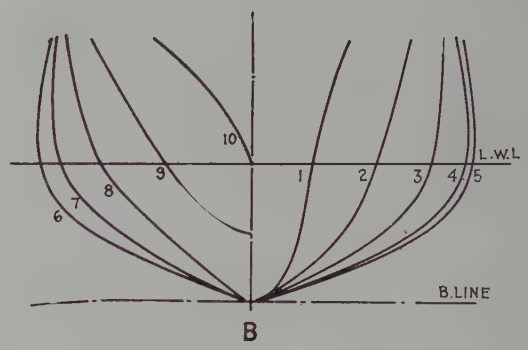
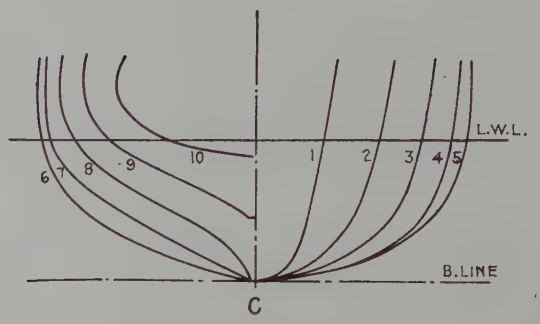
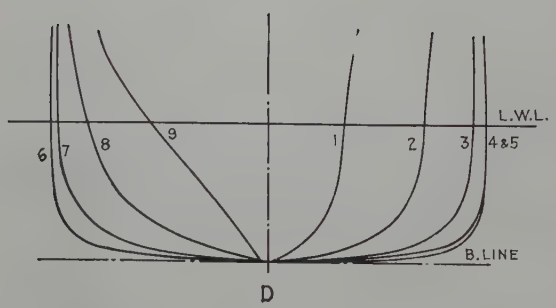


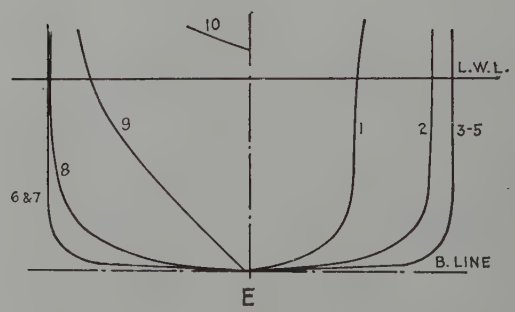
Fig. 41—Body Plans
of
Typical Vessels











has the effect of lowering the virtual longitudinal coefficient by permitting much finer ends than would be possible without its use.

Model D, however, has no parallel middle body, and yet gives a curve closely similar to that of E. Hence the above suggested explanation certainly does not cover all cases.

Typical Body Plans

In order to make the foregoing as definite as practicable, the body plan upon which Taylor's standard series is based is shown in Fig. 41 in comparison with body plans for Curves B, C, D, and E, Fig. 40.

Table 11 shows some of the characteristics of the models themselves.

Table 11—Characteristics of Models

	B	*C*	*D*	*E*
Length, W. L. in ft.....	300	360	460	455
Beam, W. L. in ft.....	30.3	37.7	60.8	56
Draft, mean in ft.....	9.25	11.3	19.6	26.2
Longitudinal coefficient	.618	.628	.659	.784
Midship section coefficient...	.68	.80	.952	.974
Displacement length coefficient	37.5	47.1	101	154

Reason for Above Comparison

The above departures of the curves derived by model basin experiment from those obtained directly and indirectly from Taylor's standard series may be considered typical of the several forms of underbody shown. The forms selected are not forms of maximum driving efficiency, but have been selected rather as averages for the type, indicating the results which should be obtained with models of good form and proper coefficients in comparison with the estimates based upon Taylor's series. This comparison is introduced in order that it may be possible for the designer to obtain as definite a knowledge as possible as to the performance of several common different types of ships compared with Taylor's standard series.

Power Curves

While it is always desirable to plot a complete curve of effective horsepower as accurately as may be for any new design, and while Admiral Taylor's work affords as satisfactory a basis as can be expected, or in most cases desired—particularly when supplemented by corrections of performance such as shown above—for purposes of quick approximation during the early stages of a design it is frequently desirable to compare the relative merits of several schemes differing in dimensions, coefficients or other characteristics. There have accordingly been developed from Taylor's standard series curves of constant power plotted on speed and length which are applicable to vessels of moderate and high speed. These are shown on Figs. 42 to 69 inclusive, where each sheet corresponds to a given value of longitudinal coefficient and displacement length coefficient. These curves make possible the ascertaining of the power for a given form in a most expeditious manner and almost to the same degree of accuracy as that of which Taylor's standard series is capable. Small variations in coefficients may be allowed for by direct proportion. A further correction may be introduced, if desired, by reference to the performance curves given above.

Importance of Driving Efficiency

The length and displacement of merchant vessels, particularly of cargo carriers, are dependent rather more upon cargo handling facilities and trade requirements than upon driving characteristics. It should not, however, be understood that driving characteristics are to be ignored in the case of cargo-carrying steamers. In fact, recently more and more emphasis has been placed upon the necessity of reducing the power required and thereby effecting as great a possible saving in fuel as is practicable. Hence it is necessary that as good a form as practicable, consistent with the carrying of an adequate amount of cargo, should be provided.

Power Curves for Slow Merchant Vessels

In order to furnish designers of slow merchant vessels with facilities similar to those above described for vessels of greater speed, considerable study has been made of the works of Messrs. Baker, Sadler, Semple, Kemp, and others. Based on this study, the sheets of power curves for cargo carriers have been prepared, Figs. Nos. 42 to 45 inclusive. These curves, like the curves of similar type (Figs. 46 to 59 inclusive provided for vessels of greater speed) should not be expected to take the place of estimates based upon the results of a similar type ship. They do, however, represent good practice and provide a good basis for comparing one proposed ship with another.

Fourth Division

Trial Ships and Their Selection

Up to this point the discussion has dealt with general considerations and has assumed the tentative selection of a ship of such displacement and length as to generally meet the requirements laid down.

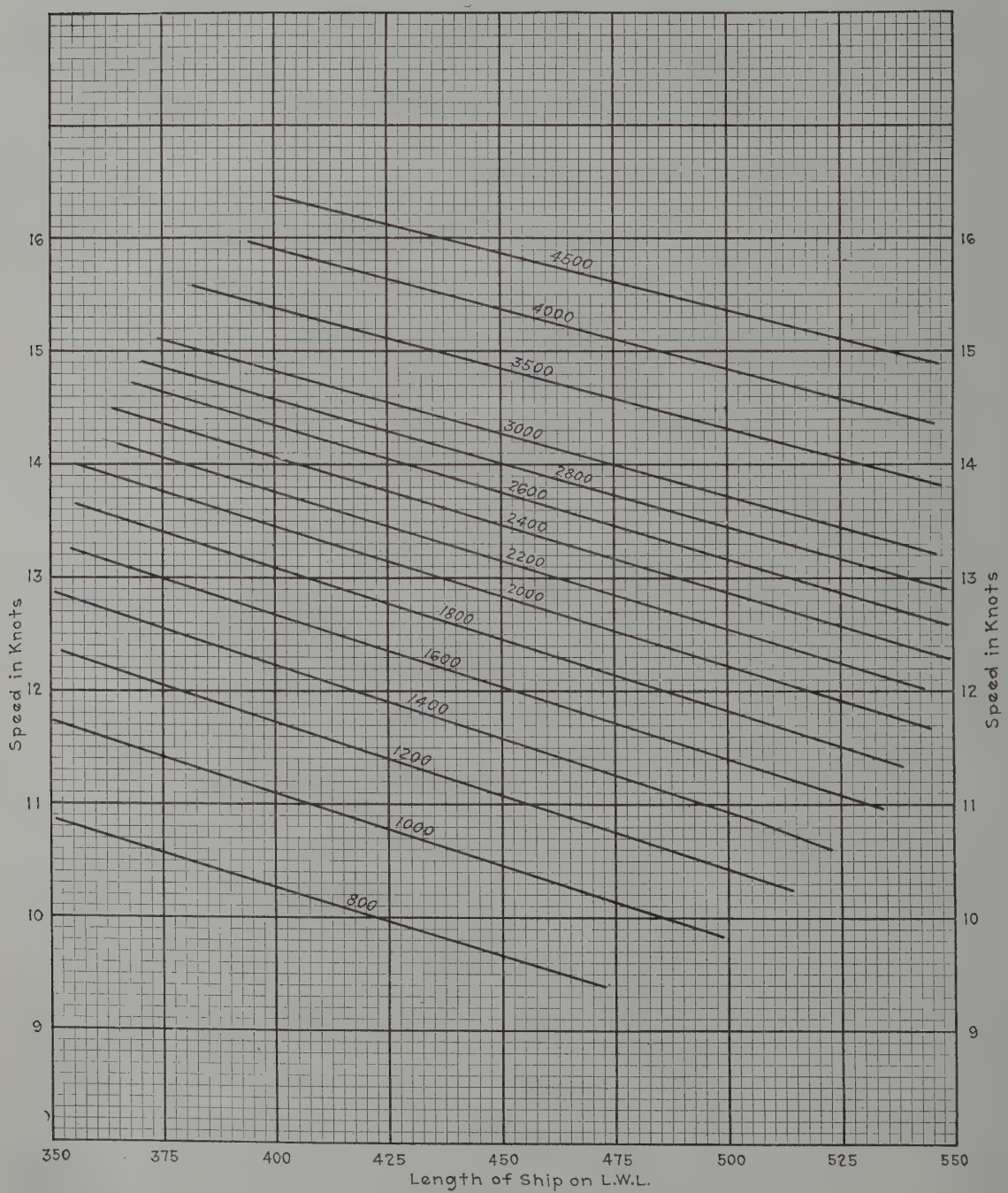
Investigation of Length

The object of the steps in this division is to investigate the subject of length and to select that length which is most efficient for the purposes in view. The deciding factor in this analysis may be any one or any combination of the following features: Displacement, longitudinal coefficient, fuel economy, size or type of machinery installation, cost. It may also involve other considerations than these. In any event, however, both displacement and longitudinal coefficient will figure prominently in the investigation—the former principally because of the cost of material and the possibility of carrying the designed load, and the latter because of the size and cost of machinery installation and the consumption of fuel.

Outline of Procedure

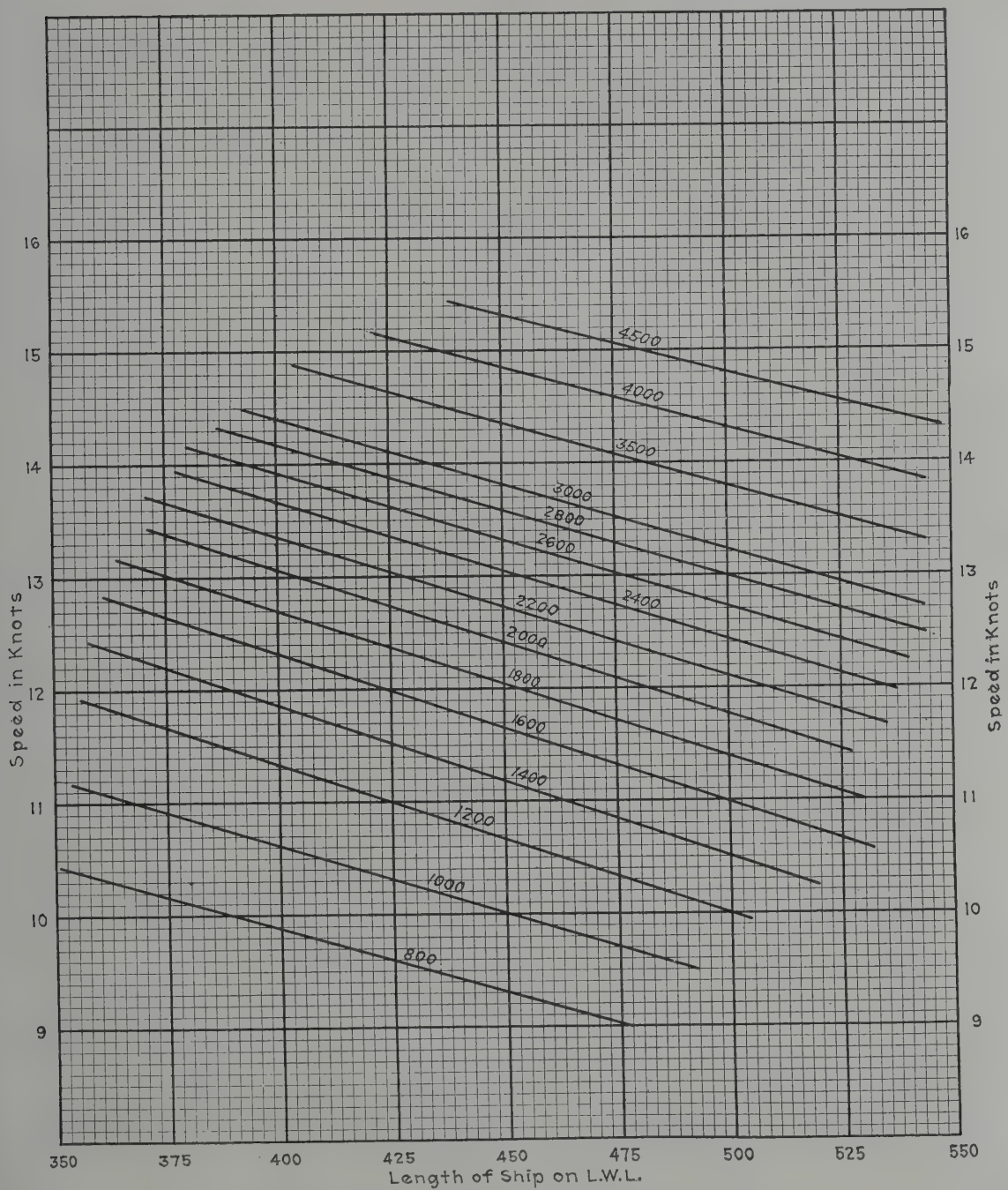
If, then, a displacement suitable for the requirements in hand be selected (presumably this will be that tentatively determined upon at an earlier stage unless subsequent work has shown it to be unsatisfactory), and the beam, draft, depth, and midship section coefficient already fixed be maintained constant, we may vary both length and longitudinal coefficient through a suitable range without changing the value of the metacentric height selected. The effect of this variation upon the weights is then noted and serves as the medium by which the study of costs, size of machinery installation, fuel consumption, etc., referred to above, is made. In practice the above investigation of displacement and longitudinal coefficient is carried out in the manner described below.

Fig. 42—Curves of Effective Horsepower
for
Cargo Ships



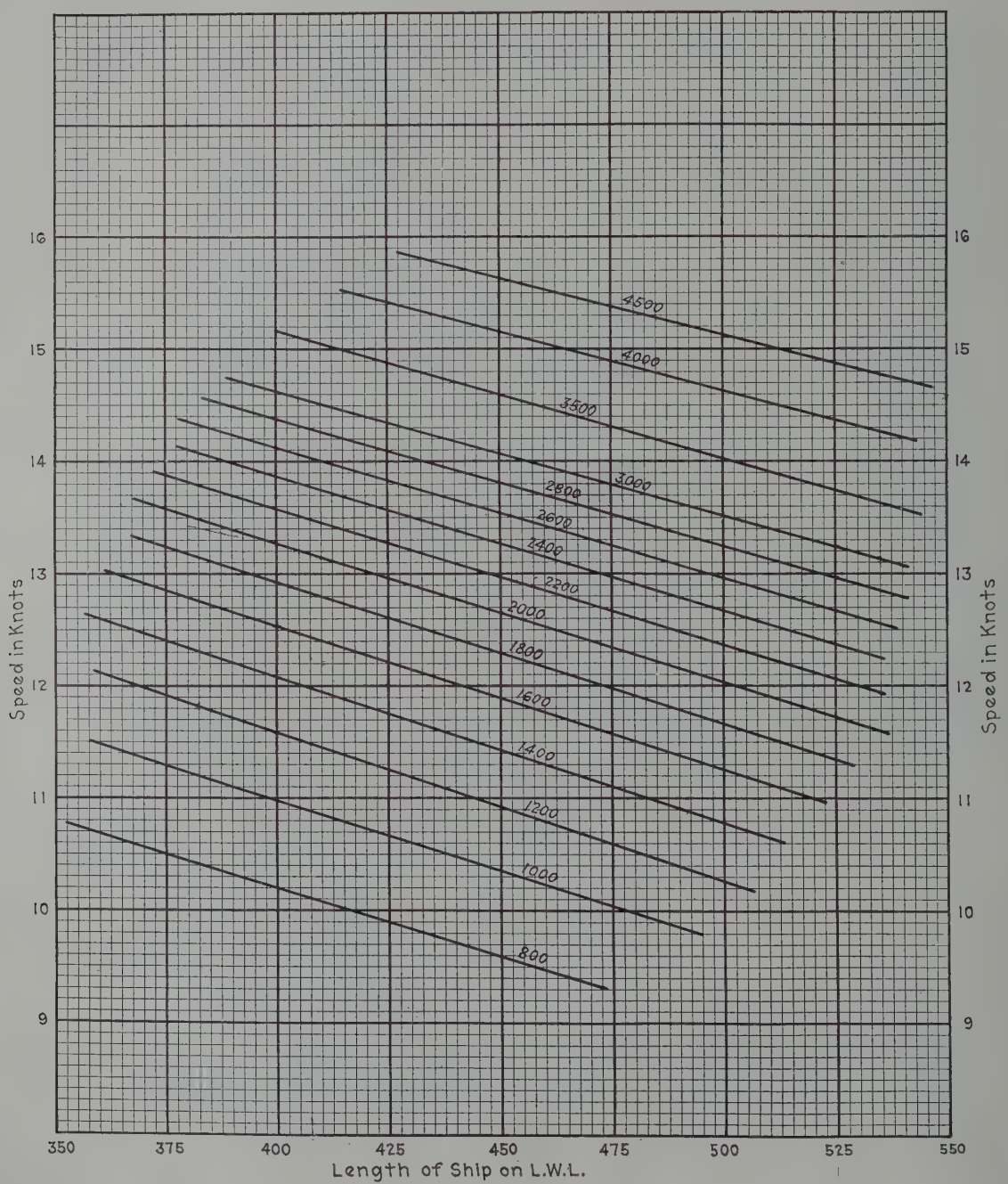
Midship Section Coefficient = 0.96
Prismatic Coefficient = 0.74
Displacement Length Coefficient = 150.

Fig. 43—Curves of Effective Horsepower
for
Cargo Ships



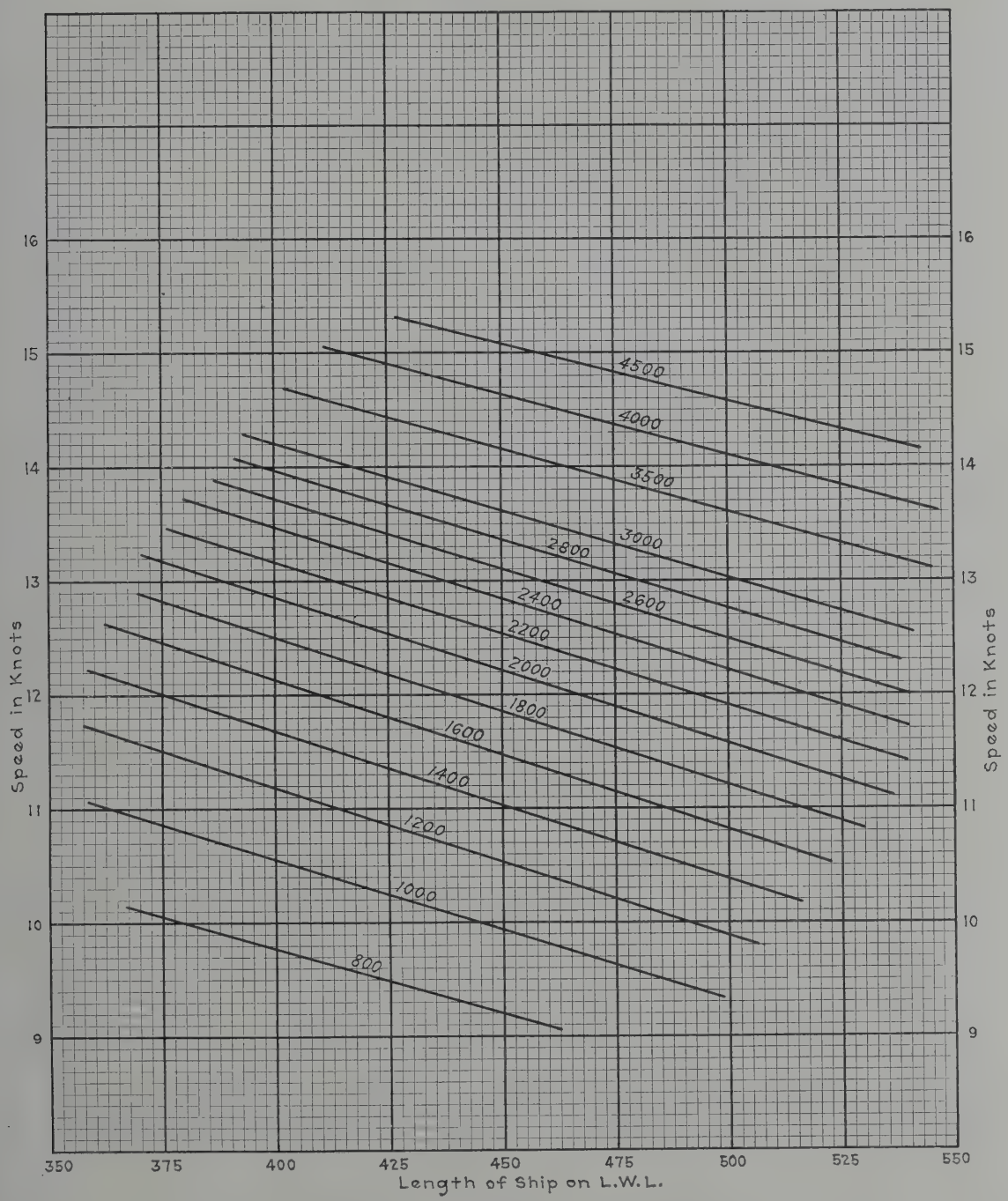
Midship Section Coefficient = 0.96
Prismatic Coefficient = 0.74
Displacement Length Coefficient = 180.

Fig. 44—Curves of Effective Horsepower
for
Cargo Ships



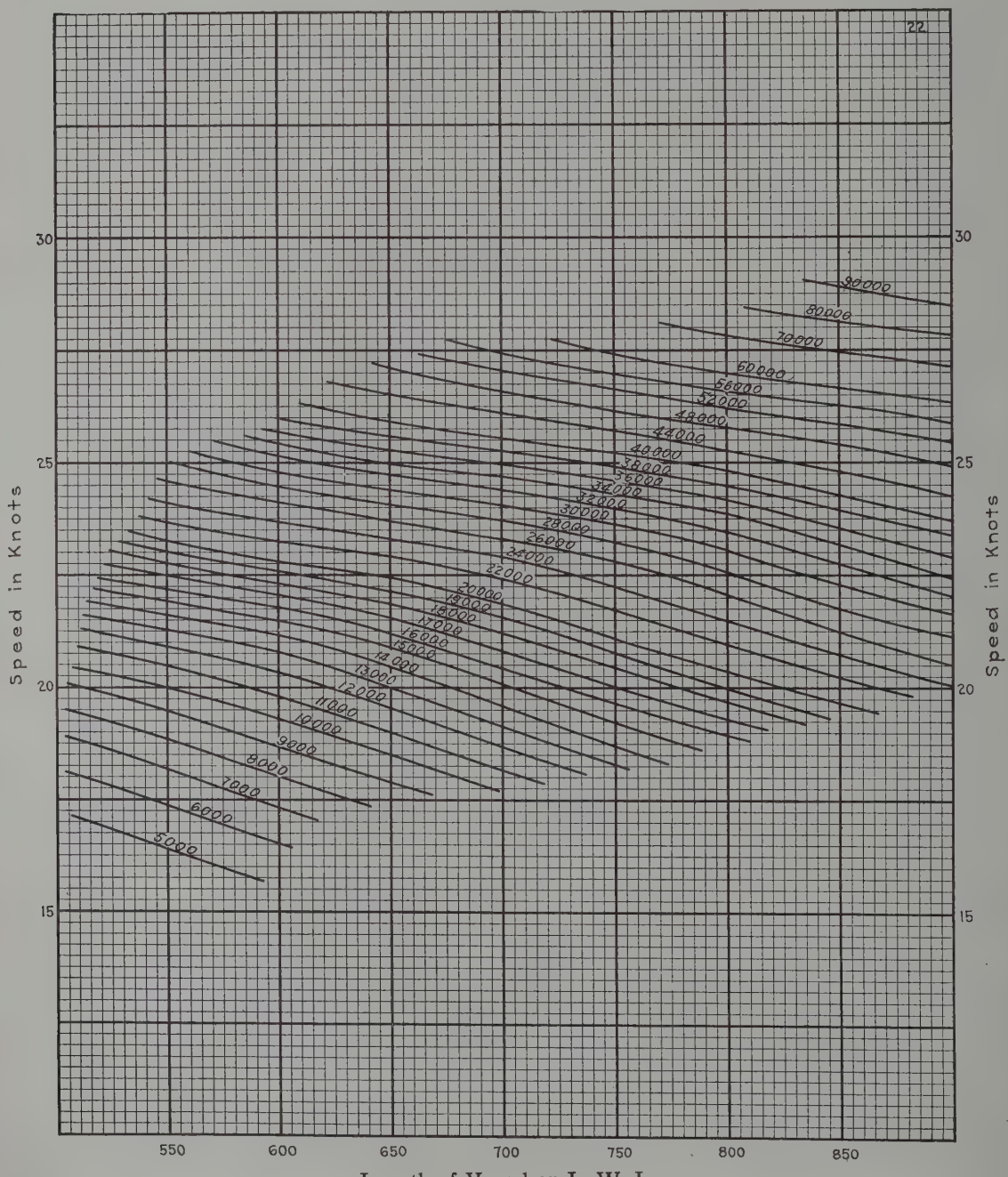
Midship Section Coefficient = 0.96
Prismatic Coefficient = 0.78
Displacement Length Coefficient = 150.

Fig. 45—Curves of Effective Horsepower
for
Cargo Ships



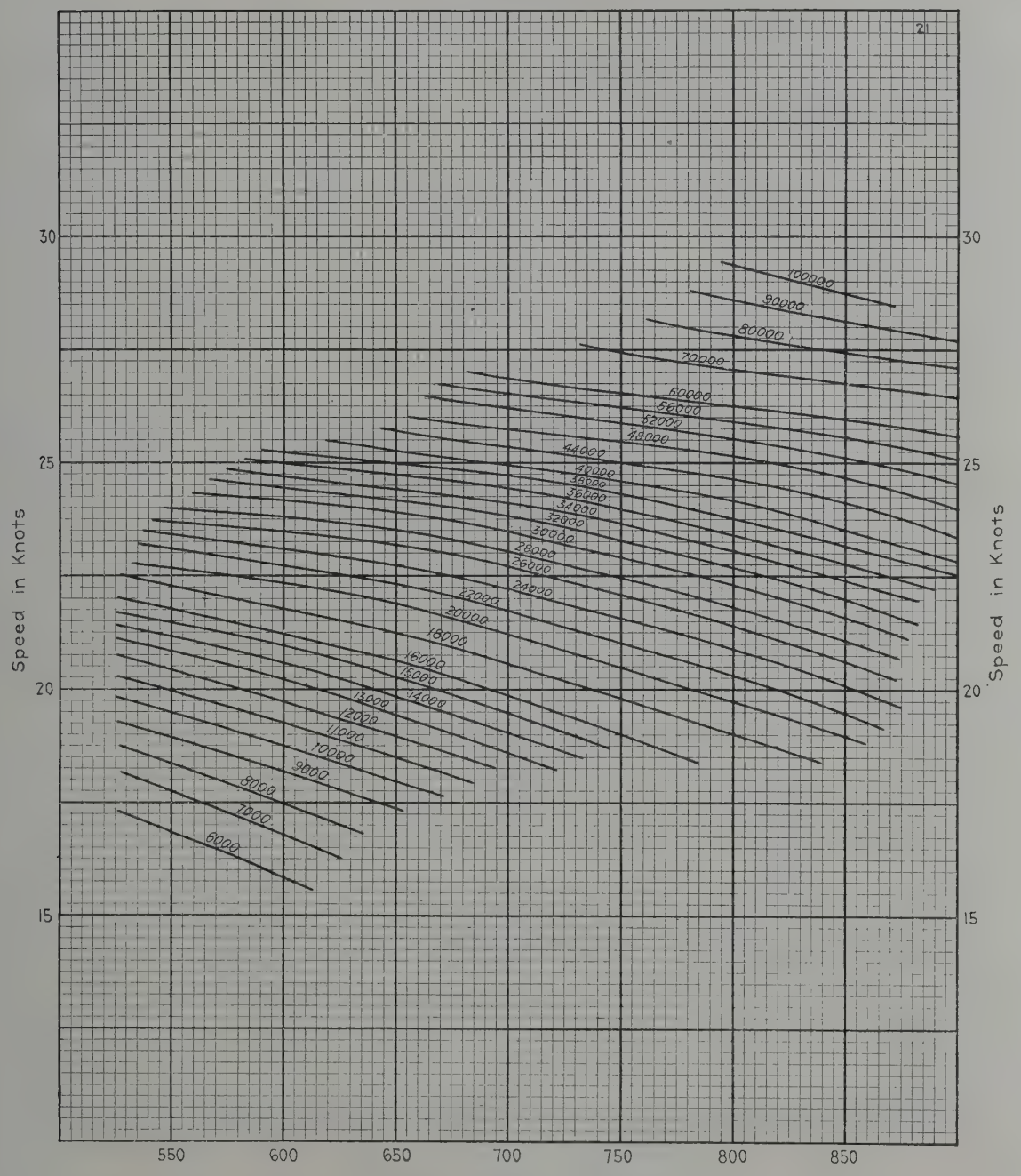
Midship Section Coefficient = 0.96
Prismatic Coefficient = 0.78
Displacement Length Coefficient = 180.

Fig. 46—Curves of Effective Horsepower
for
Battleships



Midship Section Coefficient = 0.98
Prismatic Coefficient = 0.60
Displacement Length Coefficient = 120.

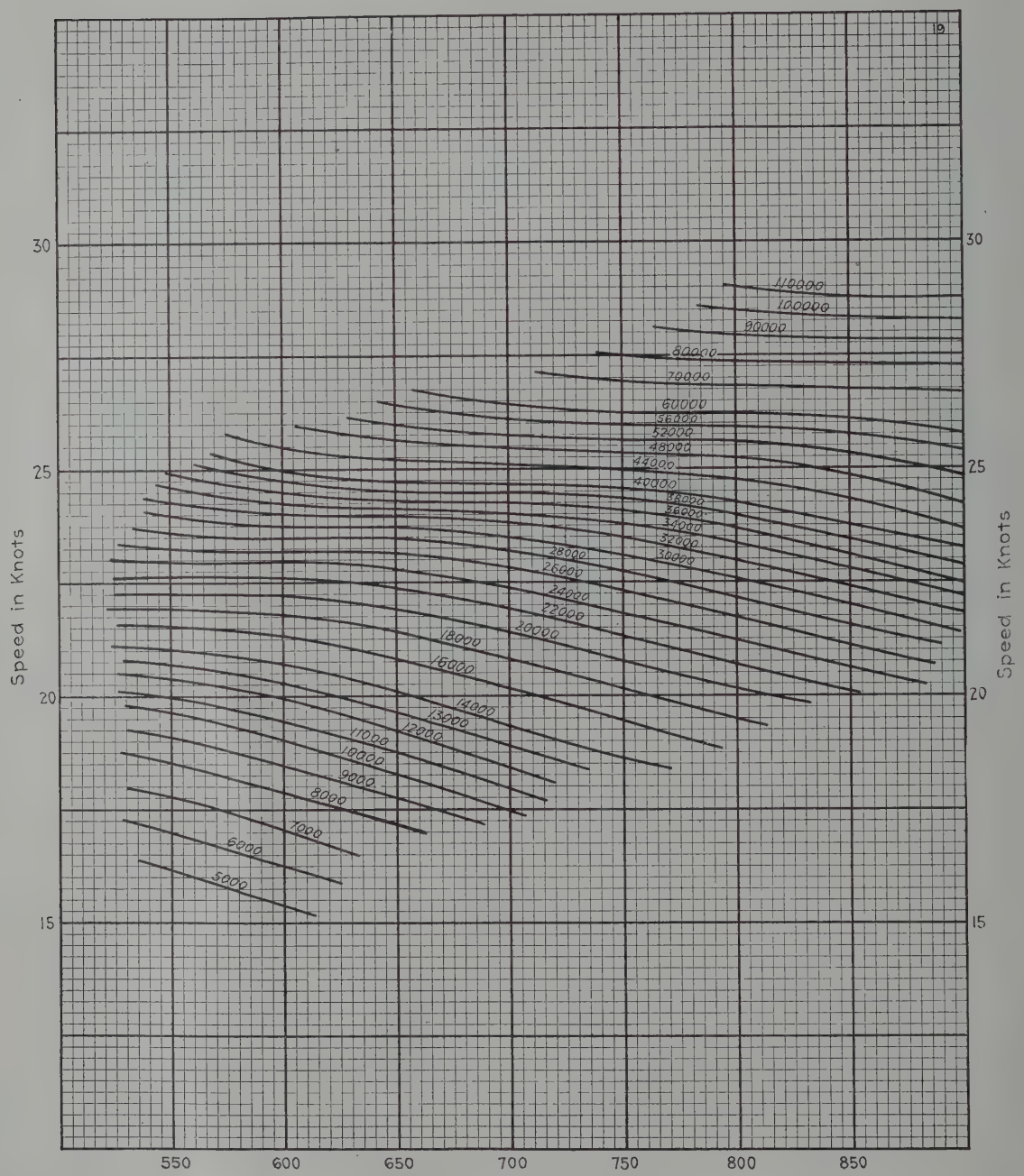
Fig. 47—Curves of Effective Horsepower
for
Battleships



Length of Vessel on L. W. L.

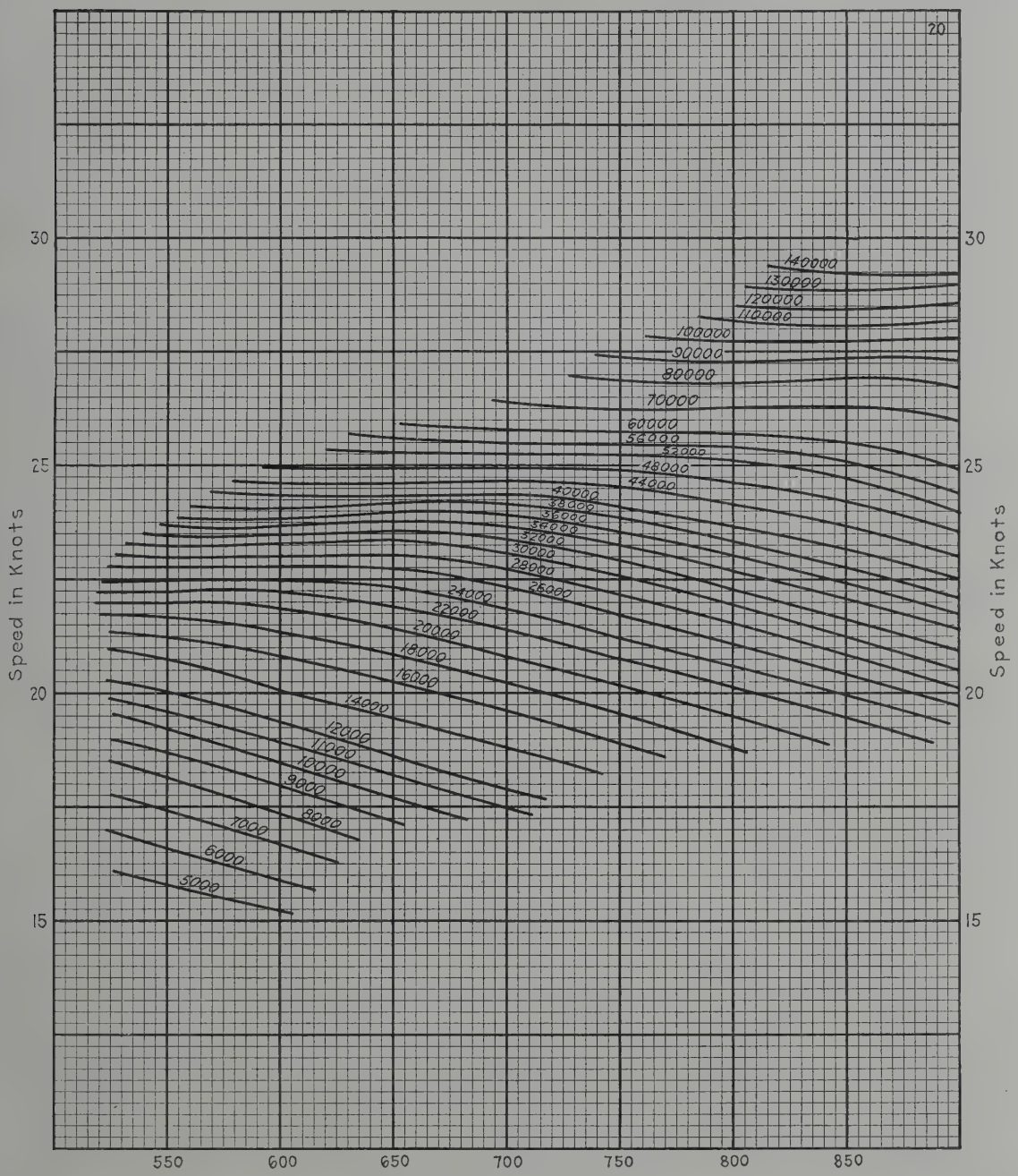
Midship Section Coefficient = 0.98
Prismatic Coefficient = 0.60
Displacement Length Coefficient = 140.

Fig. 48—Curves of Effective Horsepower
for
Battleships



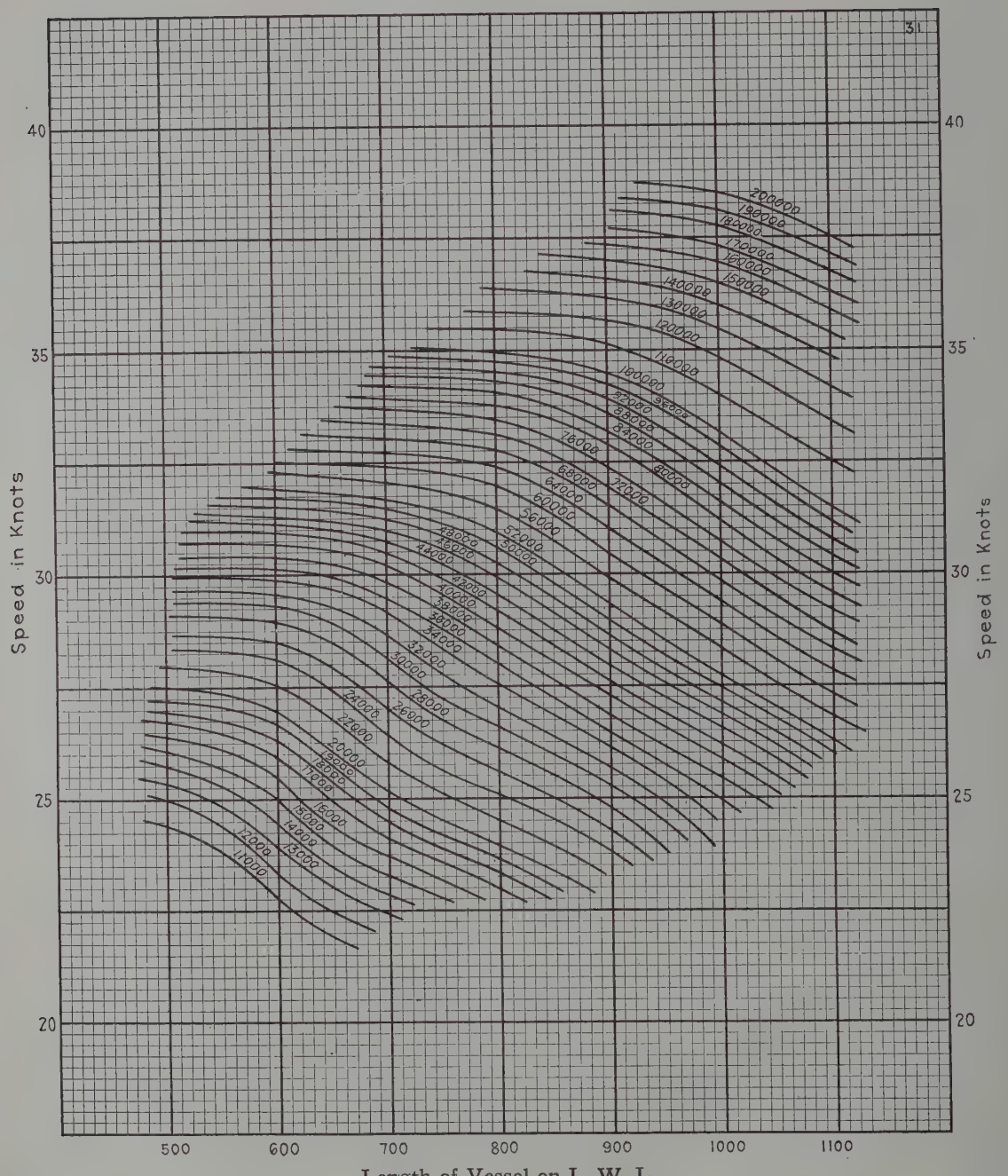
Midship Section Coefficient = 0.98
Prismatic Coefficient = 0.65
Displacement Length Coefficient = 120.

Fig. 49—Curves of Effective Horsepower
for
Battleships



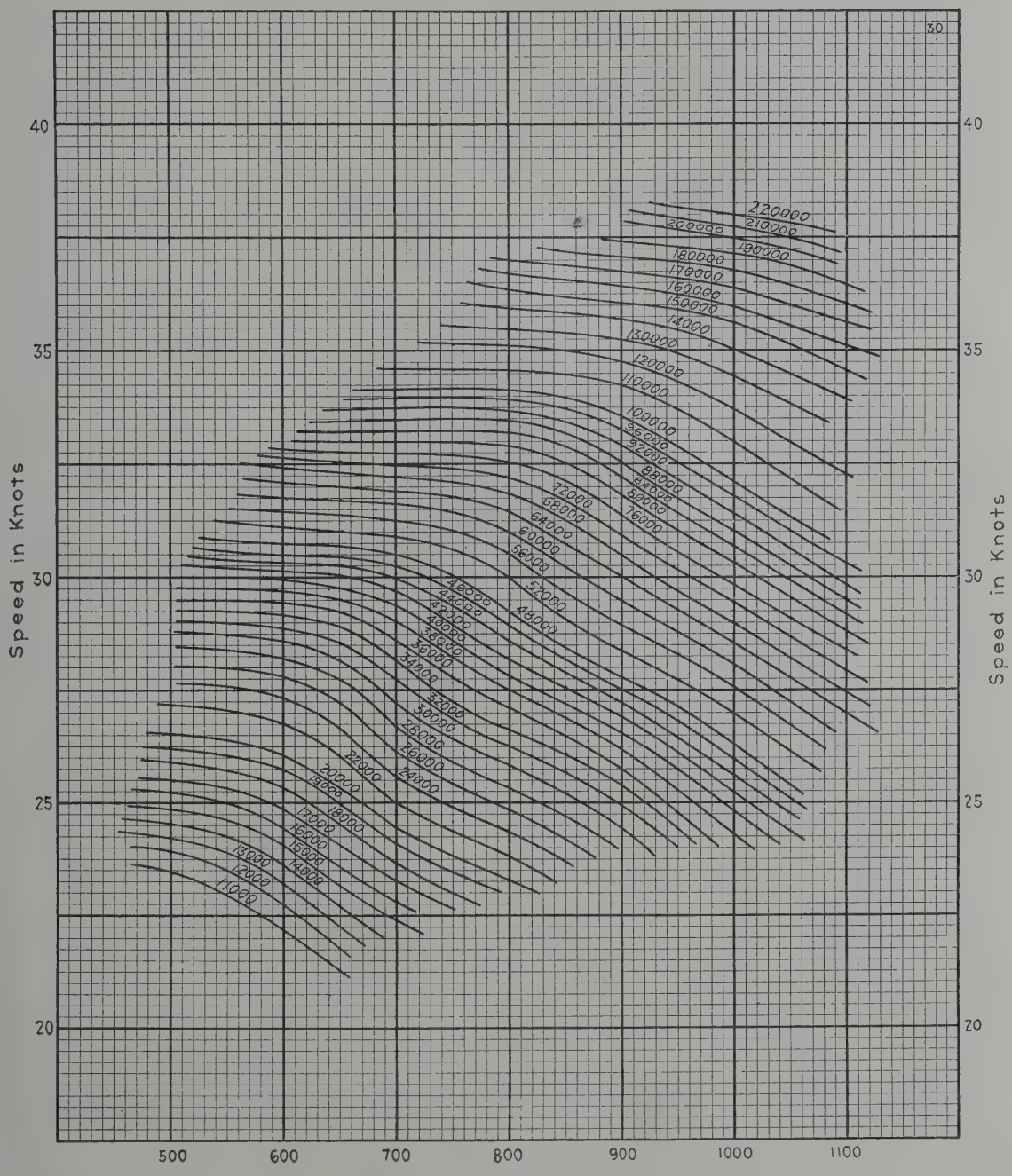
Midship Section Coefficient = 0.98
Prismatic Coefficient = 0.65
Displacement Length Coefficient = 140.

Fig. 50—Curves of Effective Horse Power
for
Large Fast Ships of Atlantic Liner or Battle Cruiser Type



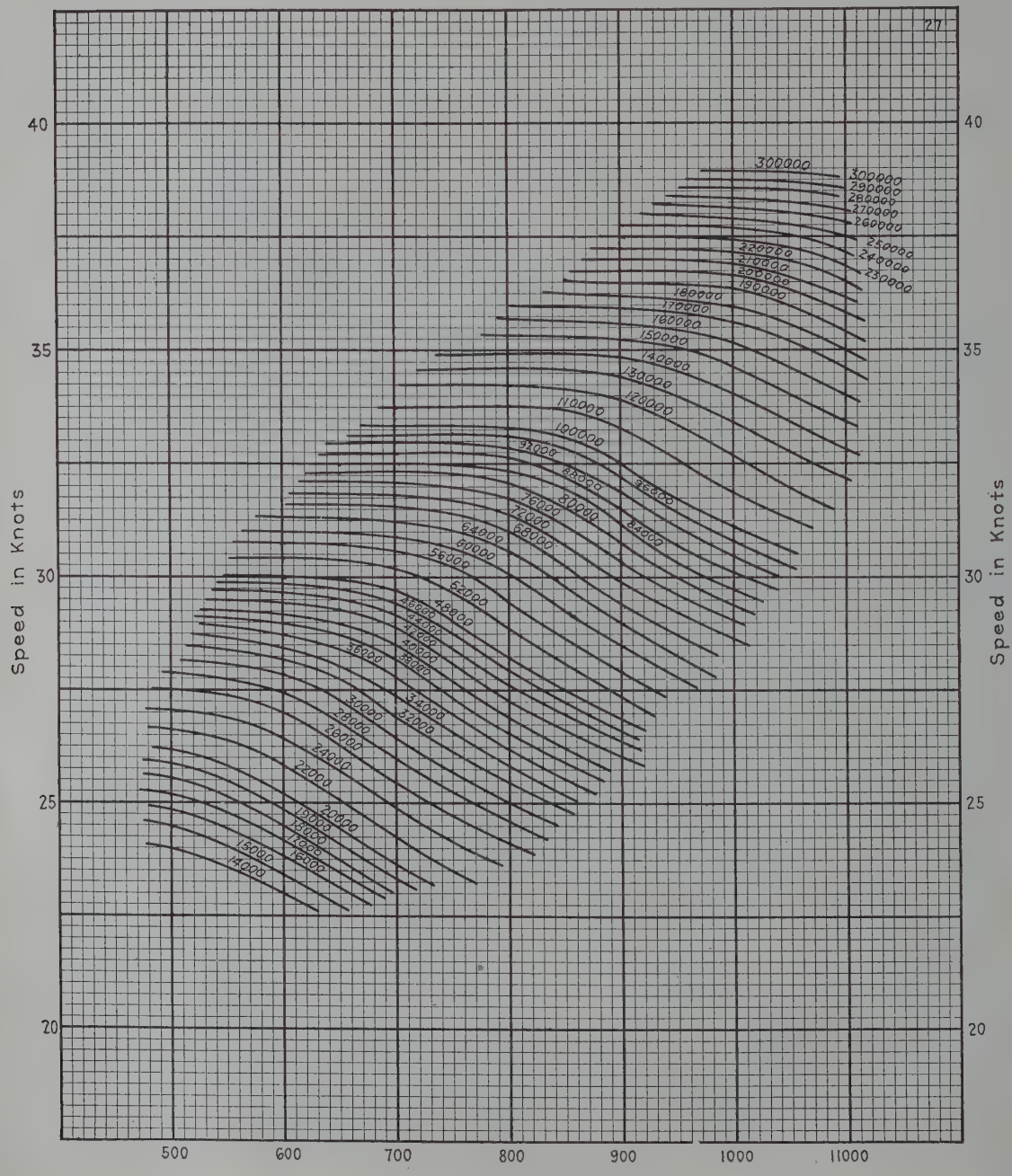
Midship Section Coefficient = 0.90 to 0.99
Prismatic Coefficient = 0.58
Displacement Length Coefficient = 60.

Fig. 51—Curves of Effective Horsepower
for
Large Fast Ships of Atlantic Liner or Battle Cruiser Type



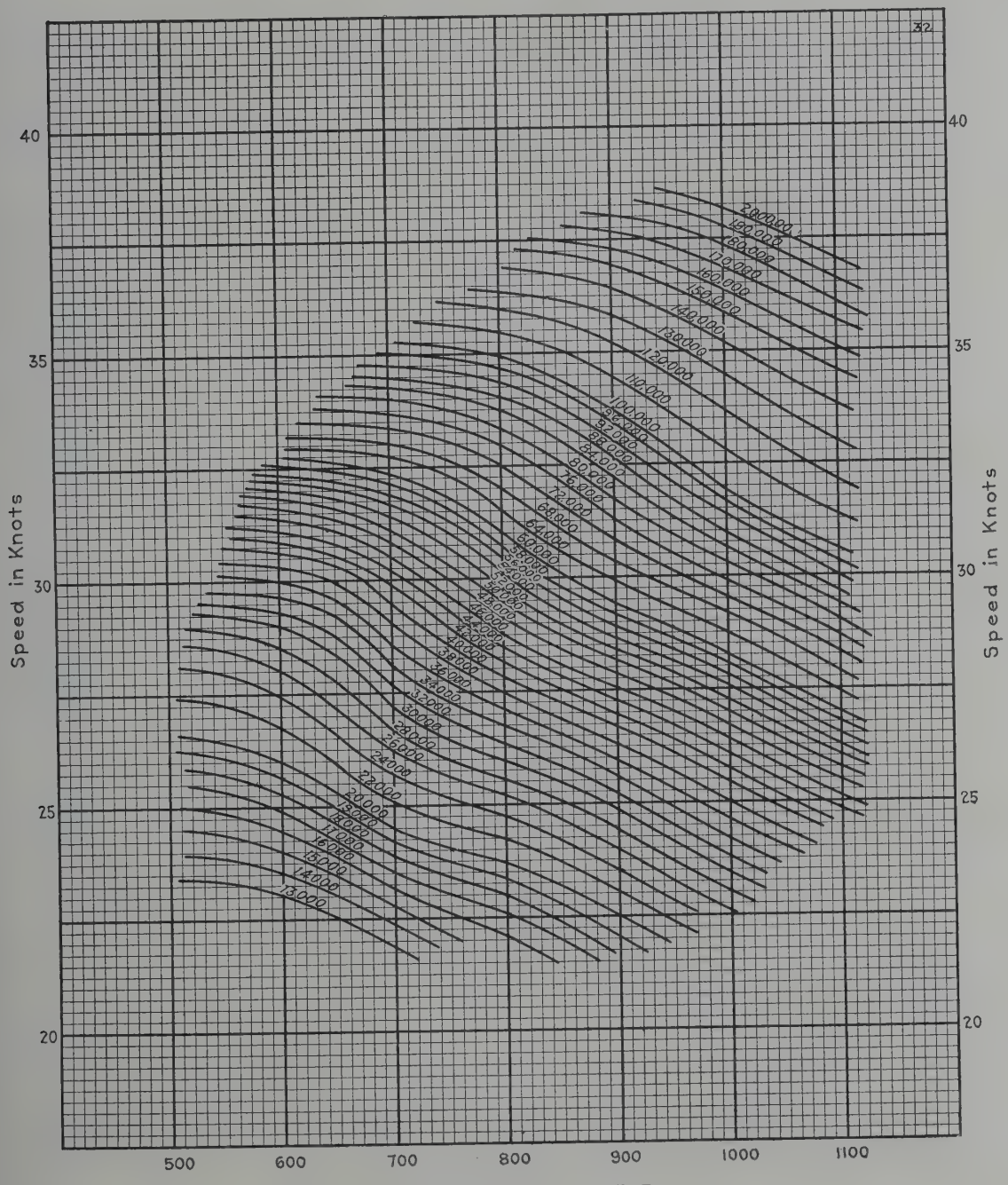
Midship Section Coefficient = 0.90 to 0.99
Prismatic Coefficient = 0.58
Displacement Length Coefficient = 70.

Fig. 52—Curves of Effective Horsepower
for
Large Fast Ships of Atlantic Liner or Battle Cruiser Type



Midship Section Coefficient = 0.90 to 0.99
Prismatic Coefficient = 0.58
Displacement Length Coefficient = 80.

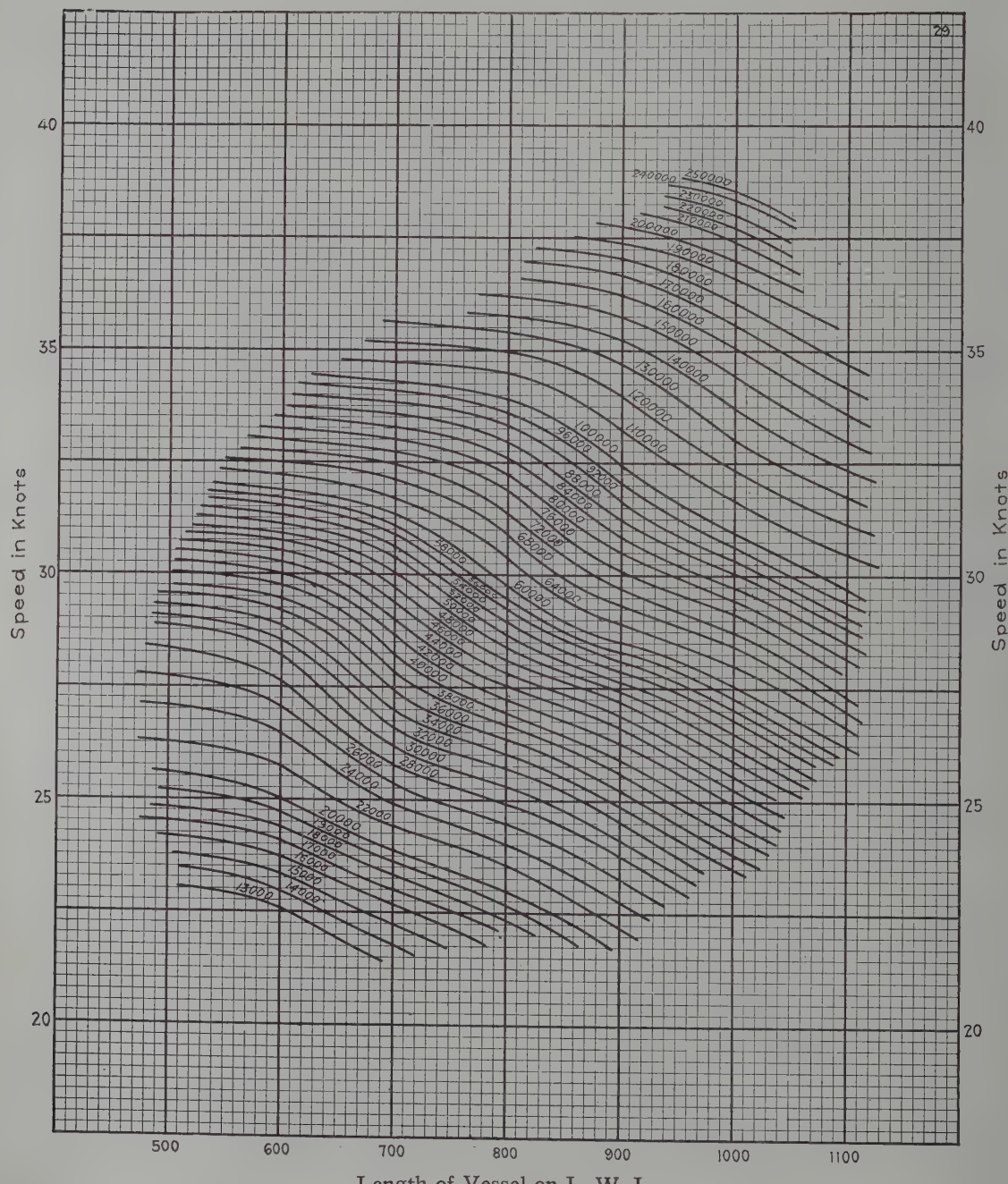
Fig. 53—Curves of Effective Horsepower
for
Large Fast Ships of Atlantic Liner or Battle Cruiser Type



Length of Vessel on L. W. L.

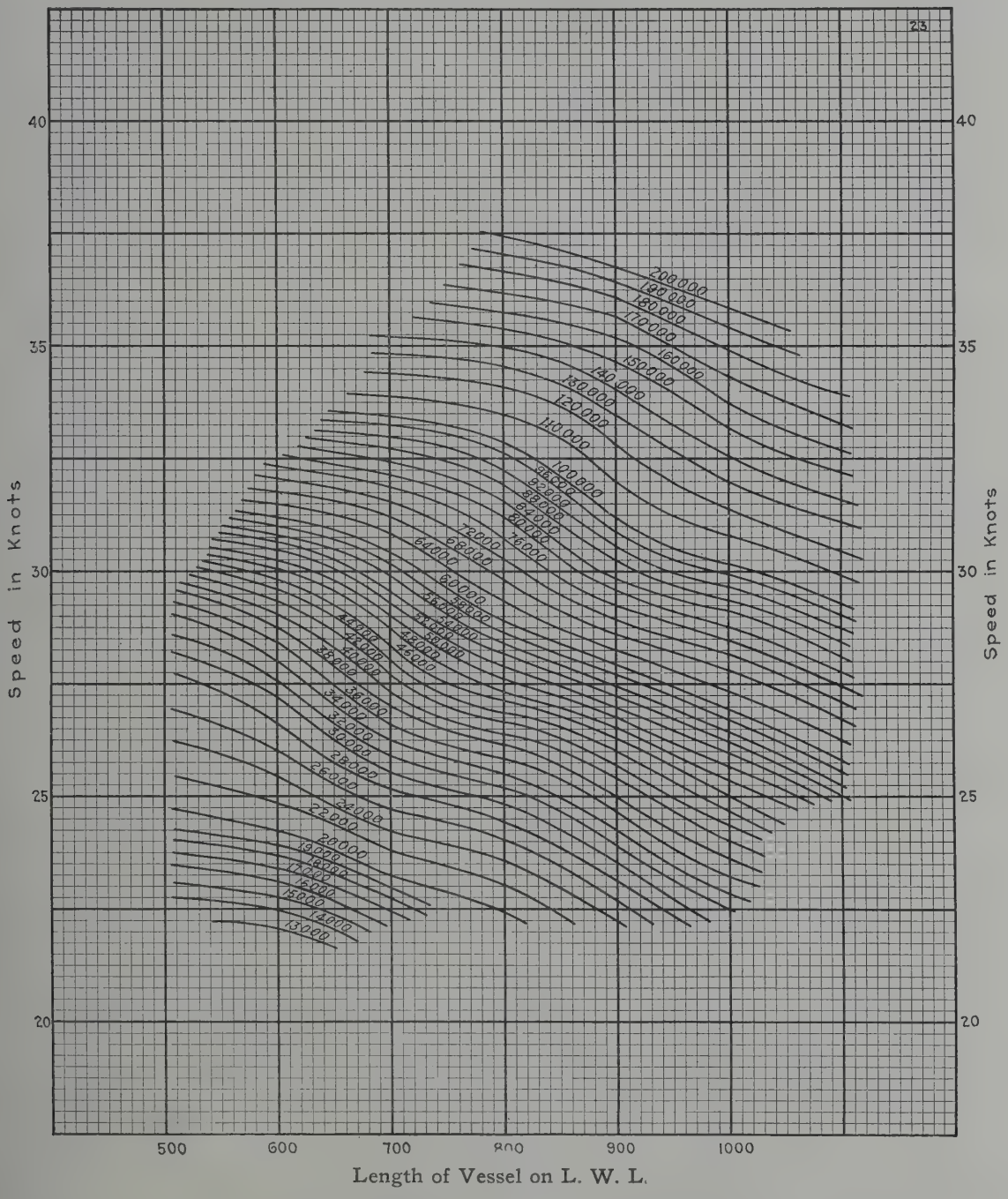
Midship Section Coefficient = 0.90 to 0.99
Prismatic Coefficient = 0.62
Displacement Length Coefficient = 60.

Fig. 54—Curves of Effective Horsepower
for
Large Fast Ships of Atlantic Liner or Battle Cruiser Type



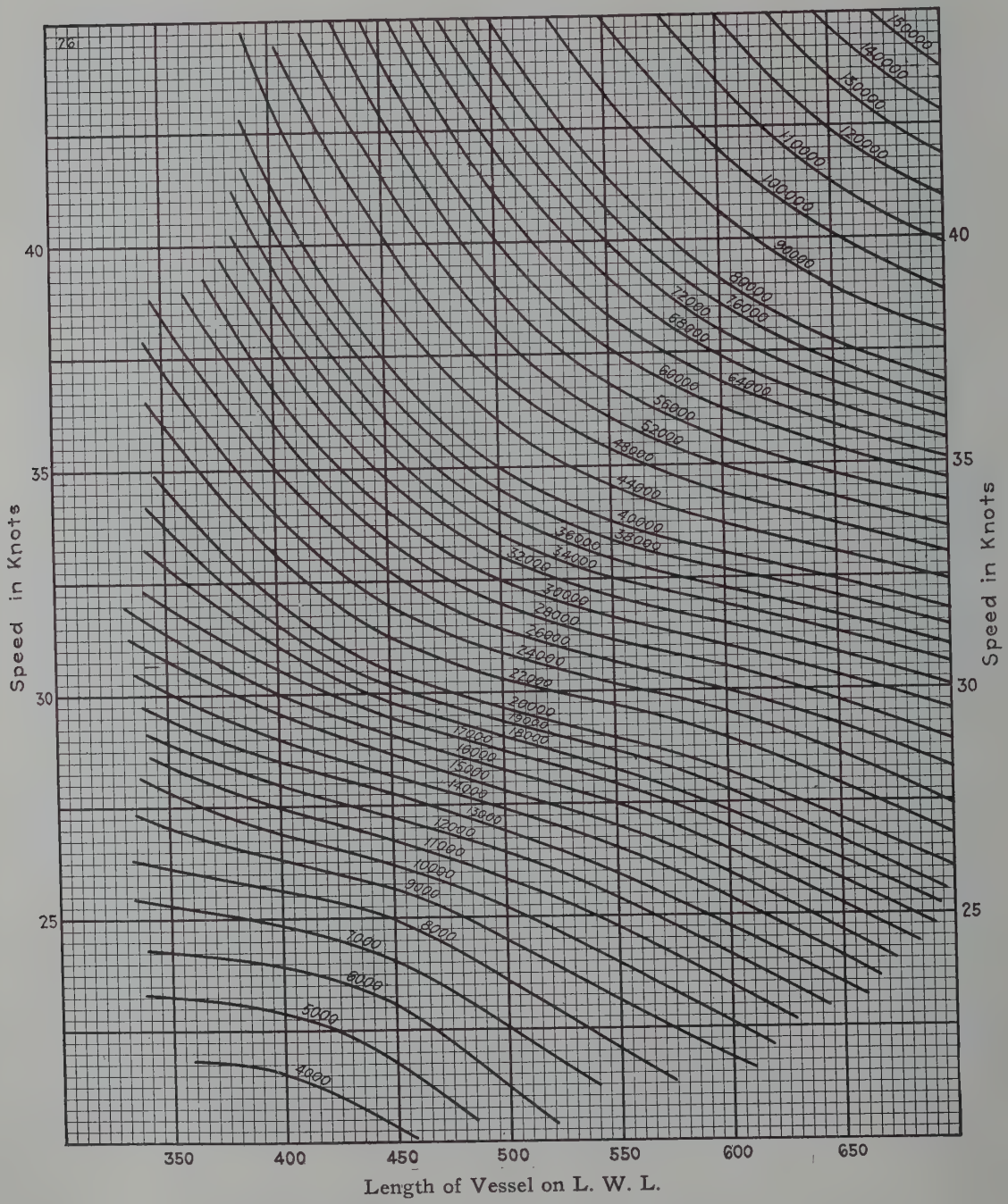
Midship Section Coefficient	= 0.90 to 0.99
Prismatic Coefficient	= 0.62
Displacement Length Coefficient	= 70.

Fig. 55—Curves of Effective Horsepower
for
Large Fast Ships of Atlantic Liner or Battle Cruiser Type



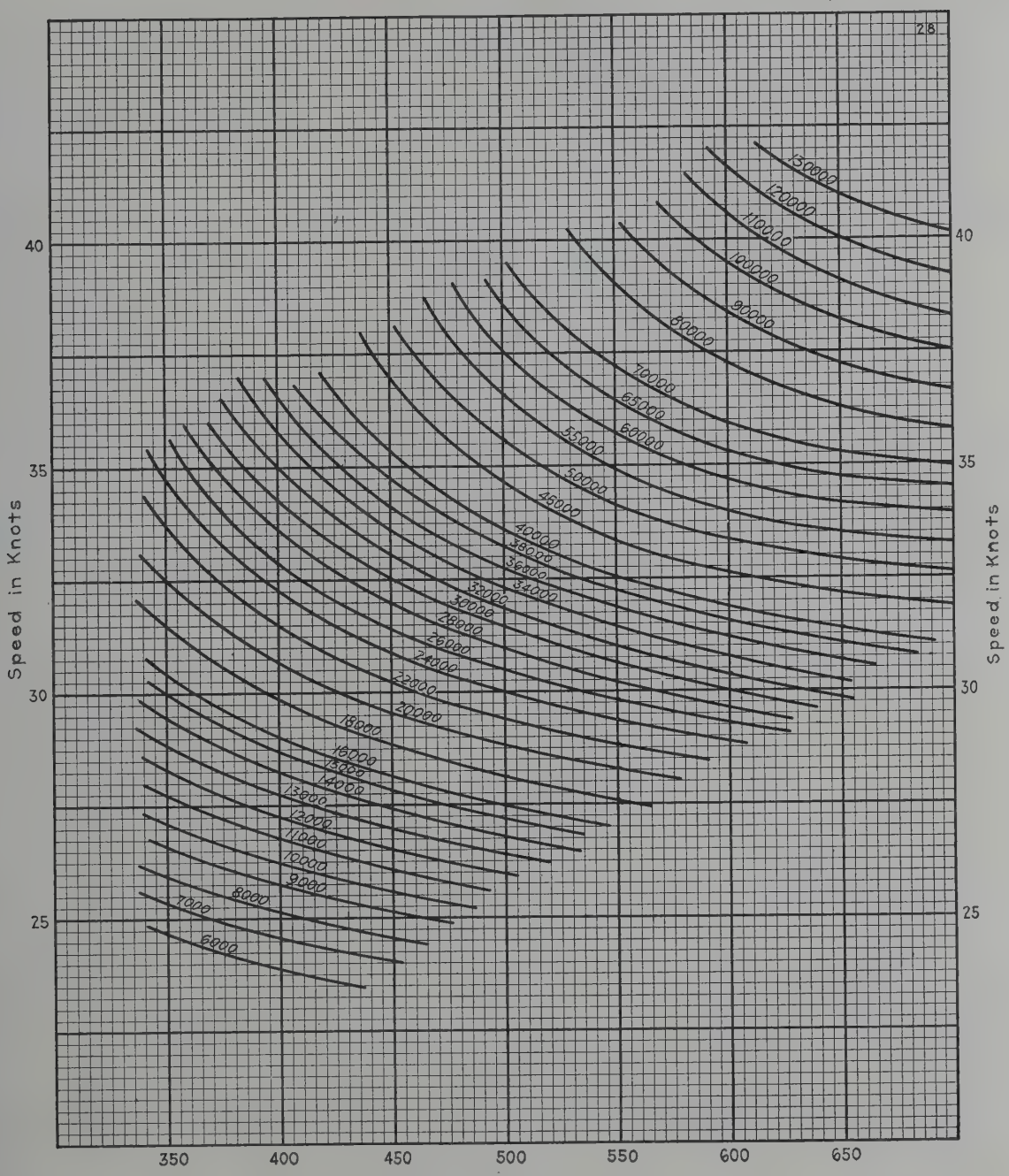
Midship Section Coefficient = 0.90 to 0.99
Prismatic Coefficient = 0.62
Displacement Length Coefficient = 80.

Fig. 56—Curves of Effective Horsepower
for
Scout and Light Cruiser Types



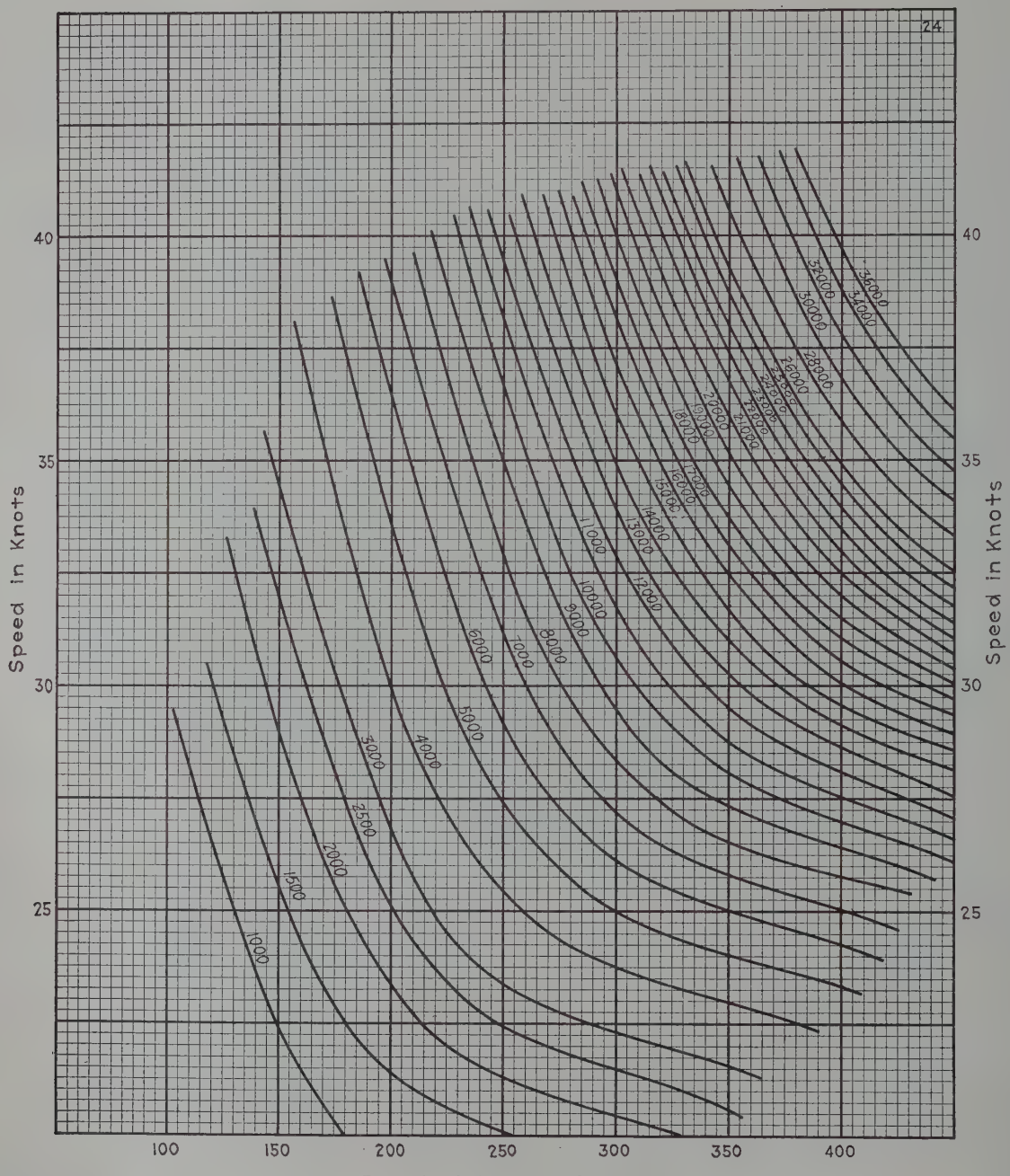
Midship Section Coefficient	about 0.93
Prismatic Coefficient	= 0.64
Displacement Length Coefficient	= 40.

Fig. 57—Curves of Effective Horsepower
for
Scout and Light Cruiser Types



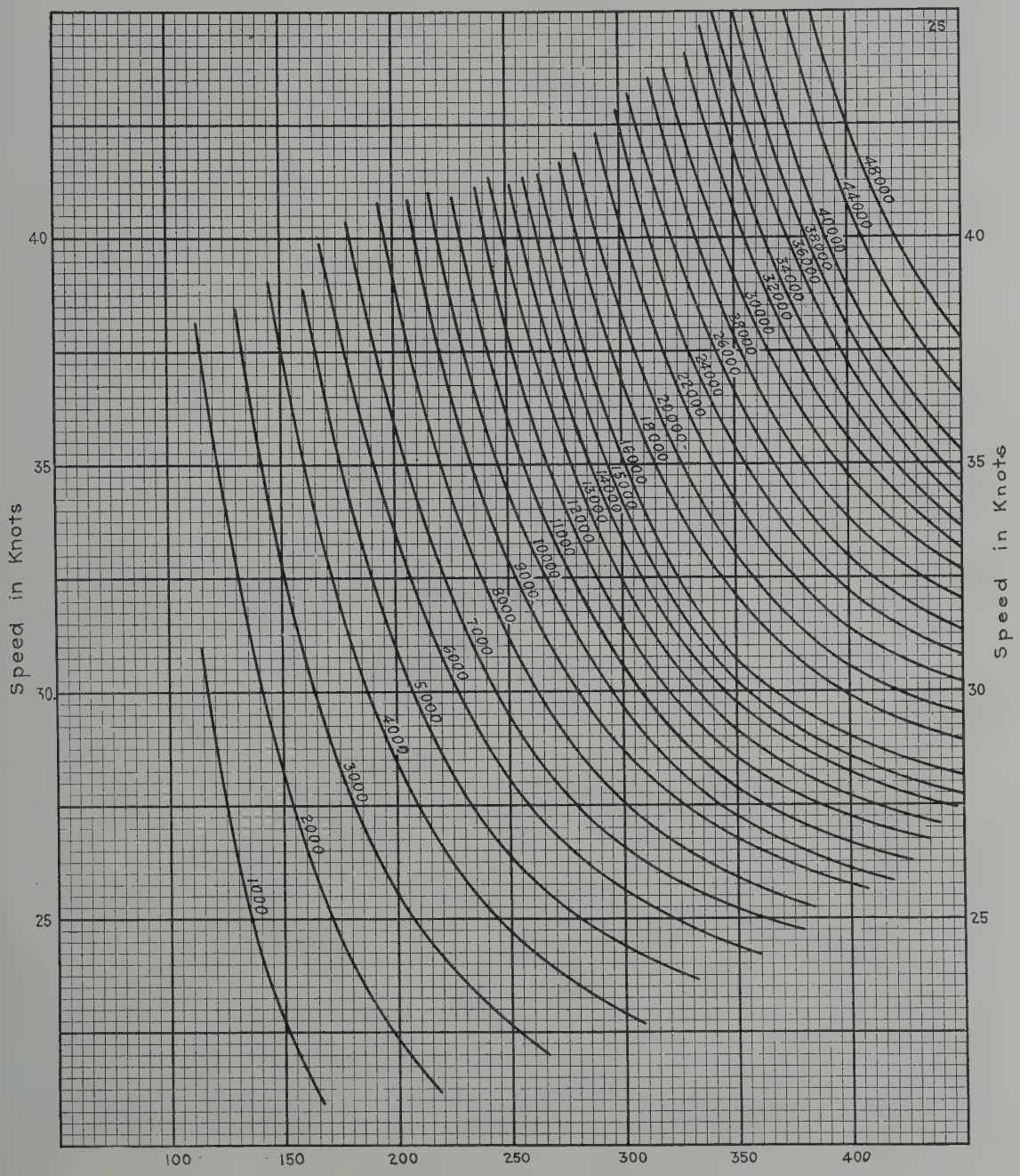
Midship Section Coefficient about 0.93
Prismatic Coefficient = 0.64
Displacement Length Coefficient = 47.

Fig. 58—Curves of Effective Horsepower
for
Destroyers and Fast Yachts



Midship Section Coefficient = 0.75 to 0.83
Prismatic Coefficient = 0.62 to 0.66
Displacement Length Coefficient = 40.

Fig. 59—Curves of Effective Horsepower
for
Destroyers and Fast Yachts



Midship Section Coefficient = 0.75 to 0.83
Prismatic Coefficient = 0.62 to 0.66
Displacement Length Coefficient = 45.

Length Required for Accommodation of Ship's Vitals

MAKE A CAREFUL STUDY of the actual length required to accommodate the vitals of the ship; namely, boiler, machinery, fuel, cargo, pumping and other spaces, as well as the length required at the ends of the vessel to accommodate storerooms, steering gear, peak tanks, etc.

In warship design the same principle applies, although the spaces required are different and special study will be necessary in order to fix the length needed to accommodate magazines, handling rooms, auxiliary machinery spaces, oil stowage, etc.

Proper Value for Longitudinal Coefficient

BEARING IN MIND THE FOREGOING, the curves shown in Fig. No. 39 relative to the variation of the longitudinal coefficient, with different values of the speed length ratio, should be consulted before finally selecting what appears to be the most desirable range of water-line length.

Extremes of Length

IN ORDER TO COVER A LENGTH RANGE sufficiently great to bring out the desired contrast between the various lengths of ships it will frequently be found necessary to give consideration to lengths which are impracticable for the ship in hand; the shortest of the vessels selected requiring more power than could possibly be accommodated and running into objectionably large values of both displacement, length, and longitudinal coefficient, while the longest of the vessels would be too fine ended and difficult to maneuver. Such trial vessels when used are to be considered merely as hypothetical ships and utilized for the purpose of determining the direction of the curves of weight rather than considered as possible of adoption.

The above points should receive careful attention before adopting the basic or mean length in order that the figure finally decided upon may prove a satisfactory basis for the steps described below.

Range of Length to Be Covered by Trial Ships

HAVING SELECTED A MEAN LENGTH which may be considered good practice from the various standpoints involved, it is advisable to cover a range of length both above and below as large as possible without making too great a change in the size of machinery installation and the number of boilers required. The reason for this is that with a considerable change in the length to be assigned to the accommodation of machinery, a corresponding change in the length devoted to cargo, in the case of merchant vessels, or to the length of citadel in war vessels, is necessary. This will be found to complicate the estimates of weight, strength, etc., and can usually be avoided if sufficient care is exercised.

If, however, there appear to be particular reasons for covering a range of length such as to involve considerable variations in the size of machinery plant, there need be no hesitancy, although the curve of margins—to be referred to later—may show certain jogs or abrupt changes in value where the number of boiler rooms or length of machinery space is changed.

Five Trial Ships

THE ABOVE POINTS having been considered, five different lengths which satisfactorily cover the range desired are selected and the necessary calculations referred to below, made for each of the five vessels, especial attention being paid to the effect of length variation and of variation in the coefficients.

Value of Standard Curves of Sectional Area and Load Water Plane

IN CARRYING OUT THESE INVESTIGATIONS the standard water-lines and sectional area curves will be found of especial value, inasmuch as they will indicate very accurately the effect of the length variation upon the areas of decks, bulkheads, etc.

In the cases of all vessels, providing time is available, greater accuracy will be obtained by actually laying out the water-lines for each of the trial ships. It will then be possible to obtain a good estimate of the area of the heavy protective decks, the shapes of platforms, the locations of machinery and gun positions, and the lengths and shapes of holds, peak tanks, etc., all of which will be found of much value in connection with the subsequent calculations.

Approximate Power

Method of Derivation

FOR PURPOSES OF COMPARISON the weight of the machinery may be proportioned to the power required at maximum speed, due allowance being made for any minor differences such as length of shafting, number of machinery compartments, etc. The maximum power corresponding to designed speed may be based in most cases directly upon the standards included herein with very satisfactory results. If desired, the correction due to the departure of the type of body contemplated from that assumed in the standard may be taken into consideration. This is not considered essential, however, inasmuch as this particular part of the investigation is intended for comparative purposes only.

In case data more directly applicable to the case in hand are available they should, of course, be used, always assuming that they are of such a nature as to indicate accurately the effect of the differences in length and coefficients in the trial vessels.

The following notes apply particularly to this part of the investigation, and though they cover to some extent material which has previously been touched upon, are inserted here for convenience.

Effect of Length on Power

THE EFFECT OF LENGTH ON THE HORSEPOWER is very appreciable, especially where ships of high speed length ratio are involved. This is because in high speed vessels the residual resistance forms a very considerable portion of the total resistance of the ship. Hence, when length is increased and this type of resistance as a result decreased, a considerable saving in power is effected, in spite of the fact that increased length nearly always involves increased wetted surface and therefore increased frictional resistance. In the case of vessels having a low value of speed length ratio, where the frictional resistance amounts to a high percentage of the total resistance, an increase of length may sometimes mean an increase in the total horsepower required.

Because of the foregoing, the following results may be anticipated in dealing with the trial ships:

For slow vessels, such as battleships, naval auxiliaries, and most merchant vessels, the longer of the five trial

ships will generally show the lowest power at top speed (that speed which governs the weight of machinery installation). In the case of the lower speed war-vessels, because the frictional resistance forms so large a portion of the total resistance, the horsepower required at the usual cruising speed will frequently be found to increase as the length of the trial vessels increases. This feature, particularly in the case of vessels required to have a large steaming radius, will to a certain extent offset the advantage due to increased length referred to above.

This condition will not ordinarily obtain in the case of merchant vessels because of their relatively high cruising or service speed as compared with their maximum speed.

For high speed vessels, such as fast yachts, destroyers, scouts, etc., even when the designed cruising speed is small compared with the designed maximum speed, it will generally be found that the power at cruising speed decreases with increased length. However, the longitudinal coefficients most desirable for high speed length ratios (those above 1.07) lie in the neighborhood of .64, while for speed length ratios below 1.5 the optimum value of longitudinal coefficient from the driving standpoint drops off very rapidly and in fixing the dimensions and coefficients for vessels of this type this feature should receive due consideration.

The Power of Large Ships at Low Speed

IT WILL BE FOUND that the actual power required to drive large ships at very low speeds is somewhat difficult of accurate calculation, inasmuch as the data available do not generally contemplate speed length ratios much below .5. The power curves published by Admiral Taylor do not go below a speed length ratio of .6. However, the data given by this author for obtaining frictional resistance are carried down to a speed length ratio of .3, so that it is possible to plot a curve of frictional horsepower for extremely low speeds. The total horsepower at these low speeds can then be obtained, either by producing the curve of total effective horsepower to the necessary point, being governed in its direction and general character largely by the curve of frictional horsepower just described,—or by increasing the frictional horsepower at the speed required by a percentage based upon results as shown by previous ships.

The curves provided herein for ships of the slow cargo type will be found valuable for this purpose. They do not, however, reach the very lowest speeds and they do not apply to vessels of fine form.

When comparing the powers of several different ships by means of these curves (plates 42 to 45, inclusive) the following procedure is suggested:

Take a basic power figure from the sheet which most nearly applies to a representative ship of the series as regarding values of longitudinal and displacement length coefficients. Then correct this figure for the differences of coefficient and length involved by the vessels of the series by the use of the following formula:

$$P = P_1\left(a\frac{\sqrt{L}}{\sqrt{L_1}} + b\frac{lL_1^3}{l_1L^3}\right)$$

Wherein P_1 = the power read from the sheet, L_1 is the length of the ship for which the power is read, and l_1 is the value of the longitudinal coefficient of the ship; P, L, and l are the same characteristics for the ship in question.

The values of a and b are to be taken from the Table 12 for vessels of the cargo carrying type.

Table 12—Constants for Power Formula

$\frac{V}{\sqrt{L}}$	a	b
.4	.815	.185
.45	.770	.230
.50	.728	.272
.55	.689	.311
.60	.653	.347
.65	.620	.380
.70	.590	.410

If the necessary information is available, it is possible to derive the effective horsepower at low speeds by proportioning it directly upon the power required for a similar type ship in the ratio of the wetted surfaces involved. This latter method is recommended wherever it is possible to use it, for checking purposes, as it is considered that it provides one of the best methods of comparing the power required by different vessels at very low speeds.

Strength

Scantlings to be Suited to Length

PARTIAL COMMENT UPON THIS SUBJECT has been made under "Depth" (see Second Division). It is only necessary to add at this point that in fixing the scantlings for the five trial ships under consideration ample provision should be made for the increases necessary in the longer vessels, in order to insure proper strength to meet the greater bending moments to be anticipated.

Various Types of Vessel Involved

FOR MERCHANT VESSELS the provisions of the Classification Societies will be sufficient, unless the changes in length and power contemplated are such as to involve a marked change in the amount or location of the heavy weights. For war vessels special strength approximations will frequently be required. In this latter class of ship the large machinery installations, the great concentration of weights in connection with turret installations or gun positions, and the large amounts of fuel and protective material carried, complicate the question further.

Effect of Form and Distribution of Weight

THE DIFFERENCE IN FORM, both underbody and upperbody, resultant upon changes of length and longitudinal coefficient exercises a noticeable effect upon the bending moments involved. This point is here mentioned only in order to place the designer upon his guard. The amount and character of such changes of form, while at times of great importance, are difficult to anticipate. Moreover, their effect as illustrated by instances occurring in the design of actual vessels, is generally so intimately associated with the effect of the distribution of the heavy weights as to make it very difficult to draw satisfactory conclusions and to properly describe the same if reached. Hence it is considered that an effort to discuss these features in general terms would be entirely out of place.

Fuel

No attempt will here be made to give values for fuel consumption, as this is essentially a matter of marine engineering. Further, the numerous types of machinery, the particular advantages and disadvantages of which for the case in hand are matters for detailed consideration, also have a direct influence. Without careful consideration of these points, any data furnished would lose much of their value, and such consideration is possible only when all the requirements of the individual case are in hand.

Service Speed of Merchant Vessels

As previously noted under the subject of power, merchant vessels usually steam at a speed closely approaching the maximum for which they are designed. Hence the fuel required for a given radius may be generally based directly on the maximum horsepower required, due allowance being made for the consumption of the various auxiliaries in use while in port.

Cruising Speed of War Vessels

War vessels usually cruise at speeds less than half their designed maximum. Hence the fuel required for the designed radius is based upon the power required at cruising speed, due allowance being made for the consumption of the various auxiliaries in use while in port.

Service as Contrasted with Trial Conditions

A point worthy of consideration, and applying alike to all classes of ships, is the necessity for providing an ample supply of fuel in order to meet service as contrasted with trial conditions. During service a ship's bottom will be always more or less foul. The resistance may be increased indefinitely by this condition. Then, too, a succession of head winds and heavy seas during the voyage will greatly increase the resistance experienced. On account of the foregoing, one authority advocates a margin of 25 per cent over the fuel required according to trial trip results as providing a proper allowance.

Weights

In naval architecture, more than in most other branches of engineering, an accurate knowledge of all weights involved is essential. The common methods of approximating to the trial displacement have already been referred to, as also the importance of properly recording and filing data obtained from previous ships. However, many cases arise in which the information available does not closely apply, and yet it is important to obtain an accurate knowledge of weights at an early stage in the design. It is generally possible to accomplish this for the principal weight divisions, as the following will illustrate.

Weight Divisions

Under the heading "Useful Load," certain weight divisions have been mentioned. These are tabulated in Table 13 as they would occur in the case both of a merchant and a war vessel, and the percentage of the designed displacement which each item covers is indicated. (The figures shown are taken from the recorded weights of vessels actually in service.)

Table 13—Relative Importance of Principal Weight Divisions of Merchant Vessels

Item.	Percentage of Displacement.
Cargo	52.0
Stores, fresh water, complement	.7
Reserve feed	.7
Fuel	11.4
Hull proper	26.4
Fittings	2.8
Equipment and outfit	1.0
Designer's margin	.7
Propelling machinery	4.3

War Vessels

Item.	Percentage of Displacement.
Protective material	36.9
Stores, fresh water	1.5
Complement	.4
Reserve feed	1.0
Fuel	7.2
Battery and foundations	9.3
Ammunition	4.0
Hull proper	26.0
Fittings	4.0
Equipment	1.4
Outfit	.6
Designer's margin	.3
Propelling machinery	7.4

The More Important Divisions Susceptible of Accurate Estimate

An examination of the percentage given above will emphasize the following fact, which is considered to be particularly important. Cargo, fuel, propelling machinery, and hull weight proper, constitute 94 per cent of the total displacement in the case of a merchant ship. Protective material, fuel, armament, hull proper, and machinery constitute nearly 91 per cent of the total displacement in the case of the war vessel. Of all these items (hull proper excepted) making up so large a percentage of the vessel's displacement, it is possible to estimate the weight accurately and quickly at this stage of the design. In order, then, to obtain a proper weight estimate it is necessary only to calculate in detail the weight of the above items, such as fuel, protective material, etc.; to allow by means of a percentage based on recorded data for the minor items of fittings, outfit, stores, etc.; and to provide some satisfactory method of estimating hull weight proper.

Methods of Estimating

Several methods of accomplishing this last object are now in use.

One consists in arranging the available data in units such as weight per square foot (plating, framing, etc., included) for decks, bulkheads, etc., and applying these units to the superficial area required in order to obtain the weights of decks, bulkheads, shell, etc.

Another reduces the various weight group allowances to the form of curves, from which can be read the information desired for each group, these results being subsequently combined to obtain the desired total.

Still another method plots bare hull weight on a basis of the cubic number or numeral of the Classification Society, allowance being made for minor differences in type.

A fourth method provides for the estimating of a weight per linear foot of continuous hull structure, and multiplying this weight by the length times a factor based upon experience.

That method which lends itself most effectively to obtaining accurate results with the minimum expenditure of time and effort, and affords meanwhile the best basis for estimates of material and cost, should be the one selected. The designer will of necessity determine which of the above-mentioned, or other similar methods, best suit the conditions under which he works.

Curve of Margins

HAVING OBTAINED THE WEIGHTS of the various divisions going to make up the designed displacement of the trial ships as above proposed, there should be made for each a weight summation, exclusive of margin. The difference between the sum thus obtained and the designed displacement tentatively selected, is to be assigned to the margin.

A curve showing the variation of the amount of margin available, plotted upon the length of the trial ships involved, will determine the most efficient ship, judged from the weight standpoint only.

The Margin Curve a Basis for Selecting the Most Efficient Length

AN EXAMINATION OF THE MARGIN CURVE will usually show that for a considerable variation in length there is very little variation in the amount of margin available. Hence the latitude allowed the designer in selecting his length is considerable, when judged from the weight standpoint only. This being the case, it will usually be found advisable to give consideration to other characteristics. In the case of war vessels, good maneuvering power is of particular value. This characteristic in the case of both slow and high speed vessels would make for a short ship.

In the case of merchant vessels—fast yachts and vessels of special type being excepted—the question of maneuvering is of relatively less importance.

In the case of both merchant and war vessels of large size, docking facilities and minimum draft (somewhat antagonistic considerations—the one making for a short ship and the other for a longer ship) are of importance.

In the case of merchant ships, cargo handling facilities at terminals must be considered.

The above are instanced, not as covering the entire range of important considerations, but as exemplifying some of the considerations which must be given weight in connection with the use of the curve of margins.

Costs

THIS SUBJECT has been briefly referred to before. It is not a proper one for detailed consideration here, because it is so important and involves so many features foreign to the considerations of design proper as to merit individual and special treatment. However, inasmuch as the question of cost invariably has an important bearing upon the subject of design, and as the information necessary to a complete consideration of the subject of costs is available at this point in the design, it is here referred to.

Several articles of interest and importance have appeared in the technical press within the last few years and should be consulted by any one confronted with the problem of costs. Among the most important of these are the following:

A paper by G. S. Baker, O.B.E., and J. L. Kemp, of the William Froude National Experiment Tank, read before the Institution of Engineers and Shipbuilders in Scotland, February 18, 1919.

A paper by Mr. J. Hamilton, "Transactions of the Institution of Naval Architects," Vol. 24, page 256.

A paper by E. Saxton White, "Transactions, Northeast Coast Institution of Engineers and Shipbuilders," Vol. 28, page 29.

A paper by Mr. John Anderson, "Transactions of the Institution of Naval Architects," Vol. LX, page 23.

FIFTH DIVISION

Body Plan

WITH THE FINAL SELECTION OF LENGTH, as arrived at in the previous division, the principal characteristics of the vessel's form are fixed. In order to obtain a satisfactory basis for the remaining investigations, as well as to put into concrete form the conclusions already reached, a preliminary body plan is required. Further, such a body plan forms an excellent basis for the development of the final body plan. (The plan contemplated is referred to as preliminary only in the sense that it is not finally faired and is not intended to be completed in the detail necessary for a working drawing.)

Mathematical Lines

IN THE DEVELOPING OF THIS PLAN, mathematical lines in the strict meaning of the term are only recommended in case a series of experiments are contemplated. In this event such a method as described by Admiral Taylor in a paper entitled "Calculations for Ships' Forms and the Light Thrown by Model Experiments Upon Resistance, Propulsion and Rolling of Ships," presented at a meeting of the International Engineering Congress, 1915, in San Francisco, is of great value, inasmuch as it provides for the logical and accurate variation of any of the several coefficients or characteristics involved in passing from one form to another. It moreover insures that the variations made shall not result in the derivation of individual forms which bear improper relationships to the group as a whole. For the development, however, of an individual body plan, the method is somewhat complicated and requires careful study and considerable experience in order to make its use with facility and assurance possible.

Use of Standard Curves of Sectional Area and Load Water Line Recommended

THE USE of the curves of sectional areas and waterlines here shown, as a basis or a point of departure in the preparation of the body plan, is recommended. The relationship between these two systems of curves has been carefully examined, particularly those portions at the ends of the vessel and at the fore and aft terminations of the parallel middle body, so as to insure their satisfactory working together in the determination of ship form. Their use assures the obtaining of an accurate displacement and satisfactory initial stability. The designer may depart to quite an extent from these curves if he so desires, without materially affecting the characteristics of the ship.

To assist in the prompt execution of the work, systems of offsets for diagonals may be used which will prove of considerable value in case they are properly derived. No effort has been made to provide such systems in connection with this work, inasmuch as it is believed that the individual will prefer to develop the sections of the underbody in accordance with his own experience and judgment.

The following points are mentioned—not as being essential to the development of the preliminary body plan, but as throwing light upon some of the minor features involved and which do not always receive proper consideration until the design has attained a state of completion such that their consideration and incorporation would involve increased work and loss of time.

Upper Body Forward

THE CHARACTER of the upper body forward is very important from the standpoint of the behavior of the ship in a seaway. Generally speaking, a fairly full entrance

and sections well flared from the water-line up, are of value in obtaining a dry ship. This is particularly true in case the principal weights are placed relatively near the ends of the vessel.

There has recently been advocated, particularly in the case of high speed vessels, the use of vertical top sides, without flare, and some form of weather deck forward which would assist in spilling the seas. Actual experiment has seemed to vindicate the claims made, but it is considered doubtful whether it would give satisfactory results even in this respect unless associated with a relatively flat floor.

Upper Body Aft

THE TYPE OF STERN adopted will, in general, limit the designer very closely in the development of the afterbody above water. In general, no form should be adopted which is likely to result in excessive pounding; neither should a form which provides inadequate reserve buoyancy be selected, as this latter will be unsatisfactory in a following sea.

Forefoot

A DEEP FOREFOOT, associated with a pronounced U section or bulb, is generally advantageous from the standpoint of resistance, excepting in the case of light draft, high speed vessels subject to considerable trim by the stern when traveling at maximum speed. A deep forefoot, moreover, may result in a dirty ship in a seaway, and one which, under some circumstances, will be difficult to steer.

Underbody Aft

BROAD WATER-LINES AFT, with straight buttocks and sections tending toward flatness, are conducive to low resistance and small turning circles, but particularly when associated with full upper bodies, are likely to produce yawing in a following sea.

Keel

WHEREVER PRACTICABLE a straight keel should be used throughout the greater portion of the vessel's length in order to simplify docking. Recent model experiments indicate that such a type of keel may be used without detriment to a vessel's efficiency from the driving standpoint.

Cross Sections

EXCEPTING in so far as they affect the shape of the load water-line and the curve of sectional areas, the forms of the immersed cross sections are negligible from the standpoint of driving.

Shaft Angle

IT IS NECESSARY to emphasize the necessity of a properly designed propeller, so located as to be efficient under ordinary working conditions. In the actual design of the underbody, particularly where more than one screw is used, the question of proper shaft angle is sometimes overlooked. Inasmuch as a small variation in the angle of shafting relative to the direction of the stream lines exercises a relatively large influence upon the efficiency of the propeller, every effort should be made to design the underbody of all high speed vessels so as to permit the shaft to be so placed as to make a small angle with the stream lines approaching the propeller.

Entrance and Run

IN THE CASE of slow speed vessels of full form, a short entrance and a relatively long run are usually adopted in order to reduce eddy-making resistance to a minimum and to insure as satisfactory a flow of water as possible to the propellers.

Preliminary Displacement and Other Curves

AS SOON AS THE BODY PLAN has reached a proper state of completion, curves of displacement, center of buoyancy, metacenter, etc., should be prepared. In laying out such curves it is generally desirable to calculate values for each curve corresponding to at least three separate drafts, the drafts being so selected as to cover the range likely to be used in practice.

Curves of displacement, center of buoyancy—both vertical and longitudinal, transverse metacenter, moment to alter trim, and tons per inch immersion, will be found useful.

In plotting the longitudinal position of the center of buoyancy, due allowance should be made for the effect of the appendages, inasmuch as these will usually pull the center of buoyancy noticeably aft of its bare hull position, and if allowance for this change is not made the designed trim of the vessel may be quite seriously affected.

Strength Calculations

IF TIME for the usual longitudinal strength calculation is available, it should in every case be made in order to avoid possible error and to obtain reliable information for future reference. In making such calculations it should be borne in mind, however, that the results have only relative and not absolute value, and that this relative value exists only so long as the proper basis for the calculation is maintained. Professor William Hovgaard, in "Structural Design of Warships," page 30, writes as follows:

> "If the longitudinal strength calculation is carried out with good judgment on sound assumptions consistently applied, it affords a valuable means of comparison between a new design and existing ships of similar type. The calculated stresses depend, however, so much on the underlying assumptions, which are probably not the same in any two navies, that data from different sources can rarely be directly compared."

No attempt is here made to cover the detailed methods to be followed in making calculations of this character; reference to writers such as Professor J. H. Biles being recommended for such information. The following observations, however, are made in order to direct attention to certain points which should be given consideration at this stage of the work.

Point of Maximum Stress in Slow, Full Vessels

THE MAXIMUM BENDING MOMENT generally occurs near amidships and does not vary greatly for some distance on each side of the maximum. It results, accordingly, that for the ordinary merchant vessel the consideration of the maximum stresses may be confined almost entirely to that portion of the structure in the vicinity of the midship section.

Points of Maximum Stress in Fast, Fine Vessels

FOR FAST VESSELS OF FINE LINES, particularly if constructed with full midship sections, special consideration should be given to the conditions obtaining in the vicinity of the quarter points. The reason for this as applied to the forward quarter point is to be found in the concentration of stresses likely to occur due to the combination of statical and dynamic forces when the vessel is driven at high speed into a heavy sea. The

depth of section at this point is as great as, if not somewhat greater than that of the midship section, and the sectional coefficient generally quite large, so that the material of the strength section may be expected to act efficiently even though the beam is usually considerably reduced as compared to that amidship. At the after quarter point the rise of floor is generally quite marked, so that the material in the lower portion of the vessel's strength girder works with relatively low efficiency. If it should so happen that a strength deck be dropped in this vicinity, the bending moments, although small compared with those amidships, may easily be large enough to produce stresses greater than those experienced amidship unless the scantling of the vessel in this vicinity be sufficiently increased over the midship scantlings to counteract this tendency. It is recommended when dealing with vessels of this class that strength sections be prepared and stresses figured at various stations throughout the vessel's entire length in order to obviate the possibility of any particular section experiencing excessive strains.

Standard Wave for Strength Calculations

IN THE CONSIDERATION of very long vessels the question frequently arises as to the proper length and proportion of wave to be used. Most of the prominent writers on this subject have agreed upon a wave having a length equal to that of the vessel and a height, measured from trough to crest, of one-twentieth of the length of the wave, the shape of the wave being trochoidal. As stated above, the results of the strength calculations as made have only relative value. This being the case, it appears impracticable to interpret the results of calculations for new vessels made upon any basis other than those which have been used for ships previously designed, actually built and put into service.

Professor J. H. Biles, in "The Design and Construction of Ships," Vol. I., page 318, states that the average waves corresponding to what sailors call a high sea are 348 feet long and 16½ feet high, and for a very high sea 485 feet long and 25½ feet high. There have been, according to other authorities, waves of considerably greater length reported, but in general with increase of length the ratio of height to length decreases. It accordingly is fair to assume that a ship having a length greatly in excess of 500 feet is unlikely to meet waves of the standard dimensions and proportions described above. The most logical method of carrying out strength calculations for such ships appears to be to use the standard wave, but to accept stresses considerably in excess of those which would be allowable for shorter ships—that is, for ships which could be expected to meet in actual service waves of size and proportions corresponding to the theoretical wave. The decision reached by the designers of the "Mauretania" and sanctioned by Lloyd's Register, to allow a stress of approximately ten tons in this vessel—the standard wave being assumed—bears out the above statement.

Effect of Inclination

THE EFFECT OF MODERATE INCLINATIONS upon the size of bending moment may be ignored, inasmuch as in vessels of ordinary proportions the maximum stresses when figured in the inclined position seldom exceed the corresponding stresses in the upright position by more than a small percentage, while for large war vessels having great beam relative to depth such stresses are almost always less.

Differences in pressure in wave hollows and crests make for a decrease in both hogging and sagging bending moments. This decrease is generally small, being rarely in excess of ten per cent. For the purpose of this calculation it may safely be ignored.

Inertia of Section and Determination of Scantlings

Effective Longitudinal Members

WHILE FOR ORDINARY MERCHANT VESSELS the provisions of the Classification Societies definitely fix the thickness and location of the principal strength members, many cases arise where additional attention may be given these members with beneficial results. The following comment made by Professor Hovgaard in "Structural Design of Warships," page 22, should be given careful consideration in this connection:

"In the calculation of the moment of inertia should be included all effective longitudinal structural members that pass through the section and which are continuous for a considerable part of the length of the ship—generally at least one-half this length, but the determination of what members ought to be considered as "effective" is a point which calls for special mention. It is perhaps the most difficult question in the strength calculation, and that on which opinions are most at variance."

Intercostal Members

THE PROPRIETY of considering longitudinal members which are cut at, and bracketed to, transverse bulkheads as portions of the vessel's longitudinal strength girder, is a case in point, it being questionable whether the riveted connections at the points of discontinuity warrant the assumption that these members are as effective in tension as the shell or deck plating at an equal distance from the neutral axis.

Distribution of Material

QUOTING from "The Design and Construction of Ships," by Professor J. H. Biles, page 260, Vol. I.—"A girder that approaches ideal conditions for resisting bending-moment stresses would be one in which as little material as possible were put in the webs, and as much as possible of the material distributed equally at the top and bottom; but in such a girder the shearing stress at the neutral axis might be large, and, unless the web of the girder were well stiffened, it might collapse if too thin. It is important to note that the area of the longitudinal parts above the strength deck, not intended to resist longitudinal stresses, should be left out of the calculation."

Support of Longitudinal Members

PROFESSOR HOVGAARD lays great emphasis upon the proper support of that portion of the plating which is to be subjected to great strains, both tension and compression, his contention being that only such plating as is qualified, either by reason of great thickness or by close proximity to a supporting member, can logically be included in the strength section. For further information in this respect, see his "Structural Design of Warships," pages 24 to 30, inclusive.

Weights

Reason for Estimate

FOR PURPOSES OF RECORD, as well as to form a basis for changes or for further investigation, estimates of weight should be made at this point. The detail develop-

ment of the design may later render these estimates slightly inaccurate, but frequently they will represent the ship with fair accuracy as actually constructed.

Character of Estimate

THE WEIGHT ESTIMATE should be in sufficient detail to assure accuracy within a small per cent. This is most readily accomplished by separately estimating the weights of many small groups, particularly in the case of a large weight division such as hull, which is composed of numerous small items well distributed in both the fore-and-aft and vertical directions. This is because in making a large number of approximations the errors made in the cases of the individual groups tend to offset each other, so that while the group allowances may not be particularly accurate, the summation of these allowances is almost always so. The same reasoning applies to the allowances for vertical and longitudinal moments.

In weight estimating of the type under discussion it is the structural and fittings groups which present the greatest difficulty. As previously noted, the fittings account for but a small amount of the total weight of the ship and may safely be cared for by a percentage allowance. For the large structural groups making up the hull the use of weights previously estimated for a type ship is advocated as the basis for the derivation of weights for a proposed vessel. Due allowance being made for changes in scantling and for the differences in dimensions, coefficients, etc., between the ships, the weights for the new ship may be derived from those of the old by direct proportion based on the ratio of the corresponding dimensions. Used with care and judgment, this method is capable of producing very accurate results.

When time is limited, the large concentrated weights should receive first and greatest attention, because these weights exercise a very important influence upon the position of the center of gravity of the ship as a whole. Groups accounting for but a small weight, particularly if the component parts are well distributed over the ship, as in the case of air-ports, doors, hatches, etc., may wisely be allowed for on a percentage basis.

Necessity for Margin

DURING THE DETAILED DEVELOPMENT of a design the addition of weight which could not be definitely foreseen in the preliminary stages is almost certain. Hence provision (usually termed "margin") must be made for this contingency in the weight allowances. Some designers make a practice of concealing such weight allowance in the various groups throughout the ship. Under some circumstances this may be excusable, but it is not considered good practice. It will in the end give equally good results, and promote confidence in the calculations themselves, if a reasonable margin be provided under its proper name and its existence and purpose be recognized.

Allowable Margin

THE DESIRABLE AMOUNT OF MARGIN is dependent primarily upon the character of the design and, to a lesser extent, on the attitude of those who later develop it in its details. One and a half to two per cent of the designed displacement is considered a fair allowance. If, however, the type of ship under consideration is unfamiliar and the characteristics subject to modification and amplification during design, three or four per cent might perhaps not be too low.

The actual size of the ship is also a factor. A margin of 30 tons in a 1200-ton yacht (2½ per cent of the displacement) might cause little comment. Two and a half per cent in a 40,000-ton battle ship or liner (1,100 tons) might easily meet with protest, the actual weight, in spite of the percentage involved, seeming very large.

Margin for Merchant Ships

AT FIRST SIGHT the foregoing might not seem to apply with particular force in the case of merchant ship design. For instance, in dealing with cargo carriers it would seem a simple matter to reduce the designed useful load or dead-weight capacity if the weight of the hull structure or machinery over-ran the preliminary allowance. This is merely a practical way of handling the proposition in case such a condition actually arises. As a matter of fact, several inches of draft are generally allowed between the maximum allowable draft, or Plimsoll mark, and the draft at which a vessel is intended to carry her designed load.

Before leaving the question of margin it should be recognized that, although the effect produced by too great an allowance of margin is less unpleasant than when too little has been allowed, from a technical standpoint one error is as serious as the other.

Stability

Character of Investigation

IF GOOD JUDGMENT is used in fixing the proportions of the ship, the question of proper stability need not at this point be carried beyond the final calculation of the value of the metacentric height for the several conditions of loading. If, however, the design in hand involves certain features which mark it as an exception to the general type of vessel, curves of statical stability should be derived before going further.

Free Surface

IT IS PERHAPS UNNECESSARY to mention the effect of free oil or water upon the value of the metacentric height. This subject has been given careful attention in recent years. It is only mentioned here in order to invite attention to the fact that if properly handled this characteristic of free liquid may be turned to the advantage of the designer, the important consideration being that its presence be recognized and definitely allowed for.

Power

CURVES OF EFFECTIVE HORSEPOWER covering the requisite range of speed and plotted for the several displacements desired, should be prepared. If the results of actual model basin experiments are available these are to be preferred; if this is not the case, curves based upon any method which satisfactorily takes account of all the factors involved will serve the purpose.

Appendages

THE DESIGN OF THE MACHINERY is based upon the power to be delivered by the propeller. The power usually obtained from the model basin is the so-called "bare hull" effective horsepower. In order to obtain the data required for the propeller design with this as a basis, the character and effect of appendages should be known as accurately as may be. This information is somewhat difficult to furnish, inasmuch as the field has not been completely covered by experiment and the data quoted by different authorities is somewhat at variance.

The following excerpts will, however, give an idea of the attitude of the foremost authorities on this subject.

Rudders for Single Screw Cargo Vessels

FOR SINGLE SCREW MERCHANT SHIPS fitted with rudder and small shaft bossings only, Admiral Taylor in "Speed and Power of Ships," page 123, writes: "For such a vessel the appendage resistance would seldom be as much as 4 or 5 per cent of the bare hull resistance."

Relative to the same subject, Mr. Baker in "Ship Form Resistance and Screw Propulsion," pages 125 and 126, writes: "The resistance of an ordinary unbalanced rudder, if properly tapered at its after-edge so that no eddy-making takes place, can be estimated from its total area, regarding the resistance as being solely due to skin friction." He states further: "For many forms this resistance may be neglected, as the rudder area is small and the forward velocity of the wake water is very considerable. This is particularly the case in vessels with very full after-lines, as incipient eddy-making is very probably present near the rudder post."

Struts for Twin Screw Cargo Vessels

FOR TWIN SCREW MERCHANT SHIPS fitted with struts of the usual type, Admiral Taylor, on page 124 of the publication previously referred to, gives a formula for figuring strut resistance. This formula takes especial account of the shape of the cross section used.

On page 124 of Mr. Baker's work referred to above, he gives a formula based on the wetted surface of the struts, it being assumed that the fore edge will be of the usual blunt shape and the after edge given a taper of not greater than 15 degrees so as to avoid eddy-making due to form. He assumes further, that the plane of the strut arm is placed in the line of flow of the stream lines. He concludes: "On an average this (the resistance of struts) amounts to 2 per cent of the whole resistance of a slow-running twin screw ship."

Spectacle Frames or Shaft Bossing

IT IS QUITE CUSTOMARY in merchant practice to fit spectacle frames or shaft bossing instead of struts. Admiral Taylor states that these appendages, if well formed, offer less resistance than thick struts with the bare shafts, but that in many instances wide, reasonably thin struts would offer less resistance than shaft bosses.

Mr. Baker, writing of shaft bossing, emphasizes the necessity of locating the webs of same at a proper angle relative to the horizontal. On page 125 of his "Ship Form, Resistance and Screw Propulsion," he writes in part: "It seems better in the present state of our knowledge to work, even with outward turning propellers, webs inclined at an angle of at least 22½ degrees, but not exceeding 45 degrees." On this same page Baker states that with the angle of the boss web at from 22½° to 45° to the horizontal, the per cent increase over the bare hull resistance due to this cause is from 2.6 to 4.

Bilge Keels

FOR THE SLOW MERCHANT TYPE OF VESSEL there remains but one other important form of appendage resistance, namely, bilge keels. This form of appendage, if properly placed, that is, with the plane following the line of flow of the water over the ship's hull, will increase the bare hull resistance only by an amount equal to the added skin friction. This statement is based upon the conclusions reached by several authorities. Perhaps the most satisfactory work has been done by Prof. C. H. Peabody. In a paper read before the American Society of Naval Architects and Marine Engineers, December, 1913, he writes: "As a conservative conclusion from the results obtained, the author suggests that, for a speed length ratio of .7 or less the resistance of normal bilge keels may be computed from friction only. At larger speed length ratios the resistance of bilge keels may be half again as much as that computed from friction only."

Appendage Resistance and Propeller Design

ADMIRAL DYSON, in "Screw Propellers for Hydraulic and Aerial Propulsion," pages 26 to 30, inclusive, discusses the whole question of appendage resistance in the light of its direct bearing upon propeller design as treated in that work. In this connection he gives figures relative to the appendage resistance of docking keels on heavy war vessels as well as similar figures for strut, shaft, and scoop resistance in light high-speed vessels.

Propulsive Coefficient

IN ORDER to arrive at a figure for shaft or indicated horsepower it is necessary to know what value of propulsive coefficient may be reasonably anticipated in a given case. This value is, however, dependent to such a great extent upon the after-body characteristics of the individual vessel that any attempt to here define the range covered in practice is believed inadvisable. Propeller tip clearance and shaft angle, location and character of strut arms or shaft bossing, the lines of the after-body as affecting the character of the wake, all considerations bearing upon hull efficiency, are factors which together with engine efficiency and screw efficiency in open water, directly affect the value of the propulsive coefficient.

SIXTH DIVISION

Freeboard

Origin of Freeboard Regulation

DUE TO THE TENDENCY of some owners to overload their vessels for obvious reasons, it was found necessary to pass laws, based upon wide experience, limiting such loading. The most notable of these laws are those of Great Britain, issued as "Instructions to Surveyors" by the British Board of Trade, which instructions establish what is known as the Plimsoll Mark, or deep load line. (Named for Mr. Samuel Plimsoll, who was active in having legislation passed in 1875 for the purpose of preventing overloading of vessels.) These laws apply generally to cargo-carrying vessels, since in passenger vessels overloading is more or less controlled by limited accommodations and may be also controlled by limiting the number of passengers to be carried.

Object of Rules

THE OBJECT of the freeboard rules is to protect the personnel of the ship and also the insurance companies by establishing a safe load line beyond which it would be considered dangerous to load.

Freeboard Defined

BY "FREEBOARD" is meant the height of the side of the vessel above the load water-line, at the mid-length, to the top of the deck plate or plank, at the inside of the waterway, projected on to the side plating. This represents in standard flush deck vessels without deck erections—i. e., vessels of a given depth to length ratio—a certain percentage of the displacement, which remains unsubmerged, thus providing the reserve of buoyancy considered necessary for safety. This percentage varies with the size of the vessel.

Factors Affecting Freeboard

THE FREEBOARDS of various types of vessels vary also in accordance with the strength of the vessel as a girder; as, for instance, a full scantling vessel with the main or weather deck forming the main upper strength member could sail with a smaller freeboard measured below the weather deck than could the spar decked type of vessel whose main upper strength member is usually the deck below the weather deck.

The question of beam does not bear directly in the determination of freeboard except in deducing the coefficient of fineness hereinafter described, it being understood that the beam of a vessel should bear such relation to the other dimensions as to provide a sufficient metacentric height to insure seaworthiness in all reasonable conditions of loading.

Basis for Freeboard Values

THE VALUES OF FREEBOARD are based primarily on percentages of displacement, and tables have been developed for standard vessels of various types in which the freeboards are expressed for convenience in linear dimensions.

The Coefficient of Fineness

THESE FREEBOARDS vary within comparatively small limits for vessels of relative fullness of form, the fuller vessels being assigned greater freeboards than those of finer lines having similar depths and lengths, thus adhering to the theory of percentage of displacement of reserve buoyancy. The relative fullness of form is derived by dividing the under deck tonnage (i. e., the internal volume of the hull to the top of floors and inside of frames below the upper deck) in cubic feet by the product of the length, breadth and depth of hold to top of floors. This result is called the "coefficient of fineness" and, although not the exact ratio of the actual hull lines to the envelopin parallelogram, it produces a correct index to the vessel's relative fullness of form. As any deviation from standard depth of floor or frame would affect the coefficient, correction must be made for such variations as deep double bottoms or ballast tanks not ordinarily included in the under deck tonnage. From the "coefficient of fineness" thus found, the corresponding basic freeboard is assigned, although the freeboard is increased or decreased, as the case may be, by any deviation from the standard proportions of a flush deck vessel.

Variation from the Standard

IN CASES where vessels are of greater or lesser length than standard, for a given depth the freeboard is increased or diminished respectively. Deviations from standard sheer or camber produce corrections to compensate therefor, as does also extra thickness of deck plating.

Correction for Closed-in Deck Erections

THE LARGEST and most important correction to the basic freeboard is that for closed-in seaworthy deck erections. This correction is based upon percentage of length covered upon which reduction in freeboard is permitted until, at a maximum, when the entire deck is covered, it becomes a spar decked vessel and is figured as such, the freeboard being measured below the spar deck at side. The basic freeboard thus corrected represents the winter load line and a reduction is permitted for summer sailing with a further reduction for fine season in the Indian Ocean, while additional freeboard below the winter line is required for winter sailing in the North Atlantic for vessels under 330 feet length.

Plimsoll Mark

THE PLIMSOLL mark or center of disc is placed amidship at the summer deep load line with the other marks above or below the center of disc, as the case may be.

Work of the Committee on Load Line

IN 1916 the Report of the Committee appointed by the Board of Trade to advise on the load lines of merchant ships was published. These reports aim to revise and improve the present freeboard rules and recommend that efforts be made to have them adopted internationally through an international conference on load lines, which up to this time has been impracticable due to the disturbed condition of international affairs. The report reduces the freeboards slightly, but dwells pointedly on questions of strength and watertightness above decks.

The freeboard of passenger vessels was thoroughly investigated by an international congress which met in London subsequently to the sinking of the S. S. *Titanic* through collision with an iceberg in 1912.

The result of the findings of this congress was to point out the necessity for complete watertight divisions extending above the waterline at frequent intervals to a complete watertight deck, in order to preserve the watertightness of compartments adjacent to those which might be bilged, the bulkheads to be so placed as to permit of a sufficient reserve of buoyancy, even though the vessel might be materially out of trim due to injury, and to permit only the injured compartments to be flooded. The recommendations of this congress on safety of ships, although of undoubted value from a standpoint of safety and being thoroughly practicable, have unfortunately not been adopted by some of the larger nations as a part of their maritime law. This failure may be due, to some extent, to the fact that in compliance with the structural requirements the cost of construction is increased.

References: Instruction to Surveyors—Load Line. Ed. 1909, issued by British Board of Trade, Marine Department.

Report of Committee appointed by the British Board of Trade to Advise on the Load Lines of Merchant Ships. 1916.

Tonnage

IN THE DESIGN OF A VESSEL for use in commerce, whether for the carrying of cargo, passengers, or both, the question of the application of tonnage laws arises and must be given careful consideration.

Tonnage is an important feature which affects the earning power of a vessel on account of forming the basis upon which dues and tolls are charged.

Not of Importance in the Design of Naval Auxiliaries

WHEN PREPARING DESIGNS for naval auxiliaries, little thought is given these matters, the reason being at once apparent, since an attempt to secure the minimum tonnage upon which dues and tolls are paid, would undoubtedly act in many cases to impair the efficiency of the vessel in its particular use and duties. Unlike other uses of the term "ton," which ordinarily express weight—as, for instance, the displacement ton or deadweight ton—the ton, as applied in tonnage admeasurement, represents capacity or volume and is expressed in units of 100 cubic feet each.

Methods of Admeasurement

THERE ARE VARIOUS METHODS of admeasuring vessels; i.e., under the National Statutes of the several countries and the special rules under which vessels are measured for passage through the Suez and Panama canals, respectively. Although there are marked differences in these several rules, they are all based primarily upon the Moorsom system of admeasurement, which was advocated by an Englishman of that name and, after protracted debate in maritime circles, was finally adopted as the basis for the British system of measuring vessels.

The Object of Tonnage Measurement

IN MEASURING THE TONNAGE OF A VESSEL, it is the aim to ascertain and express the relative earning power thereof. The register tonnages of the United States and Great Britain, which are very nearly similar, are arrived at about as follows:

Under Deck Tonnage

FIRST THE UNDER DECK VOLUME is computed from the top of floors or double bottom (which is exempted) and the inside of ordinary frames (not deep frames) to the under side of the tonnage deck, which is, in vessels having two or more decks, the second complete deck from below. This figure is known as the under deck tonnage. Ballast tanks other than double bottoms, which are not available for cargo stores or fuel, are exempted by the United States rules.

'Tween Deck Tonnage

NEXT THE VOLUME of the space between the tonnage deck and weather or uppermost complete deck is computed to the inside of frames, this figure being known as the 'tween deck tonnage. After which the volume of enclosures above the weather deck is computed, certain exemptions being allowed for passenger spaces in the upper tier, galleys, latrines, fidleys, wheelhouses, open deck houses, etc.

Gross Tonnage

THE ABOVE FIGURES, when added together, produce what is known as the "Gross Tonnage," but it is clear that this figure does not represent the earning capacity of the vessel, since no consideration has been given to the volume of space occupied by machinery, fuel, crew, navigational instruments, or necessary ship's stores. The volume of these latter spaces depend to a great extent upon the speed and length of voyage for which the vessel is designed and under which conditions it is expected to operate most efficiently and economically.

Deductions

IT THEREFORE BECOMES NECESSARY, in order to express the true earning capacity or ability to carry cargo, to deduct such spaces as are not adapted to the carrying of cargo. The deductible spaces first to be considered are those other than for propelling machinery and fuel, which deductions apply in all cases, both of sailing vessels and those otherwise propelled. Such spaces, in order to become deductible, must first have formed part of the gross tonnage. The spaces forming such miscellaneous deductions comprise those occupied as berthing spaces by officers and crew, galleys, bakeries, latrines, washrooms, engineer's office, wireless rooms, hospital spaces, dispensaries, master's quarters, and spaces for steering gear, anchor gear, chain lockers, lamp-room, boatswain's stores, chart stowage, donkey engine, sail-room, etc., provided they were not previously exempted. Subsequently the deductions for propelling power are ascertained, being based on the proportion that the sum of the actual volumes of the engine-room and other spaces assigned to propelling machinery, bears to the gross tonnage of the vessel.

Deductions for Machinery Spaces

IN ORDER TO PROVIDE the necessary deduction for fuel spaces (in screw steamers), a total deduction of 32 per cent of the gross tonnage is permitted for propelling power, provided the actual volume of the propelling machinery spaces lies between 13 and 20 per cent of the gross figure. When the volume of the actual machinery is less than 13 or more than 20 per cent the total volume of these spaces, plus 75 per cent thereof for fuel, is permitted as the deduction. In the case of paddle vessels, the allowances are slightly different from those applied to screw steamers.

Net Tonnage

THE DEDUCTION from the gross figure of the volumes of the miscellaneous spaces above enumerated and the propelling power allowance produces what is known as the "Net Register Tonnage," upon which dues and tolls are collected during the life and operation of the vessel.

Suez Rules

ADMEASUREMENT in accordance with the Suez rules produces a net tonnage usually in excess of that resulting from admeasurement under the statutes. This is due to the fact that miscellaneous deductions are limited to 5 per cent gross, and propelling power deductions to 50 per cent gross, while exemptions are at the same time less liberal than those permitted under national certificates.

Panama Rules

THE PANAMA RULES are somewhat more liberal than the Suez rules; however, it is not to be considered unlikely that some revision of the Suez rules may appear when international affairs become sufficiently stabilized to warrant adjustment to suit new conditions.

It will be observed from the facts presented that it is sometimes possible to make a considerable saving in net tonnage by laying out machinery spaces, ballast tanks, etc., so as to obtain the most advantageous deductions, particularly when the machinery spaces are close to 13 per cent of the gross. It is accordingly advantageous to make approximate tonnage calculations before the plans are completed.

References:

Measurement of Vessels, 3d Ed., Jan. 3, 1919. Bureau of Navigation Dept. Commerce.

Instructions Relating to the Measurement of Ships, 1913, issued by the Board of Trade—British.

Rules for the Measurement of Vessels for the Panama Canal.—Proclamation of the President of the United States, Aug. 24, 1912.

Suez Maritime Canal.—Universal Company Rules of Navigation, Jan. 1913, Ed.

Watertight Subdivision of Ships and Stability of Ships in the Damaged Condition

Value of Transverse Subdivision

AT AN EARLY PERIOD in the design of a ship it is desirable to know at what points transverse watertight bulkheads must be placed in order to give the degree of safety desired. Until the number of these watertight bulk-

heads and the approximate positions in which they must be placed are known the preliminary general arrangement plans of the vessel cannot be satisfactorily made.

At all times watertight transverse bulkheads properly spaced protect a ship against sinking in case of collisions with other vessels or of running upon rocks. In time of war they afford the same protection against sinking due to damage by torpedoes, mines, or gunfire. The recent war has shown that, when a belligerent needs ocean transportation to reach the field of operations, practically its entire merchant marine will be utilized for the transportation of troops and supplies. Every merchant vessel, therefore, should be regarded as a possible member of a nation's fighting forces. With this possible war-time duty in mind, the designer of a ship should provide in his design for as many transverse watertight bulkheads as will neither unduly increase the first cost of the vessel nor interfere with its economical operation as a cargo or passenger carrier in time of peace.

General Methods for Locating Transverse Bulkheads

THE PROPER SPACING of watertight transverse bulkheads results from a study of the effect of flooding on both trim, or longitudinal stability, and on metacentric height or transverse stability; but since, if bulkheads are properly spaced according to the requirements of longitudinal trim, they usually come within the requirements of transverse stability, it is found best to locate them entirely from the standpoint of longitudinal trim and then determine the greatest loss of transverse metacentric height which can occur due to flooding any of the resulting compartments. If the loss of metacentric height is found to render the ship unstable the length of the compartment in question may be shortened.

Rules for the Safety of Life at Sea

THE RULES FOR SUBDIVISION formulated by the "International Conference on Safety of Life at Sea," which met in London in November, 1913, are without doubt the best which have been devised up to the present time, as most careful consideration was given to the requirements of the vessel from a commercial standpoint, as well as from the standpoint of safety.

These rules are published in the "International Convention for the Safety of Life at Sea," which unfortunately has not been ratified by all the countries represented at the conference. They provide for a *"bulkhead deck,"* which is the uppermost continuous deck to which all transverse watertight bulkheads are carried, and a *margin line* which is drawn parallel to and 3 inches below the upper surface of the bulkhead deck at side. They also established the *floodable length* at any point of the vessel. This is the maximum percentage of the length of the vessel (having its center at the point in question), which can be flooded under the definite assumptions set forth in the convention without the vessel being submerged beyond the margin line. The bulkheads are then placed to subdivide the floodable length in accordance with *factors of subdivision* given in the convention, which vary with the length and service of the vessel. A vessel is commonly referred to as a one, two or three compartment ship in accordance with the number of transverse subdivisions of the floodable length.

Flooding Curves

THE BEST METHOD for quickly determining locations of the transverse bulkheads according to the above requirements is to use "Flooding Curves"; that is, curves plotted on the length of the vessel as a base, with floodable lengths as ordinates.

A method for constructing flooding curves is given by Sir John Harvard Biles in "The Design and Construction of Ships," Volume I, and various other methods have been proposed.

The least laborious method, however, for constructing these curves, and, in fact, the only method which can be used when the lines of the ship are not yet made, and only the principal dimensions, displacement, and general shape of the outboard profile are known, is that recommended by "The Committee Appointed by the President of the Board of Trade (British) to Consider and Report on the Subdivision of Merchant Ships" (hereinafter called the "Bulkhead Committee"), in its first report (dated November 3, 1914). This method makes use of a set of contour curves which were made from a series of flooding curves accurately worked out for a family of ship forms of the ordinary merchant type. For other ship forms of the usual seagoing merchant type, the curves are sufficiently accurate for purposes of preliminary design Later, after the lines of the ship and its general arrangement plans are completed, more accurate floodable lengths may be calculated and the subdivision as determined from the preliminary curves may be checked and modified to take care of the difference in form between the standard ship and the ship in question, according to rules given by the Bulkhead Committee in its report. The final modified curves may be considered almost identical with those which would be obtained by laboriously working out floodable lengths by exact stability methods.

The quantities needed for use with the Bulkhead Committee's contour curves are the following;

(a) Block coefficient, which is the volume of displacement to molded lines divided by the product of length, times breadth, times draft.

(b) Freeboard ratio, which is the freeboard to the lowest point of the margin line divided by draft amidships to top of keel.

(c) Sheer ratio, forward and aft. The sheer ratio at any point is the difference between the height of the bulkhead deck at side at the point in question and at the lowest point of sheer, divided by the draft amidships to top of keel.

These quantities are all known or can be decided upon before any lines or other drawings are made for the ship.

While the rules and methods proposed by the Bulkhead Committee will be satisfactory for ordinary commercial carriers in time of peace, more exact investigations of the effect of extensive damage should be made for vessels to be used as transports or for other special purposes in time of war, and subdivisions provided as may be necessary.

Effect of Flooding on Transverse Stability

Formula for Loss of Metacentric Height

WHEN A COMPARTMENT is flooded a serious loss of transverse metacentric height is likely to result. In considering this question it is proposed first to develop and study the equation used for obtaining the loss of metacentric height due to flooding.

The following symbols will be used in developing this equation.

WL_1	*Intact waterplane at which vessel floats before damage.*
WL_2	*Waterplane at which vessel floats after damage.*
d	*Draft before damage.*

V_1 *Displacement volume to WL_1 before damage.*
KM_1 *Height of metacenter above base before damage.*
KB_1 *Height of center of buoyancy above base before damage.*
B_1M_1 *Metacentric radius before damage.*
A_1 *Area of WL_1 before damage.*
I_1 *Transverse moment of inertia of WL_1.*
KM_2 *Height of metacenter above base after damage.*
KB_2 *Height of center of buoyancy above base after damage.*
B_2M_2 *Metacentric radius after damage.*
A_d *Area of WL_2, not including area of lost portion.*
I_d *Transverse moment of inertia of WL_2, not including transverse moment of inertia of the lost portion.*
V_2 *Displacement volume after damage.*
I_2 *Transverse moment of inertia of WL_2 intact, that is, including the transverse moment of inertia of the lost portion.*
v *Gross volume of flooded compartment up to WL_1.*
kb *Height above base of center of gravity of net volume flooded up to WL_1.*
a *Gross area of lost portion of water plane.*
i *Gross transverse moment of inertia of lost portion of water plane.*
p_v *Volume permeability of flooded compartment up to WL_1.*
p_a *Area permeability of lost portion of water plane.*
p_i *Transverse inertia permeability of lost portion of water plane.*
M_1M_2 *Distance of metacenter after damage below metacenter before damage.*
B_1B_2 *Distance of center of buoyancy after damage above center of buoyancy before damage.*
s *Sinkage, or increased draft, due to damage.*

The equation is developed as follows:

$$KM_1 = KB_1 + B_1M_1 \quad (1)$$

$$= KB_1 + \frac{I_1}{V_1} \quad (2)$$

$$KM_2 = KB_2 + B_2M_2 \quad (3)$$

$$= KB_2 + \frac{I_d}{V_2} \quad (4)$$

$$But\ V_2 = V_1 \quad (5)$$

since the weight, i. e., displacement, of the ship does not change when it sinks deeper into the water. The buoyancy of the flooded portion is lost and must be replaced by that of a layer equal in thickness to the sinkage of the ship and spread over the intact portion of the water plane. Hence:

$$KM_2 = KB_2 + \frac{I_d}{V_1} \quad (6)$$

$$But\ I_d = I_2 - p_i i \quad (7)$$

$$Hence,\ KM_2 = KB_2 + \frac{(I_2 - p_i i)}{V_1} \quad (8)$$

$$M_1M_2 = KM_1 - KM_2 = \left(KB_1 + \frac{I_1}{V_1}\right) - \left(KB_2 + \frac{(I_2 - p_i i)}{V_1}\right) \quad (9)$$

$$= KB_1 - KB_2 + \frac{I_1}{V_1} - \frac{(I_2 - p_i i)}{V_1} \quad (10)$$

$$KB_1 - KB_2 = -B_1B \quad (11)$$

$$Then\ M_1M_2 = -B_1B_2 + \frac{(I_1 - I_2 + p_i i)}{V_1} \quad (12)$$

$$= -B_1B_2 + \frac{(I_1 - I_2)}{V_1} + \frac{p_i i}{V_1} \quad (13)$$

$$= -B_1B_2 - \frac{(I_2 - I_1)}{V_1} + \frac{p_i i}{V_1} \quad (14)$$

Equation (14) is the formula which gives the change in metacentric height. If it gives a positive result there is a loss of metacentric height, and if the result is negative there is a gain in metacentric height.

Although in the ordinary ship WL_2 is a little greater in area than WL_1, for all practical purposes their areas may be considered equal, since the difference in area is well within the probable error made in estimating the permeability of the lost portion of the water plane. Then

$$A_d = A_1 - P_a a \quad (15)$$

The sinkage, caused by the damage, is then

$$s = \frac{p_v v}{A_1 - p_a a} \quad (16)$$

For practical purposes the center of gravity of the layer of transferred buoyancy may be considered at a point one-half the sinkage above WL_1.

Then

$$KB_2 = \frac{(V_1 \times KB_1) - (p_v v \times kb) + \left(p_v v \times \left(d + \frac{s}{2}\right)\right)}{V_1} \quad (17)$$

Then the *use* of the center of buoyancy is

$$B_1B_2 = KB_2 - KB_1 = \frac{(V_1 \times KB_1) - (p_v v \times kb) + \left(p_v v \times \left(d + \frac{s}{2}\right)\right)}{V_1} - KB_1 \quad (18)$$

or, as it may be more simply expressed by the principles of moments,

$$V_1 \times B_1B_2 = p_v v \times \left(d - kb + \frac{s}{2}\right) \quad (19)$$

$$B_1B_2 = \frac{p_v v \times \left(d - kb + \frac{s}{2}\right)}{V_1} \quad (20)$$

B_1B_2 is always positive, that is, the center of buoyancy always rises, since kb must always be less than d.

Since the rise of center of buoyancy due to damage is frequently greater than the reduction of metacentric radius the metacentric height of the vessel is often greater after damage than before. The temporary list due to the sudden inrush of water may, however, cause the flooding of compartments other than those immediately affected by the damage and this possibility should also be investigated.

After having located the transverse bulkheads according to the rules of the Bulkhead Committee the loss of metacentric height should be investigated by means of

the formula derived in the foregoing for the vessel light as well as loaded and in ballast. If any dangerous stability condition is found to exist the size of the compartment can be modified as necessary.

Watertight Decks

A WATERTIGHT DECK located in a compartment below the level of the waterline of the vessel after damage may increase or decrease the safety of the ship. If damage occurs below the deck and not above, the deck goes below the damaged waterline of the ship. Therefore, none of the water plane is lost and there is a gain in metacentric height. If damage occurred above the deck a loss of stability might result.

It therefore may be stated that a watertight deck below the waterline at which the ship will float after damage may be an element of danger, and careful investigation should be made before utilizing it to supplant any portion of the transverse bulkhead system of subdivision, but that it tends to increase the safety of the ship if it is in addition to the subdivision which would be used if the watertight deck were not fitted.

Longitudinal Bulkheads

LONGITUDINAL SUBDIVISION is likely to be a source of danger in case of damage, due to the list which would be caused by unsymmetrical flooding. If it is necessary or advisable to fit such bulkheads this feature should be investigated. The Bulkhead Committee rules provide that "* * * if watertight longitudinal bulkheads or inner skins are fitted, it should be proved that the margin line will not be brought under water when any space bounded by transverse watertight partitions between the outer skin and the inner skin, or longitudinal bulkhead on one side, is flooded for a length equal to the floodable length of the vessel in that region as determined for transverse subdivision only."

Special Requirements

THE FOREGOING considers the subdivision of ships from a theoretical standpoint only. The requirements for location of collision, after peak and other bulkheads as laid down by the laws of the country in which the vessel is registered and by the classification rules to which the vessel is to be built, must of course be observed.

Checking

IT WOULD AT FIRST THOUGHT seem unnecessary to make and comment on this subject. It has been, however, the effort to make the present discussion as practical as possible. Accordingly, as the results of the investigation herein described are to serve as the basis for the detail work of development their accuracy is of the first importance. Further, the work of checking, provided the results are tabulated in a clear and logical manner, should not be in any sense a laborious operation. It should consist primarily of comparing the requirements laid down with the results realized, and secondarily of examining these results in the light of results attained in previous designs, and accounting in a satisfactory manner for any differences discovered. Such a check carried out with conscientiousness and good judgment will serve to discover the majority of inaccuracies likely to occur.

History of Design

FEW DESIGNS are undertaken and carried to a satisfactory conclusion in which some new problems of a more or less important nature have not been encountered and solved. In order to make such material available for future use it is essential that it should be made a matter of careful record. Frequently it is impossible to cover it satisfactorily upon an ordinary standard form. For this reason it is considered desirable to prepare a history in such form as to provide for detailed descriptions of such special investigations, with the reasons therefor, in addition to the usual tabular statement of results. Such complete records are always of value as reference material in connection with future designs and frequently serve to clear up obscure points arising in connection with the vessel's performance in service.

Example of Ship Design

THE FOLLOWING ILLUSTRATION of the manner of carrying out the steps herein described is taken largely from the records covering the actual basic design of a vessel now in service.

FIRST DIVISION

Displacement and Length Requirements Laid Down for an Oil Tanker

Capacity, 7500 tons cargo oil, plus 750 tons of miscellaneous cargo.
Two-deck steel vessel having forecastle, bridges and poop.
Fitted with double bottom under machinery and in special cargo holds.
Ballast tanks suitable for steaming in light condition.
Maximum draft not to exceed 28 feet.
Machinery located aft as far as possible.
Boilers oil burning.
Engines, twin screw, reciprocating.
Maintained sea speed, 14 knots.
Endurance, 8000 miles at 10 knots, carrying full amount of cargo oil.
Cost limited to a given figure.
Miscellaneous requirements as to capacity and character of spare hold spaces, etc.

Cost

FIGURES AVAILABLE indicated that from 14,000 to 14,500 tons displacement was about the largest size ship of the desired type which could be built within the limit of expenditure.

Type

THE CHARACTERISTICS above referred to settled the type very definitely. The ship was to have two decks, forecastle, bridge, and poop; ballast tanks so located as to reduce the GM when at sea without cargo; machinery located aft; twin screws; boilers oil burning.

Displacement

THE VESSEL was required to carry cargo oil amounting to	7,500 tons
and a miscellaneous cargo of	750 tons
There was allowed for reserve feed water, stores, complement, spare gear, and miscellaneous small items	150 tons
There was allowed for bunker fuel	800 tons
There was allowed for margin	250 tons
Total assumed deal weight	9,450 tons

The ratio of dead weight to displacement to be anticipated in a vessel of this type having relatively high speed was between .63 and .67. (See Fig. No. 1.)

For this ratio	= .63	displacement	= 15,000
	= .64		= 14,775
	= .65		= 14,550
	= .66		= 14,325
	= .67		= 14,100

It was decided to accept 14,500 tons as the tentative displacement.

Length

IN SELECTING A TENTATIVE LENGTH it was recognized that this vessel lay almost on the line between what have been termed in the preceding discussion "cargo vessels" and "fast cargo vessels." The ranges of displacement length coefficient and speed length coefficient considered were as follows:

Displacement.	Length. in feet	$\frac{V}{\sqrt{L}}$	$\frac{\Delta}{\left(\frac{L}{100}\right)^3}$
14,500	527	.61	99
	493	.63	121
	463	.65	146
	436	.67	175
	411	.69	209

Evidently from the table given under "Length," First Division, the proper ranges for this ship are

$$\frac{V}{\sqrt{L}} = .63 \text{ to } .67$$

and

$$\frac{\Delta}{\left(\frac{L}{100}\right)^3} = 121 \text{ to } 175$$

A length of 455 feet was selected. This gave

$$\frac{V}{\sqrt{L}} = .656$$

and

$$\frac{\Delta}{\left(\frac{L}{100}\right)^3} = 154$$

In the case of the actual vessel the investigation of length ended at this point, as the above values of the speed length ratio and displacement length coefficient were considered sufficiently satisfactory to warrant the omission of further investigation. In order, however, to illustrate the methods followed and some of the uses to which the results may be put, all the required steps will be carried through in the usual manner.

SECOND DIVISION

Draft

ALTHOUGH THE LIMIT OF DRAFT had been set by the characteristics at 28 feet and in spite of the fact that in general the greatest draft practicable is the most desirable (as emphasized under this heading in the second division) it was decided in this case to design for a mean draft of 26 feet. This was done both to provide a margin, within the limit set, for trim due to variations in loading and to avoid imposing too low a limit upon the number of harbors, docks, etc., to which she could have access.

Depth

THE DEPTH tentatively fixed was 35.8 feet. This gave a length to depth ratio of 12.7, well within the limits of the Classification Societies relative to excessive proportions.

Midship Section Coefficient

PRACTICE permits little variation in this coefficient for this type of ship, and fortunately the high values used are at the same time conducive to easy driving, great cargo-carrying capacity and simple construction. In this case the value selected was .98.

Vertical Position of the Center of Gravity

RATIOS of height of center of gravity to midship depth are quoted in the Second Division under this heading. For light condition this averages .63 and for full load .51, giving about 22 feet and 17.8 feet, respectively, for the depth contemplated. These figures were not available at the time this design was undertaken and the height of center of gravity assumed for full load was 19.5 feet above the bottom of keel. This was intentionally made liberal in order to provide for the effect of free surface in oil tanks and to provide against the effect of weights added later during design. It was the intention to control the stability when light by the ballast tanks previously referred to.

THIRD DIVISION

Period of Roll and Metacentric Height

LITTLE INFORMATION relative to the behavior of vessels of this type in a seaway was available at the time of this design. Practically none relative to the values of radius of gyration realized on such vessels was obtainable. It was hoped, however, that a metacentric height of 3.5 feet, the ship being fully loaded, would give a reasonable period of roll. The desired height of metacenter was accordingly fixed at 23 feet.

Beam

FIG. 15 gives a height of metacenter of 23.3 ft. for a beam of 56 feet, and a draft of 26 feet. This gave a prospective metacentric height of 3.8 feet, which seemed entirely reasonable at this stage of the design.

Longitudinal Coefficient

IT WAS NECESSARY for the tentative dimensions selected to satisfy one more requirement; viz., that of a reasonable value of the longitudinal coefficient. Reference to Fig. 39 will show that for the value of speed length ratio selected,—viz., .656,—the preferred value of longitudinal coefficient is just under .75, though higher values are entirely justified by practice.

The selections made in this case gave a value of longitudinal coefficient of about .781. This figure should be especially noted, as further reference will be made to it.

Power

THE POWER REQUIRED to drive the above vessel at a speed of 14 knots was estimated as 3,000 effective horsepower, bare hull. See Fig. 44 corrected for difference in value of displacement length coefficient.

FOURTH DIVISION

Trial Ships

CHECK WEIGHT FIGURES showed the tentative displacement, 14,500 tons, to be satisfactory. With this displacement in view the following figures will serve as the basis for our length investigation and the coefficients listed will result.

Length in feet....	425	440	455	470	485
Beam in feet.....			56′		
Draft in feet.....			26′		
Depth in feet.....			35.8′		
Midship section Coefficient.....			.98		
Longitudinal Coefficient	.837	.808	.781	.757	.733
$\frac{\Delta}{\left(\frac{L}{100}\right)^3}$	189	170	154	140	127
$\frac{\text{Length}}{\text{Depth}}$	11.87	12.28	12.71	13.13	13.54

The power of the five ships at a speed of 14 knots is obtained as follows:

Fig. 44 gives 3,000 E. H. P. for a 455 foot ship with a longitudinal coefficient of .78 and a displacement length coefficient of 150 at a speed of 14 knots, that is for a speed length ratio of .655.

In the formula $P = P_1 \left(a \frac{\sqrt{L}}{\sqrt{L_1}} + b \frac{1 L_1^3}{1_1 L^3} \right)$ the values of a and b for the above speed length ratio may be taken as .623 and .377 respectively.

Solving in the case of the 425 foot ship we have

$$P = 3300$$

The powers for the other ships at 14 knots and for all the trial ships at 10 knots are similarly obtained

Based on the above dimensions and coefficients the following data relative to weight, power, fuel requirements, etc., results:

Length in feet.....	425	440	455	470	485
E. H. P. (bare hull) at 14 knots.....	3,300	3,130	3,000	2,893	2,806
E. H. P. (bare hull) at 10 knots.....	957	932	910	895	882
Weight of machinery at 5 E. H. P. per ton	660	626	600	579	561
Weight of reserve feed, complement, spare gear, stores, etc.	150	150	150	150	150
Bunker fuel 2.5 lbs. per E. H. P. per hour for radius of 8000 miles at 10 knots.....	887	864	844	830	818
Weight of hull, fittings, equipment, etc.....	3965	4120	4300	4490	4700
Total weight	5662	5760	5894	6049	6229
Remainder for cargo and margin..	8838	8740	8606	8451	8271
Required cargo			8250		

The curves (Fig. No. 60) showing the variation of the weights with length are typical of the results for this class of vessel. The curve of margins it will be noted shows a value of 588 tons for the short ship, which gradually decreases to almost nothing in the long ship.

At the time of the design of the ship the first cost of machinery per ton was about 3½ times that of hull, fittings, etc. Estimating costs in this ratio for the trial ships and allowing the machinery of the 455-ft. ship a value of unity, we obtain the following comparative figures:

Length	425 ft.	440 ft.	455 ft.	470 ft.	485 ft.
Machinery	1.10	1.05	1.00	.96	.93
Hull	1.89	1.96	2.05	2.14	2.24
Hull & machinery	2.99	3.01	3.05	3.10	3.17

The fuel consumption at cruising speed, however, is in the case of the long ship about 8% less than in the case of the short ship. This saving of the long ship over the short, full ship would be increased in rough weather. It would be further increased if, as is usually the case, the cruising speed were fixed at a value more nearly approaching the maximum.

We have accordingly the following results:

The short, full ship provides the maximum dead weight cargo capacity.

The short ships represent the minimum first cost.

The longer ships, 470 and 480 feet, represent the lowest fuel consumption, judged only on performance when under way.

These considerations are not the only ones involved, nor are they individually complete as above noted. They are only instanced as illustrative of the methods pursued and the broad basis established for such further investigations as may be required in any given case.

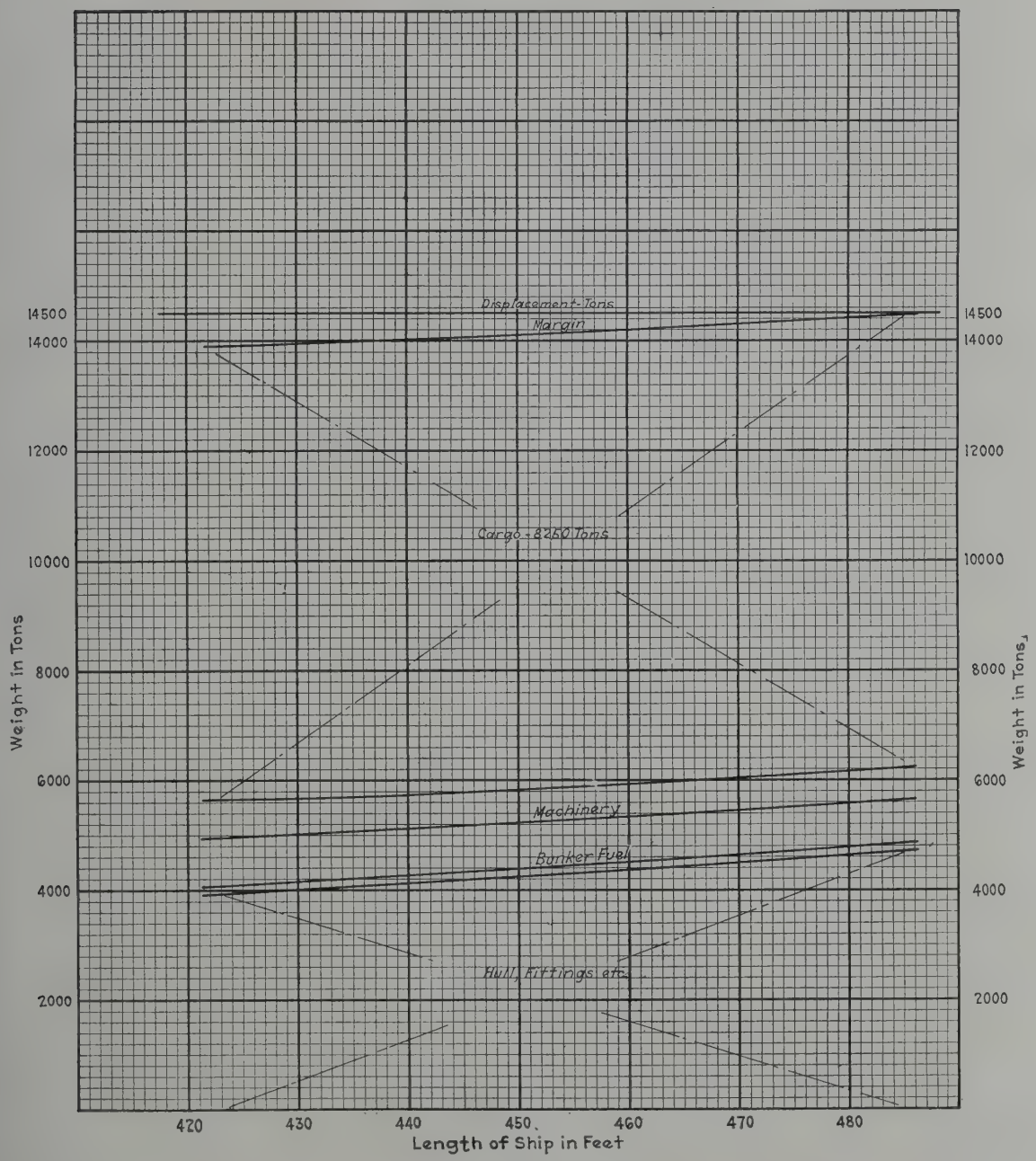
In this particular case the adoption of the short vessel on account of her greater dead weight capacity is considered inadvisable in the light of unfavorable experiences with seagoing vessels of very full underbody when attempting to make prompt passages under adverse weather conditions.

Further, the adoption of the short ship because of lower first cost only is considered inadvisable. The difference in first cost between this ship and the 470-ft. ship is only about 3% to 4%. A small saving in fuel consumption by the long over the shorter vessel would in a few years probably more than offset this small difference in first cost.

There are, however, other elements which could not be ignored in an actual case, but which are not considered in detail here as they do not serve to emphasize a point of particular value in this discussion. These elements are in part fuel consumption in port, relation of length of ship to cargo handling facilities in ports of call, maneuvering ability, size of crew, etc.

Although the problem may be presented in many different forms covering the entire range from the slow cargo vessel to a high speed destroyer, the same principles which underly the method illustrated herein may be applied in the investigation of these or other elements in their relation to the length of ships. Thus, curves may be plotted showing the variation in value of the longitudinal coefficient, the displacement, the cost of operation, the power required, etc., with change in length. It is then necessary to assign to each factor its proper weight relative to the others involved and to ascertain the cumulative effect of all in order to arrive at the desired figure.

Fig. 60—Curves Showing
Variation of Weight with Length



But one more point needs emphasis in connection with the selection of the optimum length. This is the comparatively narrow range to which the above study restricts the choice of the designer. In the present case it is believed that any length between 450 feet and 465 feet could be used with satisfactory results, but that a selection lying much outside these limits would be open to more or less serious objection.

FIFTH DIVISION

REFERENCE has previously been made to the variation in the height of the center of gravity in the actual ship from that assumed in the original calculation. The results of inclining experiments carefully conducted and worked up show that the values of GM obtained are from 4.00 ft. to 4.5 ft., the vessel being fully loaded. These values are unquestionably larger than are required and might be expected to produce an uncomfortable ship. No complaints have been received on this account, however. It is accordingly believed that if a redesign were contemplated the old beam, 56 feet, could be accepted. The draft might be increased to 26.5 feet in order to assist in reducing the value of the longitudinal coefficient, which is considered somewhat too high for the best results under average conditions of sea. The length might be made 460 feet on this account as well as in order to obtain a slight advantage in fuel consumption.

The dimensions and coefficients suggested then would be:

Displacement = 14,500 tons, Length = 460 feet, Beam = 56 feet, Draft = 26.5 feet, Midship section coefficient = .985, Displacement length coefficient = 149, Longitudinal coefficient = .755, and Speed length ratio =.653.

The offsets for the curves of sectional area and for the load water line may be obtained from Figs. Nos. 8, 9, 10 and 11, respectively. These provide for a reasonable amount of parallel middle body for the type of ship contemplated.

A comparison of the principal characteristics for the ship as built and for the ship with the alterations proposed above follows:

Item.	Ship as Built.	Ship as Proposed.
Length, feet	455	460
Beam, feet	56	56
Draft, feet	26	26.5
Depth, feet	35.8	35.8
Displacement, tons	14,500	14,500
Midship section coefficient	.98	.985
Longitudinal coefficient	.781	.755
Displ. length coefficient	154	149
Length ÷ depth	12.72	12.85
E. H. P. bare hull, 14 knots	3,000	2,940
E. H. P. bare hull, 10 knots	910	906
Weight of machinery, tons	600	588
Weight of reserve feed, complement, stores, etc.	150	150
Bunker fuel, tons	844	808
Weight of hull, hull fittings, equipment, etc.	4,300	4,350
Ship without cargo	5,894	5,896
Cargo	8,250	8,250
Margin	356	354
Vertical center of gravity	19.0	19.0
Height of transverse metacenter	23.3	23.3
Value metacentric height	4.3	4.3

As an instance of the effect of variation in draft upon a design attention is invited to the fact that both the above ships are somewhat longer than the best practice would sanction for ships of the type. The principal reason for this is probably the limitation of the draft to 26 feet. Had 27.5 feet been adopted and the freeboard been increased correspondingly it would have been possible to use a beam of 57 feet without increasing the metacentric height. This would then have permitted a length of 435 feet, giving a longitudinal coefficient of .754 and a displacement length coefficient of 176.

HULL SPECIFICATIONS

AN INDEX AND SKELETON

FOR

GROUPING ITEMS, PREPARING SHIP ESTIMATES, AND WRITING THE DETAIL HULL SPECIFICATIONS

OF

MODERN VESSELS

Foreword

This Section is primarily designed to furnish a guide for the preparation of Detail Hull Specifications. The Specifications are divided into twenty-six distinctive groups, each group representing a particular portion of the work, such as structure, fittings, operating systems, equipment, outfit, stores, etc. These groups are then subdivided in a manner that will cover every item that might possibly be considered in the Detail Hull Specifications.

A complete Index precedes the Specifications, which will facilitate reference to any and every item coming under this head.

This Section will also be found invaluable in preparing estimates for bids on proposed vessels, in preparing lists of job orders for carrying out the work, for ordering material and equipment, and for providing a basis for weight estimates.

F. B. WEBSTER.

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Hull Specifications

GROUP I

Incidentals

A 1 Dimensions
2 Description
3 Insurance Premium
4 Surety Bond on Contract
5 Classification Fees
6 Inspection & Tests of Material
7 Specifications

B 1 Drawings & Calculations, Hull & Machinery
2 Mold Loft Work
3 Drawings Furnished to Owners
4 Inclining Experiment
5 Model

C 1 Launching
2 Dry Docking Incl. Towage to & From Dry Dock
3 Care of Ship at Wharf & Mooring Same
4 Sweeping & Cleaning
5 Watchmen
6 Install & Maintain Temporary Lights
7 Blocking, Shoring, & Ribbanding
8 Staging
9 Testing all Water and Oil Tight Compartments
10 Weighing Material
11 Testing Auxiliaries

D 1 Supervision (to include salaries of foremen whose time is charged against the vessel).

E 1 Dock and Sea Trials

F 1 Delivery

GROUP II—STEEL HULL

Structural

A 1 Keels, Flat, Bar & Vertical
2 Keels, Docking & Bilge
3 Stem, Cast Steel or Bar
4 Frames & Reverse Frames
5 Floors & Bilge Brackets
6 Beams, Knees or Brackets
7 Keelsons, Center, Bilge & Side
8 Keelsons, Angles & Clips
9 Tanktop Plating & Margins, Liners
10 Boiler, Engine & Auxiliary Seatings
11 Long't. & Trans. Bhds.
12 Bounding & Stiffr. Angles, Brackets & Liners for Bhds.
13 Hold & 'Tween Deck Stringers (Clips to Same).
14 Shell Plating, Straps, Doublings & Liners
15 Decks & Flats, Plating, Liners & Straps
16 Stringers, Waterway & Face Angles
17 Web Frames, Plates & Shapes
18 Strong Beams in Engine & Boiler Spaces
19 Panting Stringers & Breast Hooks
20 Sheet Steel Bhds. in Living Quarters
21 Sheet Steel Insulation in Boiler & Eng. Casings
22 Engine & Boiler Casings
23 Trunks for Hatches, Skylights & Ladders Between Decks
24 Expansion Trunks for Oil Carriers

Structural—Continued

A 25 Steel Deck Houses
26 Girders
27 Shaft Alley
28 Doublings at all Deck Erections
29 Bridges (Steel)
30 Bilge Wells
31 Billboards
32 Breakwaters on Deck
33 Cargo Ports
34 Steel Ceiling
35 Chain Locker
36 Coal Trunks
37 Rudder Trunk

Pillars, Hold or 'Tween Deck

B 1 Pipe
2 Forgings or Pipe Pillars
3 Bar Steel or Iron Pillars
4 Pillars, Built Up

Stern Frame and Struts

C 1 Stern Frame, Forged Iron or Steel
2 Stern Frame, Cast Steel
3 Brass Bushings for Gudgeons
4 Lignum Vitae
5 Discs for Lower Gudgeons
6 Spectacle Frame, Forged or Cast
7 Struts or Shaft Brackets
8 Steel Covering around Propeller Well
9 Stern Tubes
10 Zincs

Guards and Fenders

D 1 Plates or Shapes
2 Pitch or Cement Filling
3 Wood Filling
4 Pine or Hardwood Guards
5 Steel Chafing Strips
6 Fastening for Wood Guard
7 Collision Mats

Pickling Plates and Shapes

E 1 Muriatic Acid
2 Lime
3 Wire Brushes & Scrapers
4 Galvanizing
5 Miscellaneous Treatment of Material

F 1 Steel Rivets

Sundries

G 1 Templet Wood
2 Service Bolts
3 Soapstone, Chalk, Crayons
4 Tacks
5 Marking Pots, Paint, Marking Brushes
6 Red Lead, Putty, Etc.

GROUP III

Hull Fittings

A 1 Bitts, Incl. Woodbeds & Fastening
2 Chocks, Incl. Woodbeds & Fastening
3 Cleats, Incl. Woodbeds & Fastening
4 Dollies, Incl. Woodbeds & Fastening

Hull Fittings—Continued

A 5 Fairleads, Incl. Woodbeds & Fastening
6 Airports, in Hull & Deck Houses—Deck Lights—Fixed Lights
7 Steel Doors, W. T.
8 Steel Doors, Non W. T. & A. T.
9 Ladders, Steel or Wood
10 Accommodation Ladder & Platforms
11 Accommodation Ladder Davits, Sockets
12 Accommodation Ladder Block & Falls
13 Leadsman's Stool & Fittings
14 Side Light Boxes
15 Deck Scuttles
16 Manholes, Frames & Covers
17 Galley Smoke Pipe
18 Name Boards, Names Bow & Stern
19 Name Plates, Berth & Chair Numbers
20 Bow & Stern Ornaments
21 Sidelight Screens
22 Coal Chutes, Portable
23 Hawser & Rope Reels
24 Bridge Supports & Braces
25 Reel for Log Line
26 Fairlead for Log Line on Taffrail
28 Hose Davits, Oil
29 Hose Davits, Sockets
30 Hose Davits, Eyes & Pads
31 Hose Davits, Blocks & Falls
32 Sea Steps
33 Canvas Screens for Ladders
34 Grab Rails and Fittings
35 Sundry Pad Eyes, Ringbolts, etc.
36 Eye Brows over Airports, Doors, etc.
37 Draft Figures
38 Ash Chutes, Garbage Chute
39 Galley Coal Box, Metal Built in
40 Benches, Work, Metal
41 Bulletin Boards
42 Insulation, Non-Metallic
43 Brass Sills and Kick Plates
44 Builder's Name Plate
45 Cattle Stalls, Metal Work
46 Sea Connections
47 Dumb Waiters
48 Operating Gear for Doors
49 Jacob's Ladders
50 Light Box, Stern
51 Light Boxes, Running

GROUP IV—HATCHES, SKYLIGHTS, ETC.

Hatches, Cargo and Coal

A 1 Coamings, Steel or Wood & Fastening
2 Strong Beams, Steel or Wood & Fastening
3 Hatch Covers, Wood
4 Half Round for Cover Handles
5 Screws for Securing Same
6 Round Bar for Edge Bolting Covers
7 Lettering & Numbering
8 Battens, Cleats & Wedges
9 Ring Bolts
10 Cleats or Fairleads
11 Tarpaulins
12 Rubber Sheets for Cattle Boats
13 Hatch Davits

Hatches, O. T. or W. T.

B 1 Coamings
2 Strong Beams
3 Covers
4 Hinges
5 Hinge Pins, Bronze
6 Swing Bolts & Dogs
7 Gasket Strips & Screws
8 Gasket, Rubber, Hemp, Asbestos, Fibre or Canvas
9 Ring Bolts
10 Hasps, Eye
11 Padlocks
12 Air Pipe or Cock
13 Wire Gauze for Same
14 Device for Holding Cover Open

Companion and Booby Hatches

C 1 Coamings, Sides, Ends & Top Wood or Steel Fast.
2 Doors, Wood or Steel
3 Hinges, Locks, Hooks, Hasps
4 Treads
5 Lights, Fixed, Hinged or Sliding
6 Grab and Hand Rails

Skylights, Wood

D 1 Coamings
2 Covers
3 Sash & Glass
4 Protecting Rods & Frame
5 Quadrants
6 Hinges
7 Screens

Skylights, Steel

E 1 Coamings
2 Covers
3 Lights, Fixed or Hinged
4 Operating Gear Complete
5 Hinges
6 Stanchions for Keeping Covers in Position
7 Sockets for Stanchions
8 Clips & Toggle Pins for Same
9 Screens

Canopies

F 1 Frames, Brass, W. Iron or Pipe
2 Sockets for Same
3 Toggle or Taper Pins
4 Solder or Spelter
5 Pipe Fittings
6 Canvas Covers
7 Twine & Thread
8 Rawhide or Leather
9 Grommets
10 Beeswax
11 Rope or Cordage

Fidley Top and Cover

G 1 Top and Cover, Fidley

GROUP V

Ventilation

A 1 Cowls, Incl. Turning Gear
2 Vent Trunks
3 Air Ducts
4 Air Ducts, Flanges
5 Air Ducts, Gaskets
6 Bolts & Nuts

Ventilation—Continued

A 7 Hangers for Ducts
8 Elbows
9 Bell Mouth Terminals
10 Louvres
11 Butterfly Valves
12 Automatic Valves
13 Ventilating Fans, Portable
14 Blower Engine & Stationary Fans
15 Steam & Exhaust Piping
16 Valves for Same
17 Flanges & Fittings
18 Bolts, Hangers & Packing
19 Pipe Covering
20 Fan Casing
21 Rivets
22 Wood & Steel Seatings
23 Motors for Blowers
24 Conduit
25 Wiring
26 Windsails
27 Wings Canvas, for Cowls
28 Goosenecks
29 Mushroom Vents

GROUP VI—MASTS AND RIGGING

Masts and Fittings

A 1 Masts, Steel or Wood
2 Booms, Steel or Wood
3 Derricks, Steel or Wood
4 Yards, Steel or Wood
5 Bowsprit, Steel or Wood
6 Samson or King Posts
7 Chain Plates
8 Shackles
9 Links
10 Hearts or Dead Eyes
11 Turnbuckles
12 Bands
13 Cleats
14 Pad Eyes
15 Belaying Pins, Pin Rails, Wood or Steel
16 Jack Stays
17 Mast Hoops
18 Trucks
19 Bumpkins
20 Outriggers
21 Martingale
22 Parrels
23 Fairleads for Braces through Bulwarks
24 Brace Block Supporters on Rail
25 Goosenecks
26 Boom Irons
27 Swivels
28 Hooks
29 Boom Rests
30 Stowage for Spare Booms or Yards
31 Fife Rail
32 Sheet Traveler
33 Mast Coats
34 Mast Wedging
35 Nippers for Lines on Main Rail
36 Mast Tables
37 Crows Nests
38 Ensign & Jack Staffs & Sockets
39 Slide Tracks

Masts and Fittings—Continued

A 40 Mast Steps

Rigging

B 1 Shrouds
2 Stays
3 Ratlines, Wood, Pipe, Steel or Rope
4 Sheerpoles
5 Brass Caps for Shrouds & Stays
6 Thimbles
7 Clews
8 Sheeting
9 Marline
10 Roundline
11 House Line
12 Seizing Wire
13 Paint
14 Halyards
15 Lifts, Chain & Wire Rope
16 Sheets
17 Braces
18 Buntlines
19 Clew Lines
20 Downhauls
21 Blocks
22 Brace & Lead Blocks for Braces & Sheets
23 Tacks, (Rope) for Jibs & Stay Sails
24 Cargo Falls
25 Funnel Guys
26 Hawsers
27 Heaving Lines
28 Mooring Lines
29 Rope Ladders
30 Coaling Slings
31 Tow Lines

GROUP VII—CANVAS WORK

Sails

A 1 Flying Jib
2 Outer Jib
3 Inner Jib
4 Fore Stay Sail
5 Fore Sail
6 Main Sail
7 Crossjack
8 Fore, Main & Mizzen, Lower Topsails
9 Fore, Main & Mizzen, Upper Topsails
10 Fore, Main & Mizzen, Lower Topgallant Sails
11 Fore, Main & Mizzen, Upper Topgallant Sails
12 Fore, Main & Mizzen, Royals
13 Fore, Main & Mizzen, Skysails
14 Main Staysail
15 Main Topmast Staysail
16 Main Topgallant Staysail
17 Mizzen Staysail
18 Mizzen Topmast Staysail
19 Mizzen Topgallant Staysail
20 Spanker
21 Gaff Topsail
22 Studding Sail
23 Trysail

Covers

B 1 Sail Covers
2 Binnacles
3 Telegraph
4 Capstan

Covers—Continued

B 5 Winch
6 Windlass
7 Log Rail
8 Hawser Reel
9 Rope Reel
10 Mast
11 Smoke Stack
12 Ventilator
13 Steering Wheel
14 Shelter Tents for Hatches
15 Searchlight

Awnings, Etc.

C 1 Awnings
2 Weather Cloths
3 Awning Stanchions, Braces & Rails
4 Awning Stanchions & Sockets
5 Awning Stanchions & Rail Fittings
6 Awning Ridges
7 Awning Ridge Ropes
8 Awning Jack Stays
9 Awning Jack Stay Eyes
10 Awning Rails, Wire or Rope Netting
11 Canvas Weather Screws
12 Coaling Screens
13 Coal Bags

D 1 Canvas Covering for Decks

GROUP VIII—WOODWORK

Decks, Caulked

A 1 Pine, Cedar or Teak
2 Pine or Cedar Sheathing on Same
3 Deck Bolts & Nuts
4 Grommets & Plugs
5 Oakum or Caulking Cotton
6 Pitch, Marine Glue, Putty
7 Tar Paper, or Felt, Betw. Sheathing
8 Nails or Spikes for Sheathing
9 Tar or Pitch Betw. Sheathing
10 Gang Planks

Decks, T. and G.

B 1 Cedar or Pine T. & G.
2 Canvas & Felt
3 Nails
4 Galv. or Copper Tacks

Bulkheads, T. and G.

C 1 T. & G. Single or Double Thickness
2 Pine Sills, Plates & Studs
3 Tar Paper
4 Nails, Brads, etc.

Houses, Main Framing

D 1 Coamings
2 Plates
3 Studs
4 Bracing
5 Carlines
6 Holding Down Rods & Washers
7 Bolts & Nuts for Scarphs
8 Wood Stanchions, Plain & Ornamental
9 Knees or Brackets, Plain & Ornamental
10 Steel Knees or Brackets
11 Nails
12 Carving, "Certified to Accommodate," etc.

Houses, Sheathing, Inside and Outside.

E 1 T. & G. or Shiplap
2 Panels & Pilasters
3 Frieze
4 Cornice
5 Moldings & Decorative Castings
6 Glue, Wedging & Fastening

Doors, Wood

F 1 Doors, Hinged, Swing, Sliding or Slat
2 Locks
3 Hinges
4 Hooks & Stops
5 Checks
6 Treads, Wood, Brass Lead, Universal or Mason
7 Screws, Escutcheon Pins
8 Sheaves for Sliding Doors
9 Track for Sliding Doors
10 Screen Doors
11 Doors, Wire Mesh
12 Wood Foundations

Windows and Blinds

G 1 Sash, Pine or Hardwood
2 Glass Sheet, Plate, Ground or Art
3 Pockets, Canvas or Lead
4 Drains from Pockets
5 Sash Pulleys or Springs
6 Sash Cord or Chain
7 Sash Weights, Iron or Lead
8 Sash Lifts
9 Sash Fasteners
10 Window Screens
11 Sash Stops
12 Sash Rollers
13 Sash Centering Pins for Dome Ventilation Sash
14 Sash Adjusters for Dome Ventilation, Sash
15 Sash Pulls with Handles, Dome Ventilating Sash
16 Sash Rack for Ventilating Blinds
17 Putty or Molding for Glass
18 Glazing Points
19 Visor Pilot House

Stairways, Wood

H 1 Strings, Treads, Risers, Pine or Hardwood
2 Treads, Lead, Brass, Rubber, Galv. Iron, etc.
3 Screws & Escutcheon Pins
4 Newel Posts
5 Balustrades
6 Handrails, Brass or Hardwood
7 Handrails, Brackets
8 Bolts & Nuts
9 Nails
10 Glue & Wedging
11 Canvas Lining

Ceiling, Hold-Bunker, Chain Locker

I 1 Spar Ceiling
2 Spar Ceiling, Clips & Bolts
3 Close Ceiling
4 Bar Steel Edge Fastening for Limbers
5 Half Round for Handles for Limbers
6 Screws or Bolts for Same
7 Shifting Boards in Holds
8 Clips or Bolts for Same
9 Chain Lockers if Wood
10 Fastening for Same
11 Boring for Pipes, Valve Stems, etc.

Ceiling, Hold-Bunker, Chain Locker—Continued

A 12 Air Boxes and Sounding Pipes, Wood
13 Cargo Battens
14 Insulation
15 Dumping Boards

Bridges, Wood

J 1 Flying Bridge
2 Navigating Bridge
3 Fore and Aft Bridges
4 Forward Bridge
5 After Bridge

K 1 Gratings

L 1 Bulwarks, Wood

M 1 Cattle Stalls, Wood

GROUP IX—FURNITURE

Captain's or Owner's Staterooms & Bridal Chamber

A 1 Berth with Drawers, or Bedstead, Single or Double
2 Wire Mattress
3 Transom with Drawers
4 Chair
5 Desk
6 Table
7 Toilet Rack with Mirror
8 Washstand, if Wood
9 Folding Lavatory or Toilet Set
10 Safe
11 Wardrobe
12 Towel Rack
13 Coat & Hat Hooks
14 Folding Head Board Rack
15 Life Preserver Rack
16 Lamps—Oil

Chief Engineer, First Officer and Purser

B 1 Berth with Drawers or Pullman
2 Mattress, Wire
3 Transom with Drawers
4 Chair or Stool
5 Desk
6 Toilet Rack & Mirror
7 Washstand, if Wood
8 Folding Lavatory or Toilet Set
9 Wardrobe or Clothes Locker
10 Towel Rack
11 Head Board Rack
12 Coat & Hat Hooks
13 Safe
14 Lamps—Oil
15 Life Preserver Rack

Staterooms

C 1 Berths with Drawers
2 Berths, Plain
3 Berths, Pipe
4 Wire Mattresses
5 Transoms with Drawers or Plain
6 Toilet Rack & Mirror
7 Washstand, if Wood
8 Clothes Lockers, Wood or Metal
9 Folding Lavatory or Toilet Set
10 Towel Rack
11 Head Board Rack
12 Coat & Hat Hooks

Staterooms—Continued

C 13 Life Preserver Racks
14 Lamps—Oil

Crew's Quarters

D 1 Berths, Plain
2 Berths, Metal, Single or Stands
3 Lockers, Metal, Wire or Wood
4 Mess Tables
5 Benches
6 Washstands, if Wood.
7 Coat & Hat Hooks
8 Life Preserver Racks
9 Dish Racks & Lockers
10 Mirrors
11 Lamps—Oil
12 Ditty Boxes & Racks
13 Spit Boxes

Dining Saloon

E 1 Table
2 Table Racks
3 Chairs
4 Serving Table
5 Side Board
6 Coat & Hat Hooks
7 Mirrors
8 Lamps—Oil

Social Hall

F 1 Musical Instruments
2 Music Lockers & Racks
3 Transoms
4 Tables
5 Chairs
6 Mirrors
7 Lamps, Oil

Smoking Room

F1 1 Transoms
2 Tables
3 Chairs
4 Mirrors
5 Cuspidors
6 Lamps, Oil

Bar Room

G 1 Bar or Counter
2 Back Door
3 Mirror
4 Lockers Under Back Bar
5 Shelving & Lockers Under Bar
6 Drain Board for Sink
7 Brass Foot Rail
8 Towel Holders
9 Marble Base or Front
10 Coat & Hat Hooks
11 Roller Curtain or Folding Lattice
12 Grill Work
13 Sign Board
14 Rubber Mats
15 Wood Gratings
16 Lamps, Oil

Boot Black Stand

H 1 Stand
2 Drawers Under Stand
3 Brass or Lead Treads
4 Hand Rail
5 Chairs

Boot Black Stand—Continued

H 6 Hooks for Brushes
7 Foot Rests
8 Mirror
9 Drawer Locks
10 Lamp, Oil

Passenger Accommodations

I 1 Wood Berths
2 Metal Berths, Single or Standees
3 Wood Standees
4 Toilet Racks & Mirrors
5 Folding Lavatory
6 Folding Head Board Racks
7 Stools or Chairs
8 Ladder to Top Berth
9 Transoms
10 Wash Stand, if Wood
11 Steerage Qtrs., Mess Tables
12 Steerage Qtrs., Mess Racks (Table)
13 Steerage Qtrs., Benches
14 Steerage Qtrs., Dish Lockers
15 Life Preserver Racks
16 Lamps, Oil

Pantry & Galley

J 1 Refrigerator, Portable
2 Serving Table
3 Drain Board
4 Lockers & Drawers
5 Cup Hooks
6 Plate & Dish Racks
7 Racks for Urns
8 Dressers with Drawers or Lockers

Butcher Shop

K 1 Meat Block
2 Bench or Work Table
3 Meat Hooks
4 Rods for Meat Hooks

Barber Shop

L 1 Chairs, Barber & Ordinary
2 Mirrors
3 Dresser
4 Lockers
5 Coat & Hat Hooks
6 Waste Basket
7 Lamps, Oil

Hospital

M 1 Berths or Beds
2 Operating Table
3 Dressing Table
4 Instrument Case
5 Medicine Locker
6 Shelving
7 Bottle Racks
8 Chairs
9 Dental Outfit

Bath Room

N 1 Mirror
2 Towel Racks

O 1 Work Benches

Laundry

P 1 Washing Machines
2 Fittings

Store Rooms

Q 1 Racks
2 Shelves
3 Lockers

GROUP X

Upholstery

A 1 Carpets
2 Rugs
3 Transoms Seats & Backs
4 Chair Seats & Backs
5 Linoleum, except for Deck Covering
6 Curtains, Berths, Port & Door
7 Curtain Rods & Fixtures
8 Shades, Car Type
9 Covers for Upholstery
10 Wood Frames for Upholstery

GROUP XI—REFRIGERATING PLANT

Cold Storage Chambers

A 1 Sills, Plates, Studs
2 Tongue & Groove
3 Tar Paper
4 Sheet or Granulated Cork
5 Mineral Wool
6 Saw Dust or Charcoal
7 Mastic Covering
8 Sheet Lead
9 Sheet Zinc
10 Galv. Iron
11 Drain Pipes
12 Meat Hooks
13 Hangers
14 Fastening
15 Door Hardware

Cold Storage Machinery

B 1 Refrigerating Machine
2 Brine or Ammonia Tanks
3 Pipe Coils
4 Hangers for Coils
5 Valves
6 Flanges
7 Bolts & Nuts
8 Gaskets
9 Pipe Covering
10 Pipe Fittings
11 Steam & Exhaust Piping
12 Tank Seatings, Wood or Steel
13 Brine Pumps
14 Pump Seatings
15 Ice Making Tank
16 Scuttle Butt

GROUP XII

Steam Heating

A 1 Reducing Valve
2 Radiators, Cast Iron
3 Radiators, Pipe
4 Guards, Brass or Grill
5 Tops, Marble or Slate

Steam Heating—Continued

A 6 Air Valves
7 Steam Valves
8 Exhaust Valves
9 Asbestos Backs
10 Pipe Covering
11 Deck or Bhd. Stuffing Boxes, Pipe
12 Pipes, Steam & Exhaust
13 Fittings
14 Hangers
15 Flanges
16 Bolts & Nuts
17 Gaskets
18 Relief Valve
19 Steam Trap

GROUP XIII—PLUMBING

Sanitary System

A 1 Sanitary Tanks
2 Sanitary Tanks, Seatings
3 Fresh Water Tanks
4 Fresh Water Tanks, Seatings
5 Filling, Suction, Air & Overflow Piping
6 Fittings for Same
7 Flanges, Deck & Bhd. Stuffing Boxes
8 Hangers, Gaskets, Bolts & Nuts
9 Bath Tubs
10 Bath Heaters
11 Showers
12 Toilets
13 Flush Valves
14 Bases for Toilets, C. I.
15 Urinals
16 Urinal Traps
17 Marble Partitions for Urinals & Toilets
18 Brass or N. P. Top Rail for Same
19 Corner Connections for Same
20 Legs
21 Lead Lining for Floors or Bhds.
22 Lavatories
23 Sinks
24 Drinking Fountains
25 Cups, Chained
26 Grab Rails, Toilet, Bath & Urinals
27 Faucets
28 Soap Dishes, Sponge Holders, etc.
29 Soil Pipes
30 Traps, Lead or Brass
31 Dk. & Bhd. Flanges
32 Valves
33 Piping to Basins, Baths, Toilets, Urinals
34 Fittings
35 Deck Hose
36 Steam Heaters for Plumbing Fixtures
37 Steam Heaters

Fire System

B 1 Fire Mains
2 Smothering Pipes
3 Valves, Hydrants and Manifolds
4 Flanges & Fittings
5 Hangers, Bolts, Nuts & Gaskets
6 Hose Boxes on a Rack
7 Hose Fire
8 Fire Extinguishers
9 Fire Axes

Fire System—Continued

B 10 Fire Brackets
11 Hand Fire Pump
12 Stands for Fire Nozzles

Drainage, Bilge & Scuppers

C 1 Manifolds
2 Strainer Boxes
3 Sluice Gates
4 Sluice Gate Stems & Deck Plates
5 Bulkhead Flanges & Stuffing Boxes
6 Piping
7 Fittings
8 Valves
9 Gaskets
10 Hangers, Bolts & Nuts
11 Valve Operating Gear
12 Hand Pumps
13 Lead or Galv. Pipe for Scuppers.
14 Deck Fittings & Gratings
15 Clean Out Plugs
16 Clack or Non. Ret. Valves
17 Discharge Nozzles or Lips
18 Special Fittings for Scuppers
19 Flanges & Fittings
20 Hangers, Bolts, Nuts
21 Galv. or Copper Tacks, for Lead Scuppers
22 Gaskets
23 White or Red Lead
24 Bleeder Plugs
25 Sea Connection
26 Scuppers

Ballast System

D 1 Manifold
2 Strainers, McComb
3 Bhd. Flanges or Stuffing Boxes
4 Expansion Joints
5 Nozzles, Tank Top
5 Piping
7 Flanges & Fittings
8 Valves
9 Hangers, Bolts, Nuts
10 Gaskets
11 Valve Operating Gear
12 Air & Sounding Pipes
13 A. & S. Pipes, Deck Plates & Fittings
14 A. & S. Pipes, Flanges & Fittings
15 A. & S. Pipes, Hangers, Bolts, Nuts.
16 A. & S. Pipes, Gaskets
17 Flood Valves

GROUP XV

Oil Piping (Tank Ships Only)

A 1 Oil
2 Steam & Exhaust Pipe to Pumps
3 Oil Pipe
4 Metallic Hose
5 Metallic Hose Rack
6 Metallic Hose Couplings
7 Stuffing Boxes, Deck or Bhd.
8 Valves
9 Flanges
10 Fittings
11 Strainers

Oil Piping (Tank Ships Only)—Continued

A 12 Special Fittings
13 Hangers & Saddles
14 Bolts & Nuts
15 Gaskets
16 Covering for Steam Pipes

GROUP XVI

Anchor Gear

A 1 Windlass
2 Piping
3 Valves
4 Deck Stuffing Boxes
5 Hangers
6 Bolts & Nuts
7 Gaskets
8 Anchor Crane
9 Anchor Crane Sockets & Bearings
10 Anchor Crane Guys
11 Anchor Crane Blocks
12 Anchor Crane Falls
13 Anchor Crane Trip Hook
14 Hawse Pipes
15 Hawse Pipe Deck Flanges
16 Hawse Pipe Bucklers
17 Chain Pipes
18 Chain Pipe Covers
19 Chain Stoppers
20 Devil's Claws
21 Anchor Chains or Cable
22 Anchors
23 Tripping Gear
24 Ring Bolts & Shackles in Chain Locker
25 Wood Bed for Windlass
26 Wood Bed for Chain Stoppers (or Steel)
27 Wood Bed, Anchor Stowage (or Steel)
28 Bolts & Nuts
29 Cat Heads
30 Sheaves for Same
31 Cleats & Fairleads on Same
32 Shank Painter
33 Tripping Gear on Cat Head
34 Filling Under Deck for Cat Head
35 Filling Under Deck for Windlass
36 Plates & Shapes under Deck for Windlass
37 Filling under Deck for Stoppers
38 Plates, etc., under Deck for Stoppers
39 Anchor Chain Wearing Plates
40 Anchor Buoys

GROUP XVII

Deck Machinery

A 1 Cargo Winches
2 Capstans
3 Towing Machine
4 Freight Elevators
5 Passenger Elevators
6 Piping, Steam & Exhaust
7 Valves
8 Flanges & Fittings
9 Hangers
10 Stuffing Boxes, Deck & Bhd.
11 Pipe Covering

Deck Machinery—Continued

A 12 Elevator Sheaves
13 Elevator Guides
14 Elevator Wire Rope
15 Bolts & Nuts
16 Wood Beds
17 Filling under Deck
18 Plates & Shapes under Deck
19 Plates & Shapes, Steel Seatings
20 Rivets & Tap Bolts
21 Capstan Hand
22 Winches Hand
23 Winch & Capstan Foundations

GROUP XVIII

Steering Gear

A 1 Steering Wheel
2 Steering Stand
3 Leads, Wire, Rope, Rod or Chain
4 Fairleads for Same
5 Spring Buffers
6 Beds or Supports for Same
7 Quadrant or Yoke
8 Crosshead
9 Tiller, Relieving & Tackle
10 Rudder Bearer
11 Rudder & Stock
12 Pintles
13 Sleeves for Pintles
14 Deflecting Blocks
15 Quarter Blocks
16 Sheaves & Fairleads
17 Steering Engine
18 Shafting for Control Valve
19 Universal Joint Couplings
20 Deck or Bhd. Stuffing Boxes
21 Gears
22 Hangers & Bearings for Shafting
23 Telemotor
24 Telltale
25 Steering Telegraph
26 Stuffing Boxes Rudder
27 Zincs

GROUP XIX

Boats, Boat Gear, Etc.

A 1 Boats with Outfit
2 Rafts with Outfit
3 Chocks
4 Davits
5 Davit Sockets & Bearings
6 Davit Span Lugs
7 Cleats
8 Guys & Spans
9 Skids & Platforms
10 Gripes
11 Covers, Ridge Poles, Spreaders
12 Blocks
13 Falls
14 Releasing Hooks
15 Awning & Canopies
16 Boat Crane Foundations
17 Boat Crane Machinery

Boats, Boat Gear, Etc.—Continued

A 18 Boat Booms
19 Stoppers

GROUP XX

Equipment

A 1 Boat Compass
2 Life Lines & Preservers
3 Life Rings
4 Sextants
5 Chart Weights
6 Chronometer
7 Clinometer
8 Black Balls
9 Ruby Lamps
10 Compass, Standard, Compensating, Liquid, or Card
11 Binnacle, Standard, Compensating or Wood
12 Pelorus & Stand
13 Flags
14 Charts
15 Instruments, Drawing
16 Ship Log and Line
17 Submarine Signal
18 Ship's Bell, Bracket
19 Fog Horn
20 Hand Lead Line
21 Sea Drags
22 Lyle Gun Line
23 Binoculars
24 Night Glasses
25 Aneroid Barometers
26 Clocks
27 Telescope
28 Thermometers
29 Megaphone
30 Log Glasses
31 Log Slates
32 Log Books
33 Sounding Machine
34 Deviation Cards
35 Bridge Boxes
36 Powder & Rocket Boxes
37 Nautical Almanac
38 Parallel Ruler
39 Lights, Masthead, Running, Riding, Towing, Side, Anchor (If Oil) (If Electric See Group 21)

GROUP XXI

Electric Light Plant

A 1 Generators & Engines
2 Steam & Exhaust Piping
3 Valves & Fittings
4 Bolts, Nuts, Hangers & Gaskets
5 Wood Beds for Generators
6 Marble or Slate for Switch Board
7 Angle Steel Frame
8 Volt Meters
9 Ammeters
10 Switches
11 Pilot Lights
12 Rheostats
13 Ground Detectors
14 Marble or Slate for Distributing Panel

Electric Light Plant—Continued

A 15 Hardwood Case for Distributing Panel
16 Glass, Hardware for Distributing Panel
17 Slate Lining for Distributing Panel Case
18 Fused Switches
19 Search Light
20 Search Light Rheostat
21 Lights, Running, Anchor, Signal, Masthead, etc. (if Elec.)
22 Lamps
23 Receptacles
24 Mounted Fuses
25 Fixtures
26 Conduit
27 Junction Boxes
28 Molding & Capping
29 Screws for Same
30 Cable
31 Wire
32 Portables
33 Cargo Clusters
34 Drain Pans under Generators
35 Insulators, Porcelain, Rubber
36 Name Plates

B 1 Wireless Telegraph

GROUP XXII

Interior Communication

A 1 Voice Pipes, Brass Tubing
2 Mouth Pieces
3 Flexible Tubing
4 Call Bells
5 Annunciators
6 Engine Telegraphs
7 Wire
8 Chain
9 Fairleads
10 Dials in Eng. Room
11 Gong
12 Jingles
13 Bell Pulls
14 Return from Gong to Pilot House (Brass Tubing)
15 Wiring for Call Bells
16 Conduit or Molding for Same
17 Battery for Call Bells
18 Telephones
19 Messenger to Poop & Foc's'l. from Bridge

GROUP XXIII

Cement, Tiling, Linoleum, Etc.

A 1 Cement or Concrete
Double Bottom
Bilges
Peaks
Deck Chocks
Floor Covering
2 Tiling
3 Asbestolith
4 Bitumastic
5 Linoleum & End Strips
6 Arrow Lock Tiling
7 Cork Tiling
8 Bricks
9 Mats & Matting

GROUP XXIV

Paint and Polishing

A 1 Painting
2 Polishing
3 Gilding
4 Stenciling all Articles of Outfit & Equipment
5 Cork Paint
6 Creosoting
7 Oil Tanks & Fittings

GROUP XXV—STEWARD'S OUTFIT

Galley and Cook's

A 1 Range with Racks
2 Steam Tables
3 Hot Water Urns
4 Coffee Urns
5 Steam Cooker
6 Copper Boiler & Steamer
7 Coal Box
8 Sauce Pans
9 Large Iron Kettles
10 Baking Tins
11 Soup Ladles
12 Galv. Boilers & Steamers
13 Meat Saw
14 Tormentors
15 Potato Steamer
16 Potato Masher
17 Salt Water Pump
18 Coir Mats
19 Coffee Boiler
20 Shovels, Large & Small
21 Pokers
22 Gridirons
23 Knives, Black Handle
24 Forks, Black Handle
25 Axe, Large
26 Tea Kettles
27 Coffee Mills
28 Mess Kits
29 Iron Ladles
30 Forks, Large Cook's
31 Knives, Large Cook's
32 Toasting Forks
33 Copper Tea Kettles
34 Gravy Spoons
35 Collander
36 Grater
37 Fish Pans, Tin
38 Steel
39 Stew Pans
40 Flour Cask
41 Sea Pie, 8 Gal., Oval
42 Cleaver
43 Egg Pan
44 Iron Pan
45 Rake
46 Provision Knife
47 Fire Brush
48 Chimney Brushes
49 Stove Lifters
50 Sets of Skewers
51 Cook's Pails, Galv.
52 Pepper Box
53 Flour Dredger
54 Meat Mincer

Galley and Cook's—Continued

A 55 Pudding Pans
56 Paste Roller
57 Dust Pans
58 Flour Scoops
59 Black Lead Brushes
60 Sweeping Brushes
61 Oblong Cast Iron Pots
62 Flue Brush
63 Water Cans
64 Dippers
65 Sauce Pans
66 Fish Kettles
67 Tin Opener
68 Beef Press
69 Pea Soup Masher
70 Stock Bucket
71 Stock Pot
72 Omelette Pans
73 Glaze Pot & Brush
74 Basket Ladle
75 Frying Basket
76 Salt Box
77 White Gravy Strainer
78 Grill Tins
79 Jelly Bag
80 Knives, French, Butcher, Mincing, Oyster, Potato, & Palette
81 Bill of Fare Frame
82 Pie Pans
83 Steak Tongs
84 Stove Tins
85 Mush Whisks
86 Cutlet Bat
87 Vegetable Cutters
88 Vegetable Scoops
89 Brawn Molds
90 Tongue Press
91 Pepper Dredgers
92 Hot Pot Tins
93 Plate Carriers
94 Bread Graters
95 Trussing Needles
96 Larding
97 Egg Slicer
98 Fish Slicer
99 Spoons, Iron & Wood
100 Butter Spades
101 Poultry Choppers
102 Ice Picks
103 Jugs
104 Lemon Squeezers
105 Slop Receivers
106 Milk Cans
107 Steam Egg Boiler
108 Potato Peeler

Cabin Stores

B 1 Sugar Boxes
2 Candle Boxes
3 Coffee Cannisters
4 Tea Cannisters
5 Candlesticks Brass
6 Bread Baskets
7 Large Waiters
8 Small Waiters
9 Wash Basins, Galv.
10 Corn Brooms

Cabin Stores—Continued

B 11 Cork Screws
12 Bread Trays
13 Blacking Brushes
14 Hand Scrubbing Brushes
15 Dust Pans
16 Water Filter
17 Medicine Chest
18 Brushes, Small
19 Revolver & Case
20 Cartridges
21 Spring Table Bell
22 Dinner Bell
23 Set of Scales with Scoops
24 Mats for Dishes
25 Can Openers
26 Mouse & Rat Traps
27 Water Cans
28 Slop Buckets
29 Funnels
30 Set of Tin Measures
31 Steel Yard, to Weigh up to —— lbs.
32 Smoothing Iron Set
33 Platform Scales with Scoops, to Weigh up to —— lbs.

Cutlery and Plated Ware

C 1 Ship's Name & House Flag Engraved on Each Article
2 Dinner Knives
3 Dessert Knives
4 Carvers
5 Steels
6 Bread Knives
7 Tea Pots
8 Fruit Knives
9 Coffee Pots
10 Dinner Forks
11 Dessert Forks
12 Table Spoons
13 Tea Spoons
14 Dessert Spoons
15 Cruet Stands
16 Nut Crackers
17 Nut Picks
18 Water Pitchers
19 Pickle Forks
20 Pepper Boxes
21 Salt Cellars
22 Fish Knives
23 Fish Forks
24 Toast Racks
25 Sugar Basins
26 Sugar Tongs
27 Cream Ewers
28 Salt Spoons
29 Butter Knives
30 Soup Tureens & Ladles
31 Dish Covers
32 Salt Spoons
33 Mustard Spoons
34 Waiters
35 Cake Baskets
36 Cork Screws
37 Butter Dishes
38 Asparagus Tongs
39 Finger Bowls
40 Syrup Jugs

Cutlery and Plated Ware—Continued

C 41 Sugar Sifters
42 Sardine Tongs
43 Butter Coolers
44 Cheese Scoops
45 Salad Forks & Spoons (Wood)

Crockery and Glass

D 1 Dinner Plates
2 Dessert Plates
3 Soup Plates
4 Tea Plates
5 Bread Plates
6 Fruit Plates
7 Oval Meat Plates
8 Oval Fish Plates
9 Small Butter Plates
10 Breakfast Cups & Saucers
11 After Dinner Cups & Saucers
12 Tea Cups & Saucers
13 Coffee Mugs
14 Oval Cover Vegetable Dishes
15 Butter Dishes
16 Black Coffee Cups & Saucers
17 Ice Cream Dishes
18 Bouillon Mugs
19 Water Pitchers, Large & Small
20 Sauce Bowls & Ladles
21 Gravy Bowls & Ladles
22 Sugar Bowls
23 Milk Pitchers
24 Salt Cellars—Glass
25 Tumblers
26 Wine Glasses
27 Champagne Glasses
28 Decanters
29 Chambers
30 Pickle Dishes
31 Cheese Dishes
32 Center Fruit Dishes
33 Center Salad Dishes
34 Egg Cups
35 Finger Bowls
36 Olive Dishes
37 Center Flower Stand
38 Syrup Jugs, Glass
39 Cream Jugs
40 Pepper Bottles
41 Mustard Pots
42 Vinegar Glass Decanters
43 Oil Glass Decanters
44 Celery Glasses
45 Soda Glasses
46 Bed Room Tumblers
47 Jardinieres

Bakery Outfit

E 1 Biscuit Tubes
2 Biscuit Forcer
3 Apple Corer
4 Bread Rasp
5 Galv. Bucket
6 Buckwheat Jug
7 Cake Hoops
8 Corn Bread Tins
9 Dough Knife
10 Scraper
11 Sugar Dredger
12 Flour Dredger

Bakery Outfit—Continued

E 13 Flour Scoops
14 Tin Opener
15 Casserole Molds
16 Jelly Molds
17 Pudding Molds
18 Muffin Rings
19 Bread Grater
20 Nutmeg Grater
21 Barm Can
22 Palette Knife
23 Cutlet Paste Cutters
24 Paste Brushes
25 Rolling Pins
26 Scales ¼ oz. to 14 lbs.
27 Flour Sieve
28 Spice Boxes
29 Bread Tins
30 French Roll Tins
31 Open Tart Tins
32 Patty Tins
33 Rice Pudding Tins
34 Roll Tins
35 Sandwich Bread Tins with Lids
36 Sponge Cake Frames
37 Water Can
38 Egg Whisks
39 Icing Pipes
40 Icing Bags
41 Enamel Whisking Bowl
42 Patent Egg Whisk
43 Egg Basket
44 Suet Machine
45 Bread Knife
46 Bread Sheets
47 Bread Prover, Galv., Say abt. 6′ x 2′—5″ with Copper Steam Pipe
48 Dough Mixer

Linen, Bedding, Etc.

F 1 Sheets, 2 pairs per berth
2 Blankets, 1 pair per berth
3 Bed Spreads, One per Berth
4 Pillow Cases, Two per Pillow
5 Pillows, Two per Berth
6 Mattresses, One per Berth
7 Mattresses, Covers One per Berth
8 Table Cloths, Three per Table
9 Napkins
10 Glass Cloths
11 Towels, Pantry
Towels, Passenger, Four per Passenger
Towels, Officers, Four per Officer
Towels, Lavatory

General Stores

G 1 Spring Balance
2 Scales & Weights
3 Handy Billy
4 Brooms
5 Brushes, Bannister
6 Brushes & Dustpans
7 Show Brushes
8 Buckets
9 Mops
10 Cuspidors
11 Dinner Bell

General Stores—Continued

G 12 Cork Screws
13 Knife Board
14 Table Gong
15 Deck Chairs
16 Wicker Chairs
17 Blotting Pads
18 Bibles, etc.
19 Chess Men
20 Library Books
21 Printing Press
22 Clothes Lines

GROUP XXVI—STORES

Carpenter's Stores

A 1 Pitch Pot & Ladle
2 Grindstone & Trough
3 Mallet, Caulking
4 Caulking Irons
5 Cold Chisels
6 Wood Chisels
7 Hand Saw
8 Cross Cut Saw
9 Augers
10 Bitts
11 Brace
12 Planes
13 Adze
14 Axe
15 Mallet
16 Hammers, Hand
17 Hammers, Riveting
18 Sledge
19 Screw Drivers
20 Wrenches, Spanner
21 Wrenches, Monkey
22 Wrenches, Air Port
23 Wrenches, W. T. Door or Hatch
24 Wrenches, Cargo Port
25 Tin Oil Feeders
26 Water Funnels
27 Copper Funnels
28 Hand Pump, Tin or Galv. Iron
29 Spare Hatch Wedges
30 Spare Capstan Bars & Rack
31 Propeller Notice Boards
32 Smoking Notice Boards
33 No Admittance Notice Boards
34 Passengers Not Allowed Abaft This, Notice Board
35 Passengers Not Allowed on Bridge, Notice Board
36 Steerage Passenger, Notice Boards
37 Instructions for Adjusting Life Preservers
38 Rail Straightener
39 Sounding Rods
40 Flexible Sounding Rods
41 Gimlets
42 Oil Stone
43 Pump Hook, Jointed
44 Chain Punches
45 Ring Spanners for Bunker Plates
46 Ring Spanners for Sounding Plugs

Boatswain's Stores

B 1 Tackle, Watch
2 Tackle, Relieving
3 Tackle, Luff
4 Spare Blocks, Assorted

Boatswain's Stores—Continued

B 5 Spare Sheaves for Blocks
6 Snatch Blocks
7 Cargo Gins
8 Deck Scrubbers
9 Wood Fenders with Lanyards
10 Cork Fenders with Lanyards
11 Marline Spikes
12 Crow Bars
13 Chain Hooks
14 Chain Slings
15 Hair Crate Hooks
16 Screw Shackles
17 Pairs of Grip Hooks
18 Pairs of Case Hooks
19 Coir Brooms & Handles
20 Mops
21 Ballast Shovels
22 Scrapers, File & Triangular
23 Painter's Falls
24 Painter's Planks
25 Boatswain's Chairs
26 Pilot Ladder
27 Bath Bricks
28 Hand Spikes
29 Paint Scrubbers
30 Hand Cuffs
31 Branding Irons

Boatswain's Stores—Continued

B 32 Paint Brushes, Assorted
33 Paint Pots
34 Squeegees
35 Scraping Box Tins
36 Sewing Palms
37 Sewing Needles
38 Beam Clamps
39 White Wash Brushes
40 Cotton Twine
41 Hemp Seaming Twine
42 Hemp Spun Yarn
43 Seizing Wire
44 Ratline
45 Heaving Lines
46 Set of Tin Measures
47 Wheel Barrows

Cooper's Stores

C 1 Steep Tubs
2 Draw Buckets
3 Oak Water Funnels
4 Boat Breakers
5 Water Pails
6 Oval Breakers
7 Harness Casks
8 Tar Buckets

PLANNING AND ESTIMATING

A TREATISE

DESCRIBING AND ILLUSTRATING

PLANT MANAGEMENT, ESTIMATING, JOB ORDERS, ORDERING MATERIAL AND RECORDING DATA

AS APPLIED TO

A

MODERN SHIPYARD

TOGETHER WITH

YARD AND SHOP LAYOUTS OF EXISTING SHIPYARDS AND LISTS OF THE EQUIPMENT CONTAINED IN EACH

BY

STEPHEN M. PHILLIPS

Foreword

This section is intended for the use of all persons interested in the supervision of work in a modern shipyard.

The greatest problem of the shipbuilder today is that of building ships economically and the future of a great many yards is absolutely dependent upon the manner in which this problem is solved.

During the war the greatest pressure was brought to bear on the shipbuilders to produce tremendous quantities of tonnage in the shortest possible time. Ships were vitally necessary for the successful carrying on of the war and time was of paramount importance, the cost involved being a secondary consideration. Great progress has been made in plant management and many short cuts have been found for quicker production of ships. Today marks the period of the greatest development in shipbuilding in the history of this country. With the coming of peace the cost of production once more becomes a determining factor and competition has become sharper. Efficiency is the watchword of the day. This means a demand for greater alertness, aggressiveness and capacity on the part of the shipbuilder.

Under these conditions the scientific management of the shipyard plant, with a view of securing the greatest possible production as a means of reducing the cost, will be looked to as the best means for accomplishing the desired results.

There are four important factors in the operation of a shipyard upon which the output is dependent. They are the System under which it is operated, the Personnel, the Plant Layout and the Equipment with which it is outfitted.

A systematic method of doing business, desirable in any enterprise, is absolutely essential in a shipyard where it is necessary to coordinate the activities of so many distinctively different branches of endeavor. Under a good system the work in a yard is handled economically and completed with dispatch, each operation being performed in its natural sequence without confusion or delay after which it is passed on to make way for that following.

The quality of the work done depends to a great extent upon the skill and experience of the persons doing it. A force of skilled and experienced artisans is essential to a shipyard because it is competent to carry out orders intelligently, perform the various operations more accurately and in less time than the unskilled, thereby producing a higher grade of work in greater quantity, two very important considerations.

An efficient plant layout is a point worthy of much thought. A plant correctly laid out can produce large volumes of work in a systematic manner with a minimum amount of handling and a great saving of time and money may be accomplished by an efficient arrangement.

Plant equipment is the final factor which enters into the making of an efficient shipyard. Good equipment is an advantage which no yard can overlook. It is the equipment which determines, in a large measure, the output of the plant. There are two important points to be considered when purchasing equipment. They are the quality of the machine and the amount of work which can be turned out with it. Equipment satisfactorily meeting these two requirements will go a long way toward producing the results desired in the operation of the yard and money invested in this way is bound to bring the greatest returns.

In the following pages is described a system for effectively supervising and following up the work passing through a modern shipyard. Such questions as estimating, job orders, ordering material and routing work are discussed in detail, and in addition there are included detail yard and shop layouts of some of the best shipyards in the United States accompanied by complete lists of the equipment contained in each.

S. M. PHILLIPS.

Planning and Estimating

INTRODUCTION

THE MANAGEMENT OF THE INDUSTRIAL ORGANIZATION of a shipyard is a question that has been much debated in past years and to which considerable attention will be given in the future, as on the proper determination of this question alone will depend the success or failure of a good many yards.

Every yard must have some kind of system for carrying out its work, but the system that secures the maximum production at the minimum cost will determine the most successful yard.

It is gradually being recognized that a system with a central office, charged with the administration of all affairs in the plant appertaining to production, is best suited to a shipyard.

This central office may be called "The Planning and Estimating Section or Division," as its functions consist in preparing estimates and planning the work on a ship in sufficient detail to carry it to completion with intelligence and without delay.

In order to prepare an estimate for the construction of a vessel it is necessary that reliable data concerning the cost and quantity of production in the yard be readily available. As these data are only secured through proper planning, this subject will be treated first and the methods of compiling data for estimating considered next.

Personnel

THE PLANNING AND ESTIMATING SECTION is the nucleus of the whole industrial organization. Its personnel should include a Planning Superintendent who is responsible for the entire production of the plant, an Assistant for hull work, and an Assistant for machinery work, experienced hull and machinery men for planners, experienced material men for preparing requisitions, material stubs, etc., typists, clerks and messengers, all as required by the volume of work passing through the office; a Chief Progressman who must be a good all-around ship man and a progressman, for each shop, as well as two outside progressmen, one for hulls and one for machinery.

Why a force of this kind is necessary and the methods by which they work will become apparent as the article proceeds.

Job Orders

ASSUME THAT THE YARD HAS SUCCESSFULLY BID and been awarded a contract to build a freighter.

The first thing requiring attention in connection with this contract is the preparation of a set of job orders to provide for the allocation of charges to certain specific groups. The reason for this is to secure information regarding the cost of the various parts of the vessel for estimating on future work and comparison with similar data for other vessels.

The Skeleton Specifications outlined on pages 241 to 275 may be adopted as a standard form for the preparation of job orders as they are applicable to any vessel.

In these specifications the work necessary to the proper completion of a vessel has been divided into twenty-six distinctive groups and each group has been sub-divided, first into alphabetical sub-divisions of principal portions or systems of the vessel included in that group, and second into the items which go to make up that particular portion or system.

Job orders are assigned to the items, but in such a way that the integrity of the alphabetical sub-division and the group is maintained.

It will be noted that job orders are not required for every item listed in the skeleton specifications. This, it must be remembered, is only a guide. The vessel in question will undoubtedly not contain every item listed in these specifications, and then again there are some items essential to the specifications which are not operations in the yard and other items which require special mention in the specifications but will be absorbed or taken with something else in the job orders.

An instance of the first case is the "Social Hall." While a "Social Hall" (Group 9-F) is a necessary adjunct to a passenger vessel, it would not be considered for a freighter.

"Dimensions" (Group 1-A-1) is an example of the second case. It is readily apparent that "Dimensions" is strictly a specifications requirement.

The third case may be illustrated by "Nails" (Group 8-B-3). It is sometimes desirable to state the nature of the fastenings in T and G decks in the specifications, but when the work is being done in the yard the nails are included in the material lists for the deck in question and charged against the job order for laying the deck.

The detail specifications for the vessel to be built are therefore studied, and job orders assigned to the items in the skeleton specifications which are required by the detail specifications. The majority of these items will be apparent without consulting the detail specifications, but where any doubt exists the detail specifications should be referred to.

A job order is a number composed of several terms grouped together in such a manner as to identify a certain portion of work performed on a contract. The cost of all labor and material necessary to the completion of the portion of the work in question is charged against the job order assigned plus a given percentage of the labor cost to cover what are known as indirect charges. The indirect charges include the costs of administration, clerical, storehouse, power plant, handling material around the yard, depreciation of shop equipment, etc., and as all these enter to a greater or lesser degree in each job done by the productive force, a percentage basis is worked out whereby each job bears its share of this cost in proportion to the cost of labor involved.

To allow the cost of any portion of the work on a vessel to be compared with the cost of a similar portion on another vessel of the same type, the job orders must be similar. Hence a "Skeleton Specifications," such as that found in the preceding section is invaluable as a standard form upon which to base the preparation of a job order schedule for work to be performed upon a given contract.

In all shipyards it is the custom for identification purposes to assign contract numbers to all work done in the yard. The first step, therefore, in preparing a list of job orders is to determine the contract number. For illustration purposes assume this to be 241.

The contract number having been assigned, the job orders are made up as follows:

Let the first term represent the group number, the second term the alphabetical sub-division of that group, the third term the particular item in the alphabetical subdivision, and place all these over the contract number.

Thus $\frac{1-B-2}{241}$ — Mold Loft Work, would be the job order assigned for all work necessary to be done in the mold loft for the vessel whose contract number was 241.

In like manner $\frac{2-A-27}{241}$ — Shaft Alley, would be the job order for performing all work in connection with the shaft alley except riveting.

The riveting for the entire vessel would be charged to job order $\frac{2-F-1}{241}$ — Steel Rivets.

Some items in the specifications will be purchased by the shipyard, but job orders are assigned to these items the same as the others and the purchasing price charged against the job order similar to the "material" charges made against other job orders.

As soon as notice is received that a contract has been awarded, a contract number is assigned and job orders are issued to the drafting rooms to cover the drafting work for the vessel and to the mold loft for laying down lines and making templates. This is done in advance of the completion of the job order schedule in order to get a start on the plans, with a view to ordering the structural material necessary at the earliest possible date, and to get the lines laid down in the loft and a start on the template work so that the work of laying off, etc., can begin immediately upon receipt of the material from the mills.

Ordering Material

SIMULTANEOUSLY WITH THE PREPARATION of a schedule of job orders by the planning section, the preparation of structural material schedules is undertaken by the drafting room.

The preparation of material schedules is a most important and difficult problem and there are several salient points in this connection.

To start with, it is necessary to order material as early as possible so that by the time the detail plans are made and issued to the yard the material necessary to proceed with the work will have been delivered from the mills. It generally takes at least ninety days from the receipt of material orders for the steel mills to begin making deliveries so that it becomes at once apparent that the greatest speed possible is desired in getting the orders off.

The material, however, must be ordered to sizes that will work into the vessel with the smallest amount of waste and in order to determine these sizes it is necessary to make plans for the various portions of the ship. These plans or what may be called skeleton drawings are made as simple as possible, all information not essential to the ordering of material being omitted and single lines being used to represent stiffeners, etc., wherever possible. Such information as location and size of butts and seams, weight and size of plates, size and length of stiffeners, bounding angles, clips, etc., is necessarily included. Figure I shows a skeleton drawing for a water tight bulkhead from which the material may be listed.

These skeleton drawings should be carefully numbered and kept as they may be used later for the finished detail plan by adding the further information necessary for the yard to do the work.

Upon the completion of the skeleton drawing it is sent

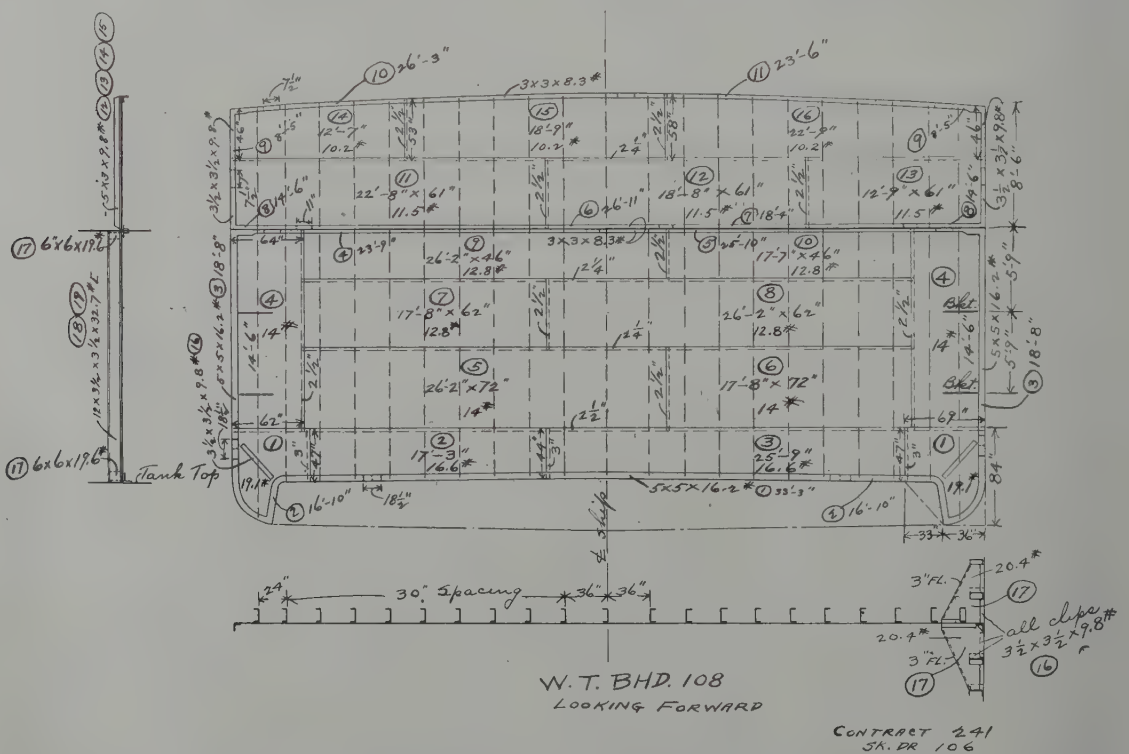


Fig. 1—Rough Pencil Drawing for Determining Material Required

to the checker who checks the material as shown and lists it on the material schedules. The material schedules are then checked and if found correct are ready for sending to the mills.

Every advantage should be taken of duplications wherever possible. For instance, in the parallel middle portion of a cargo ship there will probably be one or more bulkheads which will be similar. One plan may be used for ordering the material for all of these. The floors, frames, webs, etc., will probably be similar for a certain number of frames and these may be ordered from a type plan. All these tend to reduce the work necessary for ordering material and consequently the time.

The material is divided and ordered on two forms, one for plates and one for shapes.

Figures 2 and 3 represent typical schedules of material and the material listed in that required for the bulkhead in Figure 1.

Distinctive marks are assigned to the plates and shapes entering into the hull and these marks are put on the finished plan and are listed on the material schedules. The mills are required to mark the material in accordance with the marks on the schedules and in this way the identity of a piece of material is never lost. This method has proved very satisfactory for shipbuilding, as each piece of material is ordered to fit in a certain place and the markings insure it being located in the place intended without confusion or loss of time.

It will be noted that the dimensions of the various plates and the length of the shapes as given on the material schedules are greater than those given on the skeleton drawings. This is due to the fact that it is usual to make an allowance of ½″ on the width and 1″ to 3″ on the length when ordering plates and 1″ to 3″ on the length when ordering shapes.

Attention is invited to the fact that two different shapes are included on the schedule for shapes shown in Figure 3. In actual practice this is considered bad form and is never done. Separate schedules should be made up for different shapes such as angles, bulb angles, channels, tees, etc., and the sheets numbered in such a way that lists of a certain shape are contained on a number of consecutive sheets. This rule was not followed when listing the above material on account of the small amount of channels listed and also in view of the fact that the principal purpose of the figure is to show the form used and the manner in which the material is listed.

Plates of irregular form are called sketch plates and except in the case of a straight taper for the entire length of the plate on one or both sides, are represented on the material schedules by a sketch showing the shape required with the necessary dimensions for cutting it. Plate BHD. 108—1 is a sketch plate. A tapered plate is designated by giving the two widths in the proper column and stating "taper one (or both) sides" in the remarks column.

Skeleton drawings can be made for use in ordering material for the entire vessel except the shell and in some cases the inner bottom where this extends up the sides of a vessel to a deck as has been done in some of the modern passenger vessels. The shell plating, and inner bottom, if necessary, is lined out on a half model of the vessel, and the sizes of the plates lifted from this.

The rivets are ordered for the entire vessel in rods on a schedule for shapes where a yard is equipped for making its own rivets, or on a schedule similar to Figure 4 where they have to be purchased, the quantities being estimated from the skeleton drawings and an allowance of about 10 per cent. being added to allow for bad rivets (rivets not driven properly, necessitating cutting out and redriving) and burnt rivets.

Upon the completion of the schedules of material they should be sent to the planning section for transmission to the mills.

The preparation of the material schedules for the structural material requires the making of drawings as heretofore mentioned and therefore can naturally be handled to better advantage by the drafting room, but this is not the case with anything else and all other material should be taken care of by the planning section.

Having disposed of the material for the structure of the vessel, the planning section proceeds through the skeleton specifications noting the various items to be purchased, such as stem, stern frame, spectacle frame, struts and other large castings or forgings (if the yard is not equipped for making them), piping and tubing for stanchions, bilge and ballast, sanitary, steam and other piping systems, auxiliary machinery, pumps, lumber for blocking and staging, decks, etc., anchors and chain, boats and handling gear, rigging, articles of furniture, equipment, etc., preparing orders for securing such of this material as can be ordered right off and making note of that necessary to be delayed pending the development of plans, in order to provide same in ample time for making the installations aboard ship when that particular portion of the work is reached.

In this connection special attention should be given to the ordering of heavy castings such as the stern frame, spectacle frame, struts, stem, etc. There is almost invariably a considerable amount of delay in getting these castings, especially when purchased outside, and for this reason the necessary plans should be made and the castings ordered as soon as possible after the completion of the schedules for structural material.

The work accomplished by the planning section in preparing the orders for material is performed subject to the approval of the Naval Architect, as he, representing the engineering divisions of the yard, determines the specification requirements of the material and equipment going into the ship.

The actual placing and handling of orders is assigned to the purchasing agent and is also subject to the approval of the Naval Architect.

Material received in the yard before it is required for working into the vessel is placed in store until such time as it is needed, when it is stubbed out to the craft using it.

This is the ideal state which all yards strive to reach, i.e., to have the material in the storehouse when the work is ready to be undertaken.

Planning

THE JOB ORDER SCHEDULE BEING COMPLETED and as much as possible of the material ordered, the next step is the planning of the work through the shops and the routing of material in order to derive the best results from the yard forces and equipment.

To accomplish the best results it would be well to establish a standard form that could be applied to any vessel, listing the sequence of the various units entering into the vessel and then planning the work in such a manner that the units will be undertaken in the proper order. Such a form would be as follows:

Keel (Vertical and Flat)
Stem
Stern Frame
Bottom Plating (Plating to Turn of Bilge)
Floors and Keelsons

8¼"

PRINTS ISSUED		
TO WHOM	DATE	NO

HULL NO. 241

SHIPBUILDING CO.

NEW YORK, N.Y.

SCHEDULE OF PLATES

MADE BY _____

CHECKED BY _____ DATE _____

APPROVED _____

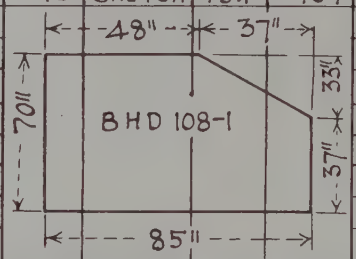
NAVAL ARCHITECT

SHEET NO. _____

REQUISITION NO. _____

MATERIAL

as required by Classification Society

MARK	NO. OF PLATES	DIMENSIONS		WEIGHT IN POUNDS			REMARKS
		LENGTH IN FT. & INS.	WIDTH IN INCHES	PER SQ. FT.	PER UNIT	GROSS	
		W. T. BHD.		108			
BHD-10-8-1	2	To	SKETCH	19.1	707	1414	
							
BHD-108-2	1	17'-4"	44½×47½	16.6	1102	1102	TAPER ONE SIDE
" " 3	1	25'-10"	44½×47½	16.6	1642	1642	" " "
" " 4	2	14'-7"	63×65	14	1088	2176	" " "
" " 5	1	26'-3"	72½	14	2220	2220	
" " 6	1	17'-9"	72½	14	1501	1501	
" " 7	1	17' 9"	62½	12.8	1184	1184	
" " 8	1	26'-3"	62½	12.8	1751	1751	
" " 9	1	26'-3"	46½	12.8	1304	1304	
" " 10	1	17'-8"	46½	12.8	878	878	
" " 11	1	22'-9"	61½	11.5	1340	1340	
" " 12	1	18'-9"	61½	11.5	1104	1104	
" " 13	1	12'-10"	61½	11.5	755	755	
" " 14	1	12'-8"	50×56	10.2	571	571	TAPER ONE SIDE
" " 15	1	18'-10"	56×63	10.2	953	953	" " "
" " 16	1	22'-10"	50×63	10.2	1097	1097	" " "
" " 17	1	11'-3"	32	2.04	613	613	SHELL BKTS.
				TOTAL		21,605	

12"

Fig. 2.—Typical Schedule for Ordering Plates

8¼"

PRINTS ISSUED		
TO WHOM	DATE	NO.

HULL NO. 241

SHIPBUILDING CO.

NEW YORK, N.Y.

SCHEDULE OF SHAPES

MADE BY _____

CHECKED BY _____ DATE _____

APPROVED _____

NAVAL ARCHITECT

SHEET NO. _____

REQUISITION NO. _____

MATERIAL

As required by Classification Society.

12"

MARK	SHAPE	NO. OF BARS	DIMENSIONS		WEIGHT IN POUNDS			REMARKS
			LENGTH IN FT. AND INS	SIZE IN INCHES	PER LIN FT.	PER UNIT	GROSS	
			W. T. BHD. 108					
BHD-108-1	∠	1	33'-4"	5 × 5	16.2	540	540	B'DRY ANGLE
" " 2	∠	2	23'-9"	5 × 5	16.2	385	770	" " & BOSOM Pcs.
" " 3	∠	2	18'-11"	5 × 5	16.2	307	614	" "
" " 4	∠	1	23'-10"	3 × 3	8.3	198	198	" "
" " 5	∠	1	25'-11"	3 × 3	8.3	215	215	" "
" " 6	∠	1	27'-0"	3 × 3	8.3	224	224	" "
" " 7	∠	1	18'-5"	3 × 3	8.3	153	153	" "
" " 8	∠	2	9'-7"	3½ × 3½	9.8	94	188	" "
" " 9	∠	2	8'-8"	3½ × 3½	9.8	85	170	" "
" " 10	∠	1	26'-4"	3 × 3	8.3	219	219	" "
" " 11	∠	1	23'-7"	3 × 3	8.3	196	196	B'DRY ANGLE
" " 12	∠	1	29'-5"	5 × 3	9.8	287	287	To CUT-STIFF
" " 13	∠	3	19'-4"	5 × 3	9.8	189	567	" " "
" " 14	∠	3	19'-0"	5 × 3	9.8	186	558	" " "
" " 15	∠	3	18'-4"	5 × 3	9.8	180	540	" " "
" " 16	∠	4	18'-0"	3½ × 3½	9.8	176	704	" " CLIPS
" " 17	∠	3	15'-0"	6 × 6	19.7	296	888	" " "
" " 18	⊏	19	18'-0"	12 × 3½ × 3½	32.7	589	11,191	STIFFENERS
" " 19	⊏	2	20'-11	12 × 3½ × 3½	32.7	684	1,368	"
					TOTAL		19,590	

Fig. 3.—Typical Schedule for Ordering Shapes

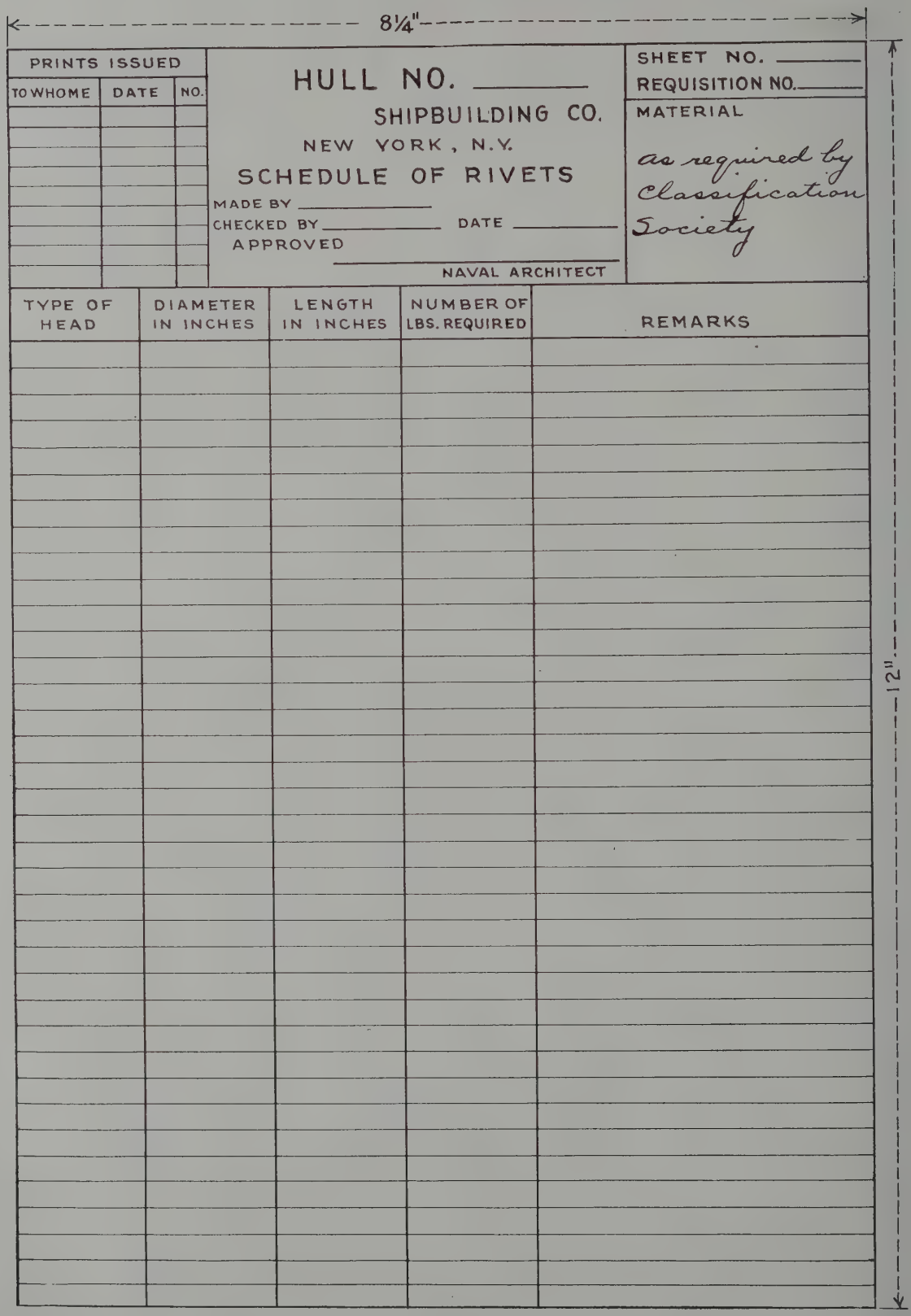


Fig. 4.—Typical Schedule for Ordering Rivets

Tank Top
Side Framing
Stringers
Side Plating
Bulkheads
Girders and Pillars
Decks
Hawse Pipes
Stern Tubes
Struts
Guards and Fenders
Bilge and Docking Keels
Sea Connections
Foundations
Hatches, Manholes, Doors, Skylights and Scuttles
Ladders
Air Ports
Rudder
Deck Erections
Rail and Awning Stanchions
Launching
Masts and Rigging
Ceiling
Auxiliaries
Steering Gear
Bilge and Ballast Systems
Oil Piping
Plumbing
Heating System
Electric Lighting
Interior Communication
Ventilation
Refrigerating Plant
Painting
Furniture
Storerooms
Deck Covering
Boats and Boat Gear
Outfit
Canvas Work
Upholstery
Equipment
Stores

While the above form is a guide to the sequence in which the structure of the vessel will be erected, and while the work must be ready for fabrication or installation in that order, it must be kept in mind that there are many different shops in the yard and that these shops should be started on the particular work for which they are adapted as soon as possible, whether the work they turn out is immediately needed or not. An example of this kind would be as follows:

The doors, hatches and manholes might not be needed for some time, but as soon as the plans become available for this unit the work on the fittings may be proceeded with, thereby providing work for the blacksmith, pattern, foundry, machine and galvanizing shops. The completed fittings may then be turned into store in the plate and angle shops and as soon as a portion of the force in that shop becomes available, the plate and angle work can be undertaken, after which the completed unit is turned into general store until such time as it is required for installation aboard ship.

It has been stated in the preceding article that skeleton drawings were essential to the ordering of material. It is quite evident that in order to make these drawings a line plan must have been first developed from which to determine the form of the vessel for which the material was to be ordered.

One of the duties of the planning section is to keep in touch with drafting work so that as soon as the line plan for a new vessel is completed in the drafting room, prints may be issued to the mold loft, in order that the lines may be faired on the mold loft floor and templates made for the first units listed in the building form, so that when the material arrives from the mills the yard is prepared to immediately work it into the ship.

There are, therefore, three important duties relating to the preliminary work on a new vessel that the planning section should keep in mind, as they will apply to any vessel to be built. They are as follows:

Issue job order for drafting work.
Issue job order for mold loft work.
Order material.

These three duties, having been properly attended to, the work embodied in each unit listed on the building form is planned as soon as the yard drawings are completed by the drafting room. The auxiliary job orders are then ready for issuing to the yard and this is done as soon as the material necessary for carrying out the work becomes available.

From this point on is where a system is required more than any other place in the plant organization. The problem of carrying out the work in such a way as to keep all of the shops producing the maximum, co-ordinating the activities of the various shops with a view to avoiding confusion and at the same time following each particular job through each shop watching out that it keeps moving, that only proper charges are made against it and that it is closed out when the work is completed, is one of the hardest that a shipbuilder has to solve.

The following has been developed with a view to supplying a system that will be simple and that will apply to any kind or type of job with a minimum of paper work.

A planner is assigned to plan a certain job. He analyzes the work to be done, separating it into the various operations necessary to complete it. These operations are written on a standard form and issued to the shops which are to perform them.

The work of the planning section is then taken up by the progressmen in the shops. This consists in seeing that the material necessary for the shop to proceed with the work is on hand, that the job is assigned and that the work is pushed to completion so far as his shop is concerned, keeping in constant touch with the progress of the work and reporting any interferences that occur to the Chief Progressman.

In illustration of how this system works out in practice the following jobs are a fair example:

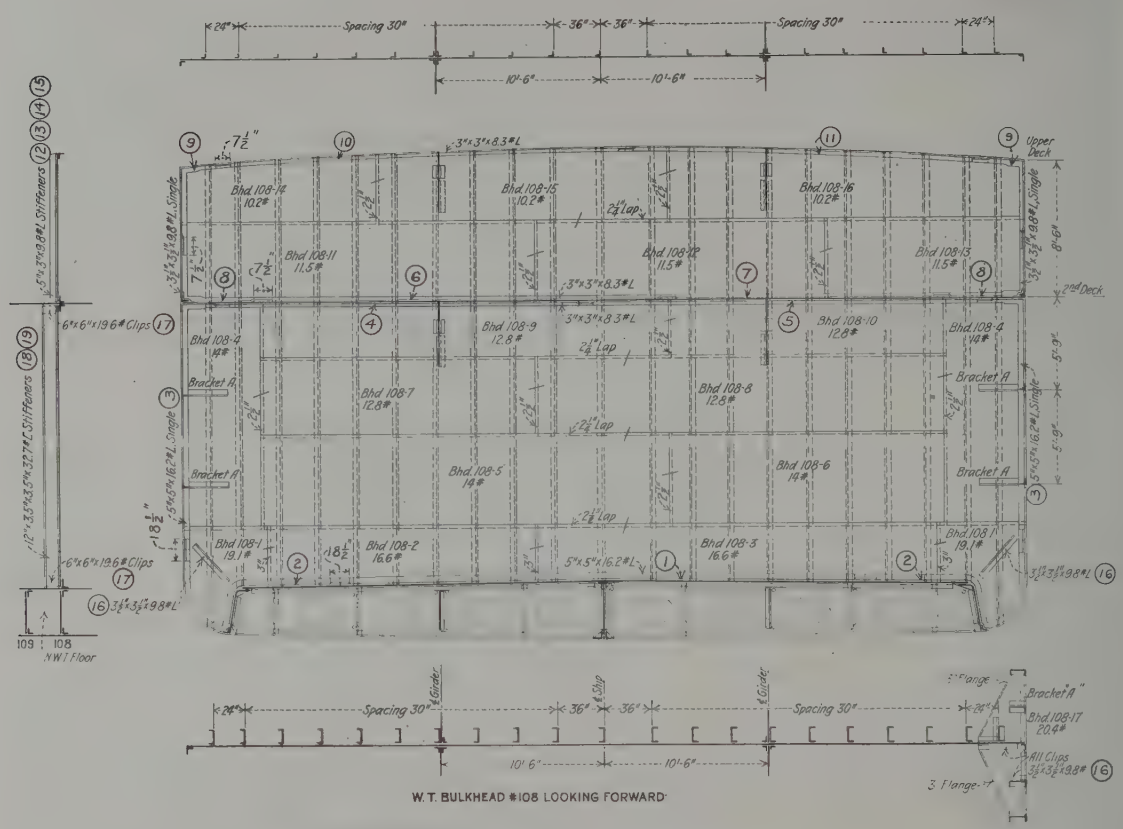
Job order $\frac{2-A-11}{241}$ — Structural Bulkheads.

(Covering the cost of all work in connection with the structural bulkheads for the vessel whose contract number is 241, except riveting.)

Job order $\frac{13-C-1}{241}$ — Bilge and Ballast System.

(Covering the cost of all work in connection with the bilge and ballast system for the vessel whose contract number is 241.)

Assume that blueprints of W. T. Bulkhead No. 108 (Figure 5) and the Independent Bilge Pump Suction Manifold (Figure 6) have been received by the planning



RIVETING SCHEDULE					
DESCRIPTION	LAP	DIA OF RIVET	SPACING DIA	SPACING IN	REMARKS
Bulkhead Edge lap	2¼"	5/8"	4½	2 3/4	
" " "	2½"	3/4"	4½	3 3/4	
" Butt "	2½"	5/8"	4½	2 3/4	
" " "	3"	3/4"	4½	3 3/4	
Bhd'r. Bars to Bulkhead		5/8"	4½	2 3/4	Plates 10.2 to 14#
" " " "		3/4"	4½	3 3/4	" 15.3# to 19.1#
" " on Tank Top		3/4"	5	3 3/4	
" " " "		7/8"	5	4 3/4	
" " to Shell		3/4"	5	3 3/4	
" " " "		7/8"	5	4 3/4	
" " " "		1"	5	5	
Stiffener to Bulkhead		5/8"	7	4½	Plates 10.2 to 14#
" " "		3/4"	7	5 1/4	" 15.3# to 19.1#
Bracket Clips to Shell		7/8"	5	4 3/4	
" " " Bulkhead		5/8"	4½	2 3/4	

NOTES
Rivets at ends of stiffeners to be spaced 4 diameters for 15% of their length at each end.
See Pillar & Girder Plan for Girder Attachment

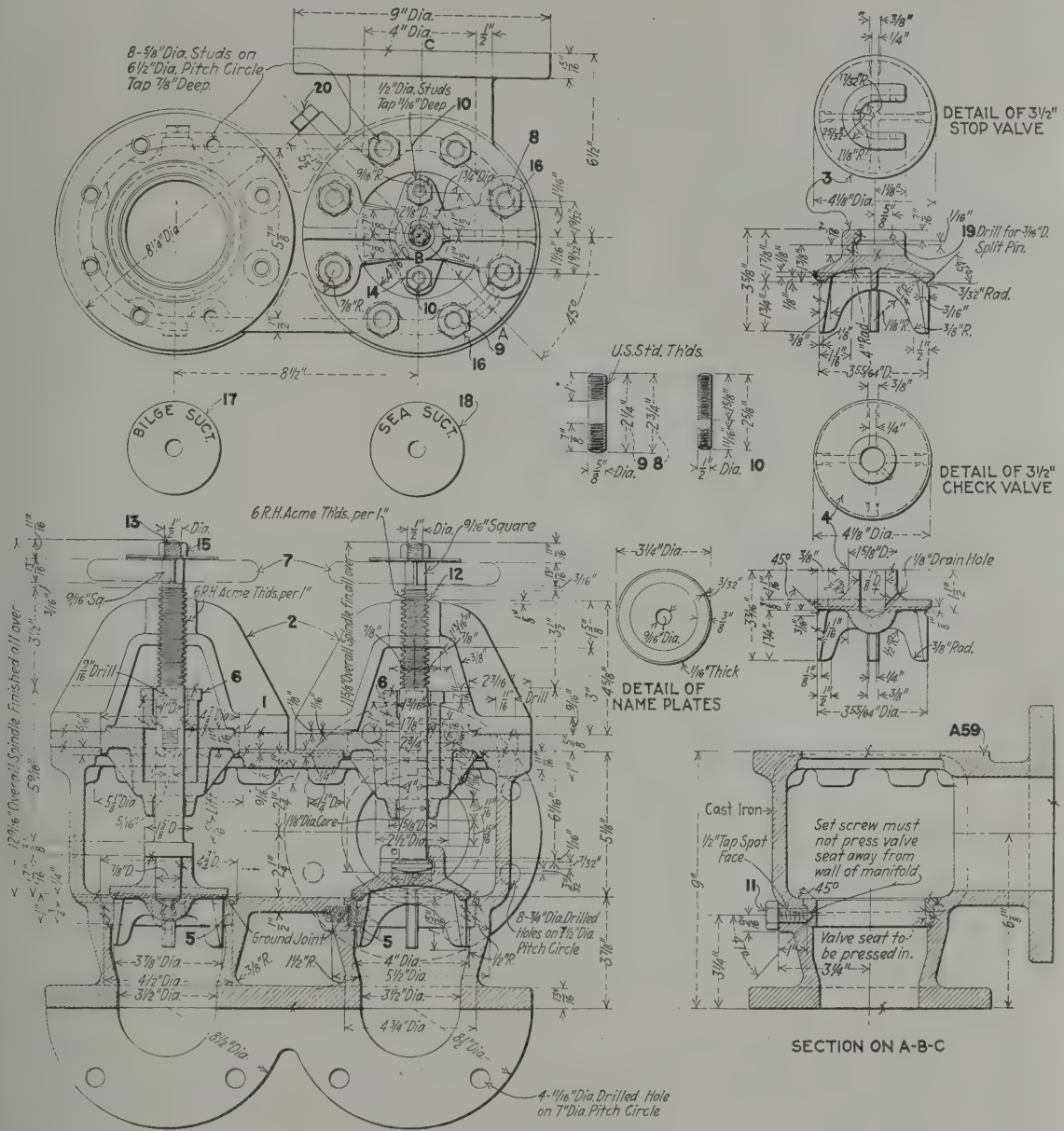
Fig. 5—Plan No. 1051—W. T. Bulkhead No. 108. Typical Working Plan as Issued to Yard

section from the drafting room. Figure No. 5 is the same bulkhead for which the material orders were prepared in the preceding article and the skeleton drawing shown in Figure 1 has been completed for issue to the yard as shown in Figure 5.

The planning superintendent receives the drawings and assigns one of his men to plan the work embodied on each. Upon receiving a drawing and instructions from the planning superintendent, the planner analyzes the job and plans it, writing out the instructions to the yard forces which are necessary for carrying out the work. These instructions are written in such a manner that each operation will be a unit by itself. The operations are then typed on the standard planning form. Serial numbers are given to the operations on the rough copy and these are placed after the third term of the numerator in the job orders as listed on the standard form. Sometimes the work shown on a drawing is only a part of a large system. In these cases the serial numbers of the operations are continued from the portions of the system which have been previously planned. Such a case is shown by the plan of work for the Independent Bilge Pump Suction Manifold. A required number of these plans of work are made and they are then cut up and the operation instructions or auxiliary job orders are issued to the yard. Usually about six copies will be required and if the standard forms are made of thin, tough paper, as they should be, it will be an easy matter to make five good carbon copies, thus providing a sufficient number of copies in one operation.

The carrying out of the above is very simple, as is demonstrated by the plans of work shown in Figures 7, 8, 9 and 10.

The rough plans of work having been written out by the planner as shown in Figures 7 and 8, they are given to a typist for copying on the standard form. Six copies


9" Dia.
4" Dia.
8-5/8" Dia. Studs on 6½" Dia. Pitch Circle Tap 7/8" Deep.
½" Dia. Studs Tap 1" Deep
8½" Dia.
BILGE SUCT.
SEA SUCT.
U.S.S.T'd. Th'ds.
DETAIL OF 3½" STOP VALVE
DETAIL OF 3½" CHECK VALVE
DETAIL OF NAME PLATES
6 R.H. Acme Th'ds. per 1"
Overall Spindle Finished all over
SECTION ON A-B-C
Cast Iron
½" Tap Spot Face
Set screw must not press valve seat away from wall of manifold, 45°
Valve seat to be pressed in.
Ground Joint
8-¾" Dia. Drilled Holes on 7½" Dia. Pitch Circle
4-1/16" Dia. Drilled Hole on 7" Dia. Pitch Circle

MATERIAL FOR ONE MANIFOLD

Pc. No.	No. Pcs.	Name	Material	Pc. No.	No. Pcs.	Name	Material
A 59	1	Manifold Body	Cast Iron	11	3	½" Pointed Set Screw	Steel
1	2	Bonnet	Cast Iron	12	1	Stop Valve Spindle	Cast. Mang. Bronze
2	2	Yoke	Cast Iron	13	1	Check Valve Spindle	Cast. Mang. Bronze
3	1	Stope Valve Disc	Red Brass	14	4	½" Standard Nuts	Brass
4	1	Check Valve Disc	Red Brass	15	2	½" Standard Nuts	Wr't Iron
5	2	Valve Seat	Red Brass	16	16	⅝" Standard Nuts	Wr't Iron
6	2	Valve Gland	Yellow Brass	17	1	Name Plate	1/16" Sheet Brass
7	2	6" Handwheel	Cast Iron	18	1	Name Plate	1/16" Sheet Brass
8	8	⅝" Yoke Studs	Steel	19	1	3/16" Dia. Split Pin	Brass
9	8	⅝" Bonnet Studs	Steel	20	1	½" Pointed Set Screw	Steel
10	4	½" Gland Studs	Steel				

Fig. 6—Plan No. 1411—Independent Bilge Pump Suction Manifold. Typical Working Plan as Issued to Yard

8¼"

DATE 1/2/20 ROUGH PLAN OF WORK J.O. 2-A-11/241

Structural Bulkheads – W.T. Bhd. #108

OPERATION NO.	SHOP	COGNIZANCE OF FOREMAN	INSTRUCTIONS
1	Plate & angle	Shipfitter	W.T. Bhd. #108 – Shape and Bevel Bounding angles as per templates furnished by mold loft.
2	Plate & angle	Shipfitter	W.T. Bhd. #108 – Lay Off Bounding angles, stiffeners, bilge angles and clips as per templates furnished by mold loft.
3	Field	Shipfitter	W.T. Bhd. #108 – Lay Off 18 plates and 8 brackets as per templates furnished by mold loft.
4	Plate & angle	Shipfitter	W.T. Bhd. #108 – Punch and Shear Plates, bounding angles, stiffeners, bilge angles, clips and brackets; flange brackets. Send to way #4.
5	Field	Shipfitter	W.T. Bhd. #108 – Bolt Up in accordance with plan #1051.
6	Ship	Chipper & Calker	W.T. Bhd. #108 – Calk and make water-tight

12"

Fig. 7—Rough Plan of Work for Bulkhead No. 108

8¼

DATE 1/2/20 ROUGH PLAN OF WORK J.O. 13-C-1/241

Bilge and Ballast System - Bilge Pump Suction Manifold

OPERATION NO.	SHOP	COGNIZANCE OF FOREMAN	INSTRUCTIONS
31	Pattern	Pattern-maker	Bilge Pump Suction Manifold - make or draw from store patterns for castings listed in bill of material on plan # 1411. Send to foundry.
32	Foundry	Molder	Bilge Pump Suction Manifold - Cast portions of bilge manifold listed in bill of material on plan # 1411 (10 castings). Send patterns to pattern storehouse; tag castings and send to machine shop.
33	Mach. Shop	Machinist	Bilge Pump Suction Manifold - machine castings delivered from foundry (10 castings) and manufactured additional parts listed in bill of material on plan # 1411. Assemble, tag, and send to outfitting storehouse, taking receipt therefor.

12"

Fig. 8.—Rough Plan of work for Independent Bilge Pump Suction Manifold

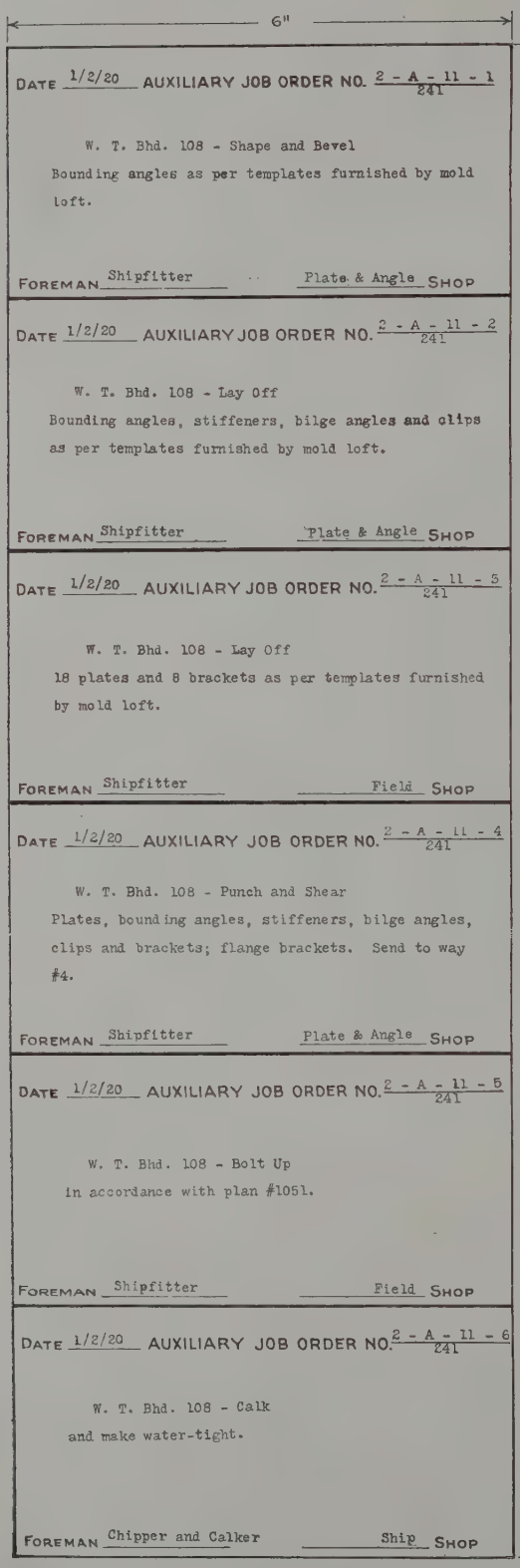

6"
18"
DATE 1/2/20 AUXILIARY JOB ORDER NO. 2 - A - 11 - 1 / 241
W. T. Bhd. 108 - Shape and Bevel
Bounding angles as per templates furnished by mold loft.
FOREMAN Shipfitter Plate & Angle SHOP
DATE 1/2/20 AUXILIARY JOB ORDER NO. 2 - A - 11 - 2 / 241
W. T. Bhd. 108 - Lay Off
Bounding angles, stiffeners, bilge angles and clips as per templates furnished by mold loft.
FOREMAN Shipfitter Plate & Angle SHOP
DATE 1/2/20 AUXILIARY JOB ORDER NO. 2 - A - 11 - 3 / 241
W. T. Bhd. 108 - Lay Off
18 plates and 8 brackets as per templates furnished by mold loft.
FOREMAN Shipfitter Field SHOP
DATE 1/2/20 AUXILIARY JOB ORDER NO. 2 - A - 11 - 4 / 241
W. T. Bhd. 108 - Punch and Shear
Plates, bounding angles, stiffeners, bilge angles, clips and brackets; flange brackets. Send to way #4.
FOREMAN Shipfitter Plate & Angle SHOP
DATE 1/2/20 AUXILIARY JOB ORDER NO. 2 - A - 11 - 5 / 241
W. T. Bhd. 108 - Bolt Up
in accordance with plan #1051.
FOREMAN Shipfitter Field SHOP
DATE 1/2/20 AUXILIARY JOB ORDER NO. 2 - A - 11 - 6 / 241
W. T. Bhd. 108 - Calk
and make water-tight.
FOREMAN Chipper and Calker Ship SHOP

Fig. 9—Finished Plan of Work for Bulkhead No. 108

of each are required to allow for distributing the auxiliary job orders as follows. One for the Planning Section files, one for the Superintendent in charge of the work, one for the Chief Progressman, two for the Craft Foreman (one being retained in the foreman's office and the other given to the man in direct charge of that portion of the work), and one to the Shop Progressman. Figures 9 and 10 show the standard forms as they appear upon leaving the typist.

The copies of the standard forms are now cut along the heavy lines between the auxiliary job orders, the auxiliaries intended for each foreman being clipped together and dispatched to his office via the planning section messengers who make hourly trips to and from the yard. There are three copies of each standard form which should not be cut up. These three are the copies to the Superintendent in charge of the work, the Chief Progressman, and the copy for the Planning Section files. It is obvious that these copies should be kept intact as they will be used by persons interested in the job as a whole rather than in an operation.

Immediately upon the receipt of the auxiliary job orders the shop progressman notes whether the necessary material is on hand and whether the work to be done in his shop may be undertaken immediately or must be delayed pending the completion of preceding operations in other shops. If the work may be undertaken immediately, he confers with the man who is to supervise the work in the shop regarding his ability to make a start and issues the necessary material where a start is possible.

He then follows the progress of the work through his

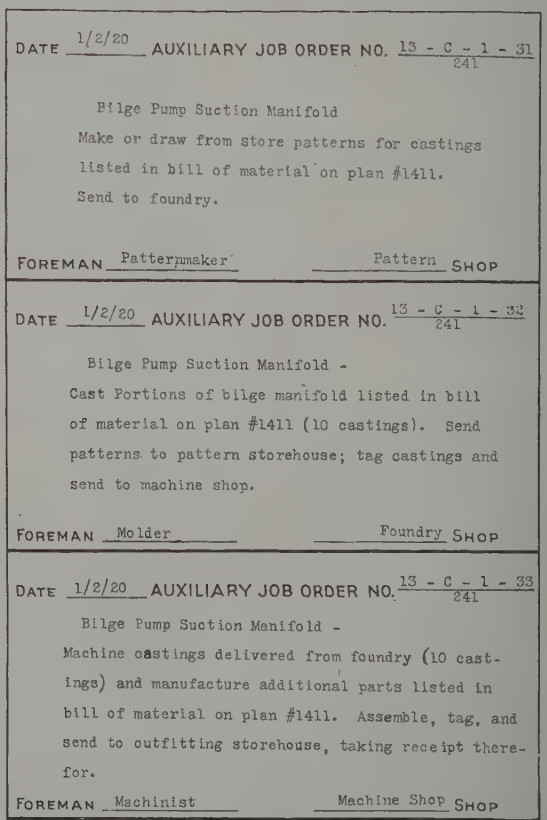

DATE 1/2/20 AUXILIARY JOB ORDER NO. 13 - C - 1 - 31 / 241
Bilge Pump Suction Manifold
Make or draw from store patterns for castings listed in bill of material on plan #1411.
Send to foundry.
FOREMAN Patternmaker Pattern SHOP
DATE 1/2/20 AUXILIARY JOB ORDER NO. 13 - C - 1 - 32 / 241
Bilge Pump Suction Manifold -
Cast Portions of bilge manifold listed in bill of material on plan #1411 (10 castings). Send patterns to pattern storehouse; tag castings and send to machine shop.
FOREMAN Molder Foundry SHOP
DATE 1/2/20 AUXILIARY JOB ORDER NO. 13 - C - 1 - 33 / 241
Bilge Pump Suction Manifold -
Machine castings delivered from foundry (10 castings) and manufacture additional parts listed in bill of material on plan #1411. Assemble, tag, and send to outfitting storehouse, taking receipt therefor.
FOREMAN Machinist Machine Shop SHOP

Fig. 10—Finished Plan of Work for Independent Bilge Pump Suction Manifold

shop, reporting any irregularities to the Chief Progressman, and seeing that it is accomplished without loss of time and passed on in accordance with the instructions contained on the auxiliary job order; also that the auxiliary job order is closed out upon the completion of the work called for.

The material for each job should be on hand before or about the time that an auxiliary job order reaches the shop. Where such is not the case, the Planning Section should be immediately notified so that the delay can be investigated and deliveries expedited.

This brings up the subject of routing material, a discussion of which follows.

Routing Material

THERE ARE TWO GENERAL CLASSES OF MATERIAL used in a shipyard, i.e., material ordered and used for a definite purpose, and material ordered and used as stock.

It is obvious that a successful shipyard cannot anticipate its needs for any specific material, as rush jobs in the way of alterations and repairs are constantly springing up for which the material must be on hand. For this reason many yards carry a stock supply of general shapes, plates, fittings, bolts and nuts, rivets, lumber, etc., that enter into the construction of a vessel. There are many advantages in having a good supply of stock material and where such is the case the planning section in preparing orders for material such as fittings, goes over the stock list with a view to securing this material from general stock. Where the needed material is found in stock it is reserved on the proper job order and new material ordered to replace it. Hence any delays in deliveries are transferred to the general stock and the work on a specific job order can proceed. This is often the case and many times a job is proceeded with and finished before the replacement material arrives.

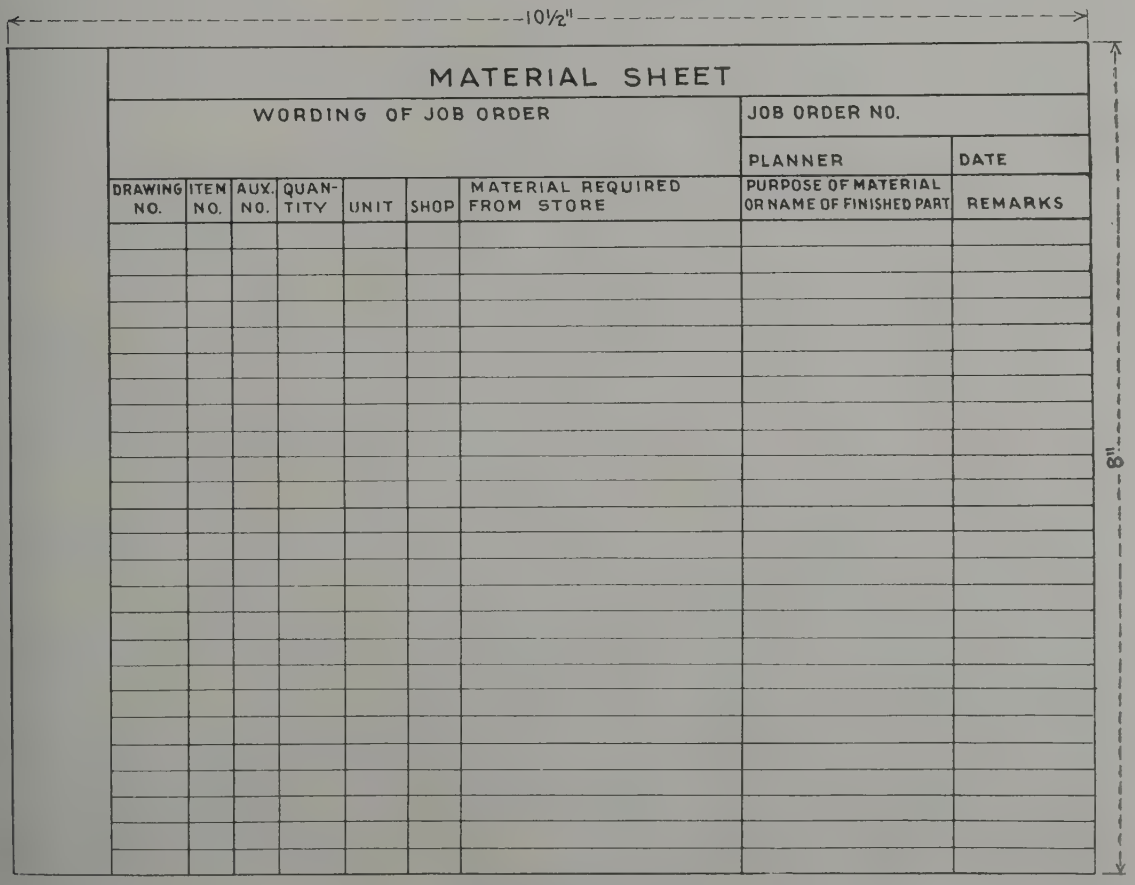
With the exception of hull plates and shapes and heavy castings or forgings, the material upon being received in the yard is inspected and then stored in material storehouses until such time as it is needed.

Plates and shapes are usually stowed in the open to allow the mill scale to rust off by the time it is needed for fabrication.

The plate and angle racks should be in the vicinity of the plate and angle shop, and as soon as the material is received and inspected it should be placed in the racks and signed over to the progressman in this shop, who will issue it to the yard when the work for which it was ordered is undertaken.

It is therefore not necessary for the planning section to prepare material sheets for material such as plates or shapes as the progressman of the plate and angle shop has already received these.

Where the material necessary is in the storehouse or is to be drawn from stock, however, it is necessary to prepare a material sheet, listing the material necessary to carry on the work. Copies of these material sheets are made as follows: one for the material section, one for



MATERIAL SHEET

WORDING OF JOB ORDER							JOB ORDER NO.	
							PLANNER	DATE
DRAWING NO.	ITEM NO.	AUX. NO.	QUANTITY	UNIT	SHOP	MATERIAL REQUIRED FROM STORE	PURPOSE OF MATERIAL OR NAME OF FINISHED PART	REMARKS

Fig. 11—Material Sheet

the progressman of each shop that material will be delivered to and one for the Chief Progressman.

The material clerks, upon receipt of the material sheets, make out duplicate stubs for the material under the various storehouse divisions, forward one stub to the storehouse, filing remaining stub and material sheet in the planning section files. The storehouse men, upon receipt of the stubs, deliver the material called for to shops listed on the stubs. When the material is delivered to the shop intended, the progressman of that shop receives it and signs the stub which is returned to the storehouse for filing. The storehouse man, upon receiving the stub signed by the progressman, enters that material in his books as having been delivered and makes proper charges for it against the auxiliary job order listed on the stub.

The forms used in connection with the issue of material from the storehouse are shown in Figures 11 and 12.

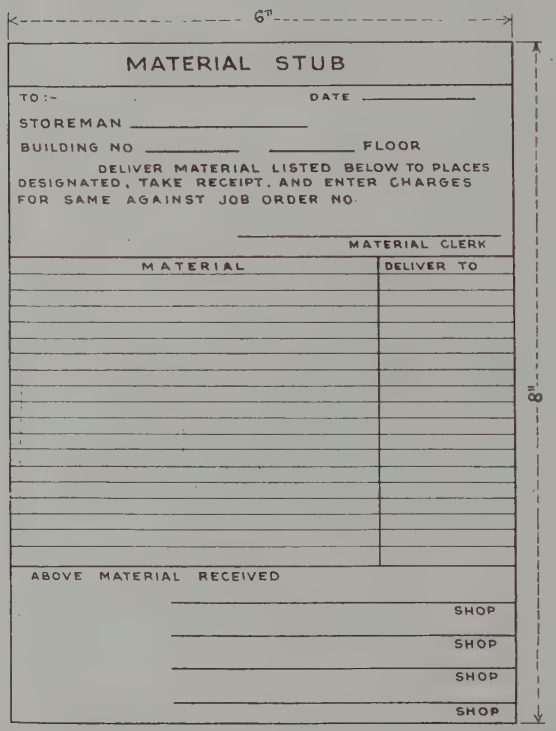


Fig. 12—Material Stub

Estimating

IT HAS BEEN SAID that a man becomes a master workman when he is able to prepare reliable estimates.

Ability to estimate is acquired only by long experience supplemented with reliable data collected from work actually performed. These data in order to be of any value must be properly segregated and compiled in such a manner that the information relative to the cost of principal portions of a ship's structure, the various heavy castings and forgings, piping systems, joiner work, decking, etc., will be readily available for use in assisting the preparation of estimates for contemplated work. The "Skeleton Specification" preceding this section furnishes an excellent form for listing this information and as the job orders are prepared from this same form the work involved becomes a matter of summing the charges made against the auxiliary job orders and listing them on a blank form of the specifications.

In listing the cost data on the specification form the cost is entered in several ways. The total cost is always desirable and in addition the cost per pound or unit. Where the cost per pound is used, the weight also is necessary and full information can conveniently be listed as follows:

Group II

A 1 — Keels, flat and vertical —— lbs. |—— total cost.
—— cost per lb.

This method of recording the weight of principal portions of a vessel is also an advantage in that it provides a fund of valuable information, which is readily available, for use in preparing the weight estimates for new designs.

In the case of units, the total cost and unit cost are listed.

There are some portions of the work for which it is not feasible to attempt a reduction to unit cost or cost per pound. Estimates for these portions are generally prepared by skilled estimators who work up the cost for each specific case to suit the proposed installation. The total cost, for purposes of comparison, is all that it is necessary to list in cases of this kind. The steam heating, or plumbing system, is a job of this nature.

The following gives an outline of the principal divisions for the hull and the basis on which the cost may be listed:

Division	Basis on Which the Cost May Be Listed
Main structure such as hull, tank top, framing, decks, bulkheads, etc.	Cost per pound
Heavy castings and forgings	Cost per pound
Hull fittings, hatches and skylights	Cost per unit
Ventilator cowls, mushroom tops, and turning gear	Cost per unit
Ventilation system (blowers, trunks and ducts)	Total cost for purposes of comparison
Ventilation trunks (straight trunks from cowls)	Cost per foot in length for various diameters
Masts, booms, derricks, etc.	Cost per pound for steel Cost per unit for wood
Rigging	Total cost for purposes of comparison
Canvas work	Cost per square yard
Wood decks and ceiling	Cost per square foot or yard
Wood deck houses, etc.	Total cost for purposes of comparison
Furniture	Cost per unit
Upholstery	Cost per unit except in case of carpet, which can be taken as cost per square yard
Refrigerating, steam heating, plumbing, and oil piping systems, anchor gear, deck machinery and steering gear.	Total cost of each for purposes of comparison
Boats or rafts and outfit	Total cost of each size boat or raft and outfit
Chocks, davits, etc.	Total cost of handling and stowing arrangement for each size boat or raft
Boat cranes	Total cost of boat cranes of different capacities
Equipment	Cost per unit

Electric light plant and interior communication	Total cost for comparison
Cement, tiling, linoleum, etc., and painting	Cost per square foot or yard
Galley and cook's outfit	Total cost for comparison
Cabin stores	Total cost for comparison
Cutlery and plated ware	Total cost for comparison
Crockery and glass	Total cost for comparison
Bakery outfit	Total cost for comparison
Linen, bedding, etc.	Total cost for comparison
General stores	Total cost for comparison
Carpenter's stores	Total cost for comparison
Boatswain's stores	Total cost for comparison
Cooper's stores	Total cost for comparison

A special file is kept for filing these forms and in this manner a fund of information is always available for use in preparing estimates of cost for new designs. This file should be divided so that the cost data for vessels of a similar nature and within certain limits of size are kept together, thus insuring the most efficient use of the data on hand. The reason for separating these data by types and sizes of vessels may be made clearer by the following example. Suppose there are being built, side by side, a car float and large cargo vessel. On the bottom of the car float we could pick out a plate, say 30′—0″ x 66″ x 10♯, and we could probably find a plate on the bottom of the cargo vessel that might be 30′—0″ x 66″ x 20♯. These plates are both 30′—0″ long by 66″ wide, but one is twice the weight of the other. The cost of laying off, punching and shearing these plates will be about the same for each one. Were this cost to be divided by the weight of each plate, it is readily seen that the cost per pound of laying off, punching and shearing for the car float would be twice that for the cargo vessel. Hence it is at once apparent that the cost per pound for this work gathered from data on building the car float would be entirely inapplicable for use in estimating on the cargo vessel and vice versa. Were another car float to be estimated the information relative to the previous one would be very desirable and the same would apply to the cargo vessel. It is necessary, therefore, to carefully divide the files in the manner enumerated above, as this method insures the most reliable results.

The method of estimating a vessel's structure on a cost per pound basis has often been severely criticised and methods advanced to replace it which were based on cost per square foot for laying off plates, cost per running foot for laying off angles, shearing plates, chipping and calking and planing; cost per 100 holes for punching, reaming, drilling, and tapping; cost per 100 rivets for riveting. This method is an ideal method for securing data from which to determine rates for piece work and it should be noted that the method of planning the work through the yard is such that it is possible to secure it whenever desired by merely stating on the auxiliary job order that the total number of square feet of plates laid off, or the lineal feet of angle laid off, plates planed, number of holes punched or drilled, etc., is to be stated on the auxiliary job order when the job is closed out. This makes the progressman responsible for furnishing the information desired and the cost can be easily worked out from the total labor cost charged against that operation.

The old method is just as reliable if properly segregated and filed, however, and permits the completion of an estimate on new work in much less time and with a great deal less work.

A specification form used for listing data in accordance with the foregoing will insure reliable information concerning the cost of performing work in the yard and if in addition to this the market conditions, affecting the cost of the many things that are purchased outside, are kept constantly in touch with the preparation of estimates becomes more of a fact than a guess.

Plant Layout

THE BENEFITS DERIVED FROM AN EFFICIENT SYSTEM of planning and routing work will be very much greater if the idea of maximum output with the least handling has been followed in a shipyard plant layout.

Plant layout, therefore, is a factor in the shipbuilding industry which is of vast importance at any time and at the present time in particular. It is a subject which should be studied very closely where a new yard is to be built or where a reorganization or rearrangement of an existing yard is contemplated as any efforts expended in this direction will be more than compensated for in the increased production and economy resulting therefrom.

At the present time there are many shipyards which have been built during the war and as most of these yards will undertake to stay in the business, it appears certain that the shipbuilding world is approaching a period of competition keener than any ever before experienced, and it will be during this period that plant layout will count as never before.

The ideal condition is reached in a plant layout when the material is received in the yard and passes constantly forward from the storehouse through the various shops necessary for preparing it for installation and thence to the ways, repair dock or wherever its ultimate destination may be. The arrangement should be such that the work is constantly moving ahead, the shops being arranged in the sequence of the work they do and the machines in each shop also arranged so that work received at the rear end of a shop will pass through in the sequence of the operations to be performed, reaching the front end in a state of completion so far as that shop is concerned.

Thus the work goes ever forward, never doubling back, thereby insuring the greatest output with the least amount of handling and effecting economies not thought possible until demonstrated by actual results. It is not always practical nor possible to reach the ideal condition in plant layout, but the subject is worthy of earnest consideration and careful study.

Conclusion

THERE ARE, THEREFORE, THREE IMPORTANT FACTORS entering into a shipyard which make for its successful operation in a business which must be run on a strictly competitive basis. They are as follows:

First:—An efficient and practical system for co-ordinating the activities of a large body of men engaged in practically every branch of modern engineering.

Second:—The organization of a force of artisans skilled in the diverse activities necessary to the building of a modern vessel.

Third:—The scientific arrangement of the shipyard plant.

Each of these factors is dependent upon the other in so many ways that a yard that does not embody the three of them is working at a disadvantage to another yard which does.

It is evident that a force of skilled mechanics is absolutely essential to any yard.

Without an efficient system, however, the work of these mechanics is bound to be more or less aimlessly performed, and in this way there is a great deal of energy wasted which directly affects the shipbuilding company in the way of increased cost of production and loss of time due to improper co-ordination.

The third factor is essential to the other two in that it eliminates lost motion in the organization working in conformity to the system adopted.

In connection with the shipyard plant there is another salient point which is of great importance. This is the equipment used throughout the plant. A yard may have an exceptionally fine organization operating under a most efficient system in a plant ideally laid out, but if the tools furnished to work with are defective the results are bound to be unsatisfactory. A first-class man cannot be expected to turn out first-class work on an antiquated and poorly-built machine. It is, therefore, in the best interest of the yard to equip its plant with the highest grade of machinery and tools of every description, proper attention being given not only to the quality of the machines, but also to the quantity of work they are capable of turning out. The initial cost may be greater, but false economy in this respect has cost the shipbuilders many thousands of dollars, much loss of time, and general regrets.

Therefore the system, organization, and plant must be maintained in the highest state of efficiency if shipbuilding is to prove as profitable an undertaking as any other engineering venture.

The following pages show some typical yard and shop layouts of successful shipbuilding and repair yards in the United States, and accompanying them is a complete list of the equipment embodied in each.

LIST OF EQUIPMENT—LOWER PLANT

The Baltimore Dry Docks and Shipbuilding Co.

Blacksmith Shop

1001 *Steam Hammer*
1002 *Oil Combustion Furnace*
1003 *Steam Hammer*
1004 *Oil Combustion Furnace*
1005 *Steam Hammer*
1006 *Steam Hammer*
1007 *Emery Grinder*
1008 *Blower*
1009 *Blower*
1010 *Shear*

Copper Shop

1011 *Drill Press*
1012 *Emery Grinder*
1013 *Hand Punch*
1014 *Hand Shear*
1015 *Hand Power Rolls*

Central Tool Room

1016 *Lathe*
1017 *Twist Drill Grinder*
1018 *Emery Grinder*
1019 *Power Hack Saw*
1020 *Knife Grinder*
1021 *Power Motor*
1022 *Lathe*
1023 *Tool Grinder*

Pattern Shop

1024 *Embossing Machine*
1025 *Embossing Machine*
1026 *Embossing Machine*
1027 *Power Motor*
1028 *Planer*
1029 *Sander*
1030 *Sander*
1031 *Cross Cut and Rip Saw*
1032 *Band Saw*
1033 *Disc Sander*
1034 *Band Saw*
1035 *Band Saw Setting and Filing Machine*
1036 *Band Saw Filing Machine*
1037 *Pattern Makers' Lathe*
1038 *Pattern Makers' Lathe*
1039 *Pattern Makers' Lathe*

Pipe Shop

1040 *Pipe Cutting and Threading Machine*
1041 *Pipe Cutting and Threading Machine*
1042 *Pipe Cutting and Threading Machine*

Machine Shop

1043 *Pipe Cutting and Threading Machine*
1044 *Hand Power Coil Bender*
1045 10-*H.P. Power Motor*
1046 *Lathe*
1047 *Lathe*
1048 *Lathe*
1049 *Milling Machine*
1050 *Crank Shaper*
1051 *Lathe*
1052 *Emery Grinder*
1053 *Lathe*
1054 *Lathe*
1055 *Milling Machine*
1056 *Power Motor*
1057 *Lathe*
1058 *Lathe*
1059 *Drill Press*
1060 *Lathe*
1061 *Flat Turret Lathe*
1062 *Flat Turret Lathe*
1063 *Flat Turret Lathe*
1064 *Lathe*
1065 *Lathe*
1066 *Lathe*
1067 *Lathe*
1068 *Crank Shaper*
1069 *Crank Shaper*
1070 *Lathe*
1071 *Power Motor*
1072 *Power Motor*
1073 *Lathe*
1074 *Lathe*
1075 *Keyseating Machine*
1076 *Radial Press*
1077 *Planer*
1078 *Power Hack Saw*
1079 *Drill Press*

(Continued on next page)

No Layout of Yard Shown for Lower Plant

LIST OF EQUIPMENT—LOWER PLANT—Continued

The Baltimore Dry Docks and Shipbuilding Co.

Machine Shop—Continued

1080 *Centering Machine*
1081 *Horizontal Boring Mill*
1082 *Radial Press*
1083 *Emery Grinders*
1084 *Radial Press*
1085 *Planer*
1086 *Horizontal Boring Mill*
1087 *Bolt Cutter*
1088 *Bolt Cutter*
1089 *Turret Lathe*
1090 *Drill Press*
1091 *Tool Grinder*
1092 *Lathe*
1093 *Electric Hoist*
1094 *Bench Drill*
1095 *Power Hack Saw*
1096 *Lathe*
1097 *Drill Press*
1098 *Drill Press*
1099 *Lathe*
1100 *Lathe*
1101 *Vertical Turret Lathe*
1102 *Vertical Boring Mill*
1103 *Power Motor*
1104 *Planer*
1105 *Radial Press*
1106 *Radial Press*
1107 *Vertical Boring Mill*

Brass Foundry

1108 *Melting Furnace*
1109 *Melting Furnace*
1110 *Melting Furnace*
1111 *Core Oven*
1112 *Blower*
1113 *Melting Furnace*
1114 *Melting Furnace*
1115 *Melting Furnace*
1116 *Melting Furnace*

Punch Shed

1117 *Double Angle Shear*
1118 *Radial Press*

Punch Shed—Continued

1119 *Punch*
1120 *Shear*
1121 *Punch*
1122 *Bending and Straightening Rolls*
1123 *Punch and Shear*
1124 *Double End Punch*
1125 *Radial Drill*
1126 *Edge Plane*
1127 *Bridge Crane*

Mold Loft

1128 *Band Saw*

Joiner Shop

1129 *Emery Grinder*
1130 *Molder*
1131 *Hand Glue Press*
1132 *Band Saw*
1133 *Tenoning Machine*
1134 *Chisel Mortising Machine*
1135 *Surfacer*
1136 *Rip Saw*
1137 *Jig Saw*
1138 *Hand Joiner*
1139 *Variety Molder*
1140 *Grindstone*
1141 *Power Motor*

Carpenter Shop

1142 *Planer*
1143 *Band Saw*

Ship Shed

1144 *Radial Drill*
1145 *Punch*
1146 *Bolt Cutter*
1147 *Shear*
1148 *Bolt Cutter*
1149 *Power Motor*
1150 *Punch*
1151 *Punch*
1152 *Shear*

(*Continued on next page*)

No Layout of Yard Shown for Lower Plant

LIST OF EQUIPMENT—LOWER PLANT—Continued

The Baltimore Dry Docks and Shipbuilding Co.

Ship Shed—Continued

1153 *Horizontal Punch*
1154 *Bending Machine*
1155 *Emery Grinder*
1156 *Grinding Machine*
1157 *Edge Planer*
1158 *Blower*
1159 *Planing Mill Exhauster*

Angle and Plate Furnace Building

1160 *Furnace*
1161 *Furnace*

Compressor Building

1162 *Air Compressor*
1163 *Drill Press*

Dry Dock Pump House

1164 *Pump*
1165 *Pump*
1166 *Pump*

Compressor Building

1167 *Air Compressor*
1168 *Air Compressor*
1169 *Fuel Oil Pump*
1170 *Fuel Oil Pump*
1171 *Blower*
1172 *Air Compressor*

Transformer Building

1173 *Panel Board* }
1174 *Panel Board* } Second Floor
1175 *Panel Board* }
1176 *Transformers* }
1177 *Transformers* } First Floor
1178 *Transformers* }
1179 *Transformers* }
1180 *Transformers* } First Floor
1181 *Transformers* }

Boiler Room

1182 *Steam Boiler*
1183 *Steam Boiler*
1184 *Steam Boiler*
1185 *Water Heater*
1186 *Automatic Damper*
1187 *Steam Pump*
1188 *Steam Pump*

Power House

1189 *Switch Board*
1190 *Generator*
1191 *Generator*
1192 *Pump*
1193 *Pump*
1194 *Lathe*
1195 *Air Compressor*
1196 *Air Compressor*
1197 *Air Compressor*
1198 *Steam Pump*
1199 *Portable Emery Grinder*

Dry Dock Gate

1201 *Centrifugal Pump*

General Plant

1200 *Quadruple Geared Electric Hoist*
1202 *Locomotive Crane*
1203 *Locomotive Crane*
1204 *Locomotive Crane*
1205 *Locomotive Crane*
1206 *Locomotive Crane*
1207 *Locomotive Crane*
1208 *Locomotive Crane*
1209 *Locomotive Crane*
1210 *Locomotive Crane*
1211 *Horizontal Punch*
1212 *Coke Crusher*
1213 *Gasoline Pump*
1214 *Concrete Mixer*
1215 *Double Cylinder Steam Hoist*
1216 *3x2x3 Pump*
1217 *6x8" Double Cylinder Hoisting Engine*
1218 *Portable Air Compressor*
1219 *Pipe machine*
1220 *Steam Tug Solicitor No. 1*
1221 *Gasoline Tug Solicitor No. 2*
1222 *Gasoline Tug (Eva Lillian)*
1223 *Gasoline Tug (Locust Point)*
1224 *Gasoline Tug (Louisa)*
1225 *Coal Scow*
1226 *Coal Scow*
1227 *Coal Scow*
1228 *Scow*
1229 *Scow*

No Layout of Yard Shown for Lower Plant

LIST OF EQUIPMENT—UPPER PLANT

The Baltimore Dry Docks and Shipbuilding Co.

Building No. 1

1 *Electric Grinder*
2 *Punch*
3 *Power Motor*
4 *Shear*
5 *Punch*
6 *Punch*
7 *Bolt Cutter*
8 *Countersinking Machine*
9 *Angle Shear*
10 *Horizontal Punch*
11 *Drill Press*
12 *Bending and Straightening Machine*
13 *Power Motor*

Building No. 1, 2nd Floor—Mold Loft

14 *Band Saw*
15 *Power Motor*

Building No. 2

16 *Lathe*
17 *Crank Shaper*
18 *Edge Planer*
19 *Electric Hammer*
20 *Blower*
21 *Bending Rolls*

Building No. 3—Marine Railway Building

22 *Marine Railway Hoist*

Building No. 4—Marine Railway Building

23 *Steam Boiler and Engine*

Building No. 7—Boiler House

24 *Steam Boiler*
25 *Steam Boiler*

Building No. 8

26 *Steam Engine*
27 *Molder*
28 *Rip Saw*
29 *Timber Sizer*
30 *Jig Saw*
31 *Band Saw*
32 *Universal Saw*
33. *Grind Stone*

Building No. 8—2nd Floor

34 *Band Saw Filing Machine*
35 *Band Saw Stretching Machine*

Building No. 8—2nd Floor—Continued

36 *Band Saw Grinder*
37 *Emery Grinder*
38 *Planing Mill Exhauster*
39 *Blower*

Building No. 9

40 *Band Re-Saw*

Building No. 10

41 *Steam Boiler*
42 *Steam Boiler*
43 *Steam Boiler*
44 *Water Heater*
45 *Pump*
46 *Air Compressor*
47 *Air Compressor*
48 *Centrifugal Pump*
49 *Centrifugal Pump*
50 *Centrifugal Pump*
51 *Centrifugal Pump*
52 *3x2x3 Duplex Steam Pump*

Building No. 11

53 *Air Compressor*
54 *Air Compressor*
55 *Pump*

Building No. 15

56 *Emery Grinder*

Building No. 16

57 *Lathe*

Building No. 18

58 *Pipe Cutting and Threading Machine*

Building No. 23

59 *Steam Hoisting Engine*

Building No. 27—Drydock Gate

60 *Centrifugal Pump*

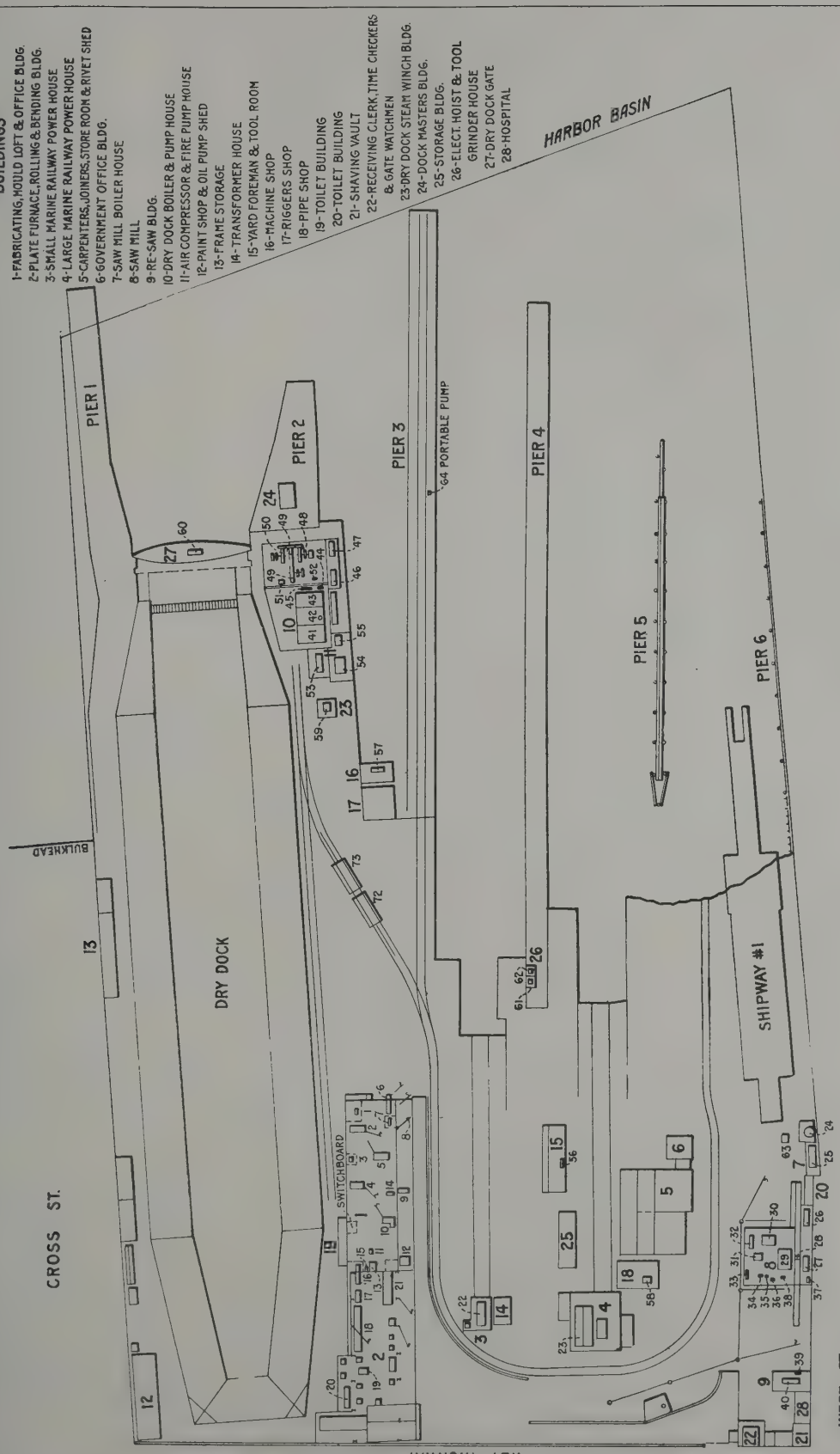
Building No. 26

61 *Electric Hoist*
62 *Emery Grinder*

General Plant

63 *Steam Hoist*
64 *Pump*

For Layout of Yard See Opposite Page



LAYOUT OF YARD—UPPER PLANT
The Baltimore Dry Docks and Shipbuilding Co.
Baltimore, Md.
For List of Equipment See Opposite Page

LIST OF EQUIPMENT—SOUTH PLANT

The Baltimore Dry Docks and Shipbuilding Co.

Building No. 1—General Office

2001 *Blue Print Washing and Drying Machine*
2002 *Blue Print Machine*
2003 *Low Pressure Boilers*
2004 *Vacuum Cleaning Pump*
2005 *Vacuum Pump for Heating System*
2006 *Charging Panel*

Building No. 3—Heating Plant

2007 *Circulating Pump*
2008 *Circulating Pump*
2009 *Centrifugal Pump*
2010 *Feed Pump*
2011 *Water Heater*
2012 *Feed Pump*
2013 *Feed Pump*
2014 *High Pressure Water Tube Boilers*
2015 *High Pressure Water Tube Boilers*

Building No. 4—2nd Floor—Mold Loft

2016 *Radial Wood Boring Machine*
2017 *Band Saw*
2018 *Planer*
2019 *Rip Saw*
2020 *Joiner*
2021 *Band Saw*
2022 *Radial Wood Boring Machine*
2023 *Electric Hoist*

Building No. 4—Mezzanine Floor—Tool Making Department

2024 *Power Hack Saw*
2025 *Flat Turret Lathe*
2026 *Tool Grinder*
2027 *Tool Grinder*
2028 *Milling Machine*
2029 *Lathe*
2030 *Lathe*
2031 *Lathe*
2032 *Tool Grinder*
2033 *Drill Press*
2034 *Drill Press*
2035 *Crank Shaper*
2036 *Lathe*
2037 *Milling Machine*
2038 *Milling Machine*
2039 *Emery Grinder*
2040 *Electric Furnace*
2041 *Electric Furnace*
2042 *Electric Furnace*
2043 *Tempering Plate*
2044 *Tempering Pot Furnace*
2045 *Tempering Drawing Plate*

Building No. 4—Mezzanine Floor—Tool Making Department—Continued

2046 *Electric Grinder*
2047 *Cooling Tank*

Building No. 4—1st Floor—Tool Repair Department

2048 *Knife Grinder*
2049 *Twist Drill Grinder*
2050 *Grinder*

Building No. 4—1st Floor—Fabricating Shop

2051 *Gate Shear*
2052 *Angle Shear*
2053 *Electric Hammer*
2054 *Furnace*
2055 *Pneumatic Power Hammer*
2056 *Beveling Machine*
2057 *Hydraulic Bending Machine*
2058 *Horizontal Bending Machine*
2059 *Drill Press*
2060 *Straightening Rolls*
2061 *Double End Punch*
2062 *Double End Punch*
2063 *Double End Punch*
2064 *Double End Punch*
2065 *Double End Punch*
2066 *Punch*
2067 *Punch*
2068 *Bar and Angle Furnace*
2069 *Bar and Angle Furnace*
2070 *Plate Furnace*
2071 *Blower*
2072 *Electric Hoist*
2073 *Hydraulic Ram*
2074 *Hydraulic Joggling Machine*
2075 *Horizontal Punch*
2076 *Bending Rolls*
2077 *Edge Planer*
2078 *Shear*
2079 *Countersinking Machine*
2080 *Shear*
2081 *Countersinking Machine*
2082 *Radial Press*
2083 *Edge Planer*
2084 *Punch*
2085 *Punch*
2086 *Punch*
2087 *Horizontal Punch*
2088 *Portable Countersinking Machine*
2089 *Drill Press*
2090 *Combination Oil and Gas Combustion Furnace*
2091 *Pneumatic Riveter*
2092 *Combination Oil and Gas Combustion Furnace*

(Continued on next page)

For Layout of Yard See Plate I Opposite Page 302

LIST OF EQUIPMENT—SOUTH PLANT—Continued

Building No. 4—1st Floor—Fabricating Shop—Continued

2093 *Pneumatic Riveter*
2094 *Emery Grinder*
2095 *Portable Scarphing Machine*
2096 *Bolt Cutter*
2097 *Plate Scarphing Machine*
2098 *Bending Rolls*
2099 *Jib Crane*
2100 *Bridge Crane*
2101 *Bridge Crane*
2102 *Monorail*
2103 *Electric Traveling Hoist*
2104 *Electric Traveling Hoist*
2105 *Electric Traveling Hoist*
2106 *Electric Traveling Hoist*
2107 *Electric Traveling Hoist*
2108 *Monorail Hoist*
2109 *Electric Traveling Hoist*
2110 *Bridge Crane*
2111 *Bridge Crane*
2112 *Portable Countersinking Machine*

Building No. 5—Boiler Shop

2113 *Blower*
2114 *Hydraulic Jib Crane*
2115 *Electric Hoisting Winch*
2116 *Hydraulic Jib Crane*
2117 *Hydraulic Flanging Machine*
2118 *Hydraulic Jib Crane*
2119 *Hydraulic Jib Crane*
2120 *Plate Vise or Clamping Machine*
2121 *Hydraulic Jib Crane*
2122 *Hydraulic Jib Crane*
2123 *Pneumatic Hammers*
2124 *Hydraulic Riveter*
2125 *Horizontal Multiple Drill*
2126 *Hydraulic Riveter*
2127 *Shear*
2128 *Hydraulic Jib Crane*
2129 *Punch*
2130 *Radial Drill*
2131 *Edge Planer*
2132 *Radial Press*
2133 *Bending Rolls*
2134 *Emery Grinder*
2135 *Punch*
2136 *Bolt Cutter*
2137 *Punch*
2138 *Drill Press*
2139 *Punch and Shear*
2140 *Shear*
2141 *Emery Grinder*
2142 *Welding Machine*

Building No. 5—Boiler Shop—Continued

2143 *Gate Shear*
2144 *Drill Press*
2145 *Drill Press*
2146 *Rotary Shear*
2147 *Power Bending and Brake*
2148 *Bridge Crane*
2149 *Bridge Crane*
2150 *Bridge Crane*
2151 *Portable Hand Bending Machine*
2152 *Portable Bending Rolls*

Building No. 6—Joiner Shop

2153 *Molder*
2154 *Band Saw*
2155 *Chisel Mortiser*
2156 *Jointer*
2157 *Planer*
2158 *Tenoning Machine*
2159 *Lathe*
2160 *Molder*
2161 *Variety Bench Saw*
2162 *Scroll Saw*
2163 *Panel Raiser*
2164 *Band Saw*
2165 *Hand Clamping Machine*
2166 *Elevator*
2166-A *Electric Hoist*

Building No. 6—Carpenter Shop

2167 *Swing Saw*
2168 *Jointer*
2169 *Vertical Borer*
2170 *Band Saw*
2171 *Grind Stone*
2172 *Grind Stone*
2173 *Planer*
2174 *Band Saw*
2175 *Surfacer*
2176 *Rip Saw*
2176A *Portable Hand Power Shear*

Building No. 6—Pipe Shop

2177 *Flanging Machine*
2178 *Pipe Cutting Machine*
2179 *Pipe Cutting Machine*
2180 *Pipe Cutting Machine*
2181 *Pipe Cutting Machine*
2182 *Pipe Cutting Machine*
2183 *Pipe Cutting Machine*
2184 *Pipe Cutting Machine*
2185 *Pipe Cutting Machine*
2186 *Elevator*

(*Continued on next page*)

For Layout of Yard See Plate I Opposite Page 302

LIST OF EQUIPMENT—SOUTH PLANT—Continued

Building No. 6—Machine Shop

2187 *Lathe*
2188 *Arbor Press*
2189 *Drill Press*
2190 *Emery Grinder*
2191 *Drill Press*
2192 *Crank Shaper*
2193 *Crank Shaper*
2194 *Vertical Turret Lathe*
2195 *Flat Turret Lathe*
2196 *Flat Turret Lathe*
2197 *Power Hack Saw*
2198 *Bolt Cutter*
2199 *Slotter*
2200 *Radial Drill*
2201 *Lathe*
2202 *Emery Grinder*
2203 *Engraving Machine*
2204 *Drill Press*
2205 *Drill Press*

Building No. 7—Power House

2206 *Air Compressor*
2207 *Air Compressor*
2208 *Air Compressor*
2209 *Hydraulic Pump*
2209A *Hydraulic Accumulator*
2210 *Air Compressor*
2211 *Oil Pump*
2212 *Oil Pump*
2213 *Oil Pump*
2214 *Rotary Converter*
2215 *Rotary Converter*
2216 *Main Plant Switchboard*
2217 *Rotary Converter*
2218 *Transformer*
2219 *Transformer*
2220 *Transformer*
2221 *Transformer*
2222 *Transformer*
2223 *Transformer*
2224 *Transformer*
2225 *Transformer*
2226 *Transformer*
2227 *Transformer*
2228 *Transformer*
2229 *Transformer*
2230 *Transformer*
2231 *Transformer*
2232 *Transformer*
2233 *Transformer*
2234 *Transformer*
2235 *Transformer*
2236 *Transformer*
2237 *Transformer*
2238 *Transformer*

Building No. 8—Riggers

2239 *Sewing Machine*
2240 *Elevator*

Building No. 8—Electric Shop

2241 *Lathe*
2241A *Electric Grinder*

Building No. 10—Employees' Entrance—Time Checkers

2242 *Low Pressure Steam Boiler*

Building No. 20—Acetylene Gas Plant

2243 *Horizontal Acetylene Compressor*

Building No. 26

2244 *Punch and Shear*
2245 *Emery Grinder*

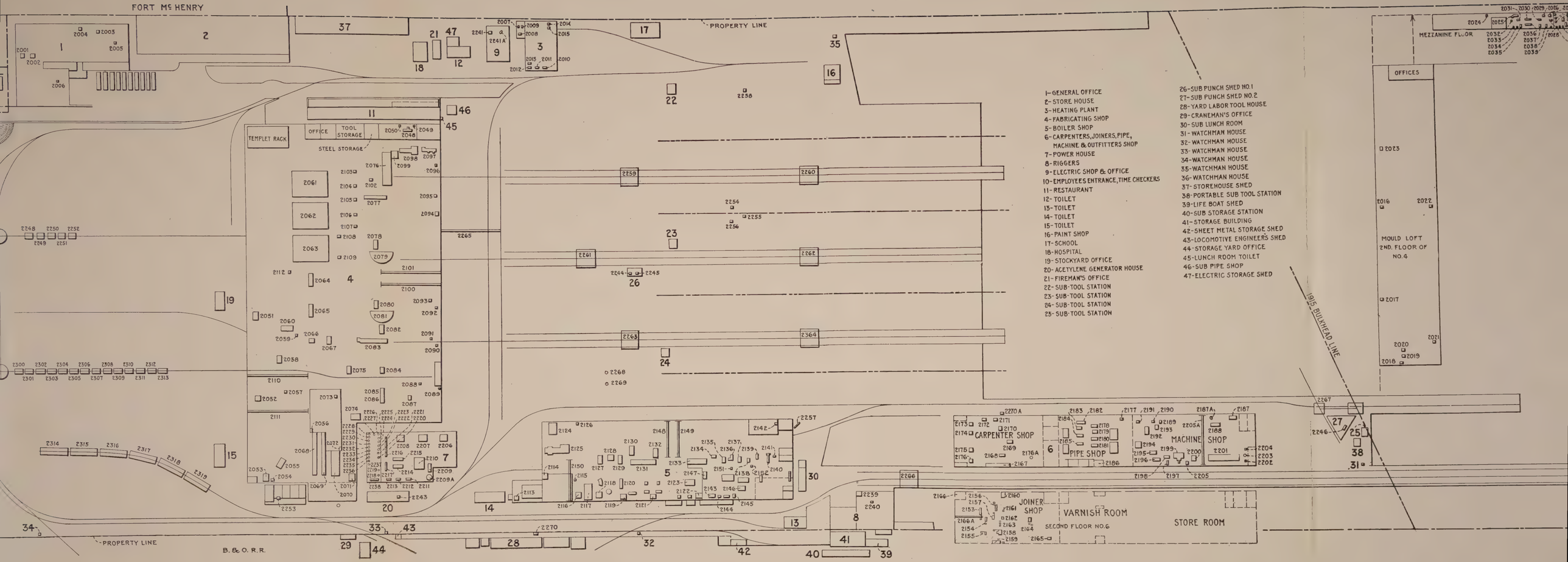
Building No. 27—Sub-Punch Shed

2246 *Punch and Shear*

General Plant

2247 *Locomotive*
2248 *Crane Locomotive*
2249 *Crane Locomotive*
2250 *Crane Locomotive*
2251 *Crane Locomotive*
2252 *Crane Locomotive*
2253 *Coke Crusher*
2254 *Bolt Cutter*
2255 *Bolt Cutter*
2256 *Shear*
2257 *Bending Rolls*
2258 *Paper Baling Press*
2259 *Tower Crane*
2260 *Tower Crane*
2261 *Tower Crane*
2262 *Tower Crane*
2263 *Tower Crane*
2264 *Tower Crane*
2265 *One Leg Gantry Crane*
2266 *Tower Crane*
2267 *Stiff Leg Derrick*
2268 *Vertical Steam Boilers*
2269 *Launching Triggers*
2270 *Concrete Mixer*
2270A *Portable Deck Planer*
2300 *Hand Push Car*
2301 *Hand Push Car*
2302 *Hand Push Car*
2303 *Hand Push Car*
2304 *Hand Push Car*
2305 *Hand Push Car*
2306 *Hand Push Car*
2307 *Hand Push Car*
2308 *Hand Push Car*
2309 *Hand Push Car*
2310 *Hand Push Car*
2311 *Hand Push Car*
2312 *Hand Push Car*
2313 *Hand Push Car*
2314 *Hand Push Car*
2315 *Eight Wheel Flat Car*
2316 *Eight Wheel Flat Car*
2317 *Eight Wheel Flat Car*
2318 *Eight Wheel Flat Car*
2319 *Eight Wheel Flat Car*

For Layout of Yard See Plate I Opposite This Page



LAYOUT OF YARD—SOUTH PLANT
The Baltimore Dry Docks and Shipbuilding Co.
Baltimore, Md.

OUTSIDE EQUIPMENT LIST

Key No.	Description	Size
1	*Sheer Legs*	100 *Tons*
2	*Oil and Water Tanks*	
3	*Oil Tank*	9,000 *Gal.*
4	*Elect. Locomotive*	
5	*Oil Tanks*	3—9,000 *Gal.*
6	*Stiff Leg Derrick*	5 *Tons*

CRANE LIST

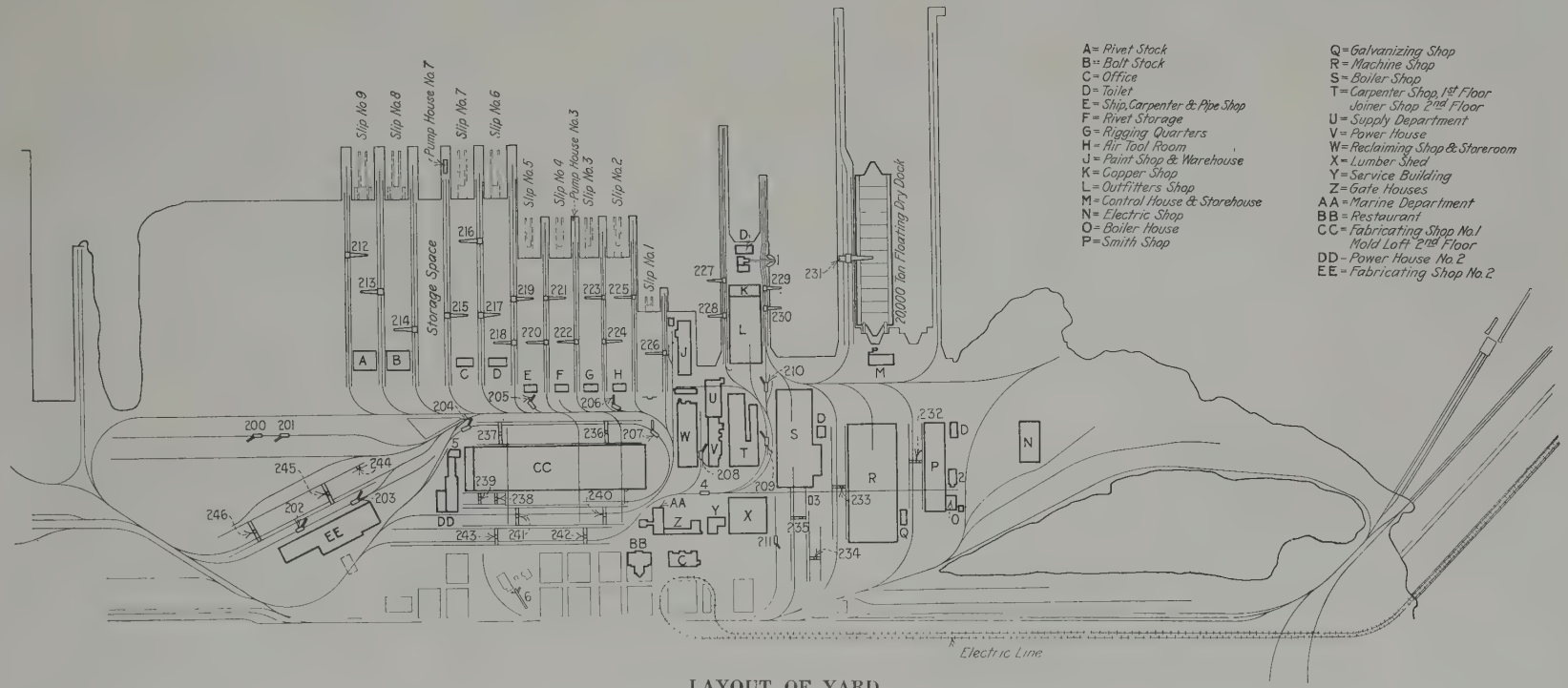
Key No.	Type	Operation	No.
200-201	*Locomotive*	*Steam*	2
202	*Locomotive*	*Steam*	1
203	*Locomotive*	*Steam*	1

CRANE LIST—Continued

Key No.	Type	Operation	No.
204	*Locomotive*	*Steam*	1
205	*Locomotive*	*Steam*	1
206	*Locomotive*	*Steam*	1
207	*Locomotive*	*Steam*	1
208	*Locomotive*	*Steam*	1
209-211	*Locomotive*	*Steam*	3
212-214	*Tower*	*Electric*	3
215-218	*Tower*	*Electric*	4
219-220	*Tower*	*Steam*	2
221-225	*Tower*	*Electric*	5
226	*Tower*	*Steam*	1
227-230	*Tower*	*Steam*	4

CRANE LIST—Continued

Key No.	Type	Operation	No.
231	*Hammerhead*	*Electric*	1
232	*Single Leg Gantry*	*Electric*	1
233	*Single Leg Gantry*	*Electric*	1
234	*Bridge*	*Electric*	1
235	*Single Leg Gantry*	*Electric*	1
236-237	*Single Leg Gantry*	*Electric*	2
238	*Bridge*	*Electric*	1
239	*Bridge*	*Electric*	1
240-241	*Bridge*	*Electric*	2
242-243	*Single Leg Gantry*	*Electric*	2
244	*Bridge*	*Hand*	1
245-246	*Bridge*	*Electric*	**2**



LAYOUT OF YARD

Sparrow's Point Plant—Bethlehem Shipbuilding Corporation

POWER HOUSE NO. 1—EQUIPMENT LIST

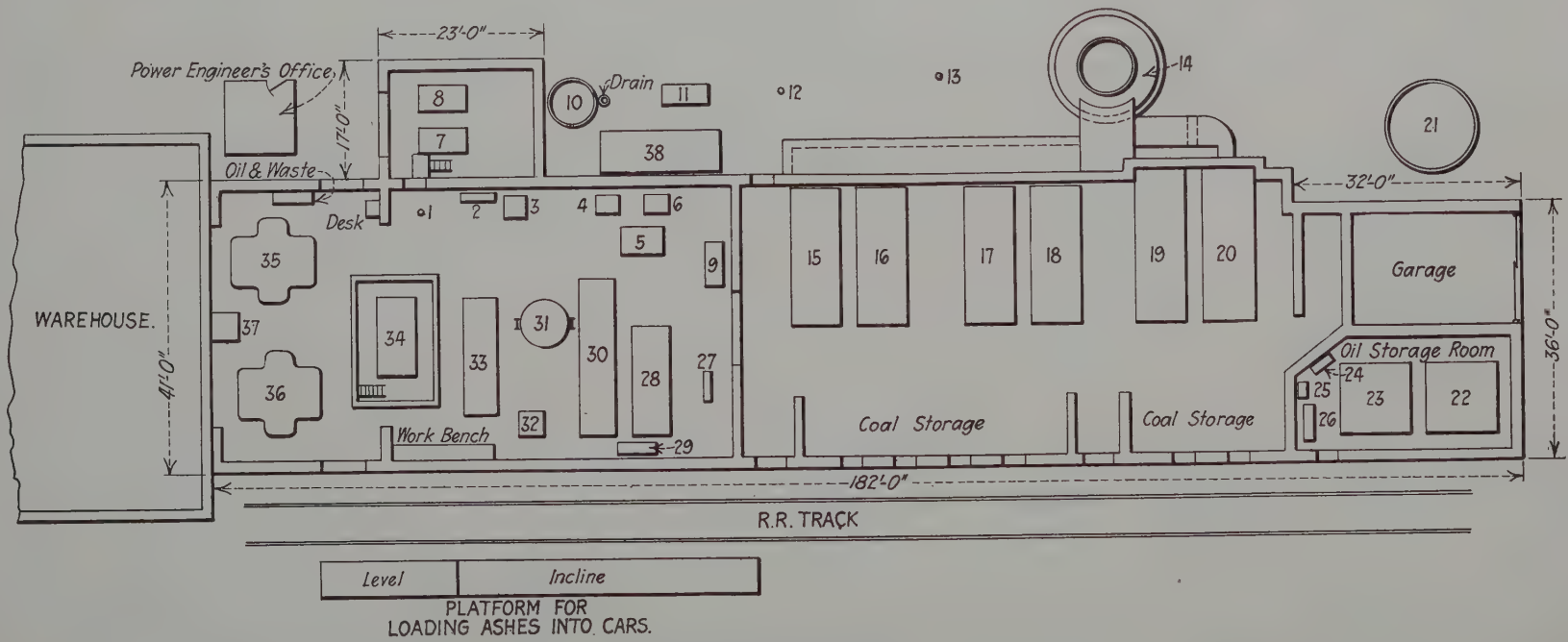
Key No.	Description	Size
1	*Artesian Well*	85′—0″ *Deep*
2	*Heating Return Pump*...	5′—6″x10″
3	*Feed Water Heater*.....	35″x11′—0″
4	*Boiler Feed Pump*	12″x8″x24″
5	*Service Pump*	18½″x8½″x10″
6	*Boiler Feed Pump*.....	12″x8″x24″
7-8	*Fire Pump*	8″x10″x12″
9	*Tank Pump*	12″x7″x12″
10	*Water Filter*	6′—8″x9′—9″
11	*Duplex Pump*	12″x7″x12″

POWER HOUSE NO. 1—EQUIPMENT LIST—Continued

Key No.	Description	Size
12	*Artesian Well*	187′—0″ *Deep*
13	*Artesian Well*	287′—0″ *Deep*
14	*Stack*	
15–18	*Boiler*	150 *H.P.*
19–20	*Boiler*	220 *H.P.*
21	*Stand Pipe*	12′—0″x42′—0″
22–23	*Oil Storage Tanks*.....	10′—0″x10′- 0″
24	*Pump*	6″x4″x6″
25	*Pump*	4½″x3″x4″
26	*Pump*	6″x10″x12″
27	*Blower*	

POWER HOUSE NO. 1—EQUIPMENT LIST—Continued

Key No.	Description	Size
28	*Hyd. Pump*	18″x28″x4½″x18″
29	*Drinking Water Pump*...	10″x7″x12″
30	*Hyd. Pump*	19″x30″x4⅞″x24″
31	*Hyd. Accumulator*	1800#
32	*Water Storage Tank*....	42″x16′—0″
33	*Air Compressor*.....	700 *Cu. Ft. P.M.*
34	*Duplex Pump*	14″x22″x24″
35–36	*Air Compressor*.....	30″ *Stroke*
37	*Air Receiver*	*Cap.* 550 *Cu. Ft.*
38	*Water Storage Tank*.....	6′—0″x17′—0″



POWER HOUSE NO. 1

Sparrow's Point Plant—Bethlehem Shipbuilding Corporation

CARPENTER SHOP EQUIPMENT LIST

Key No.	Description	Size
1	Rack for Mouldings	
2	Rack for Mouldings	
3	Rack for Mouldings	
4	Engine for Blower	5" Stroke
5	Blower Fan	7'—4" Dia.
6	Work Bench	
7	Boring Machine	
8	Moulding Machine	
9	Joiner	
10	Boring Machine	
11	Swing Saw	
12	Tennoning Machine	

CARPENTER SHOP EQUIPMENT—Continued

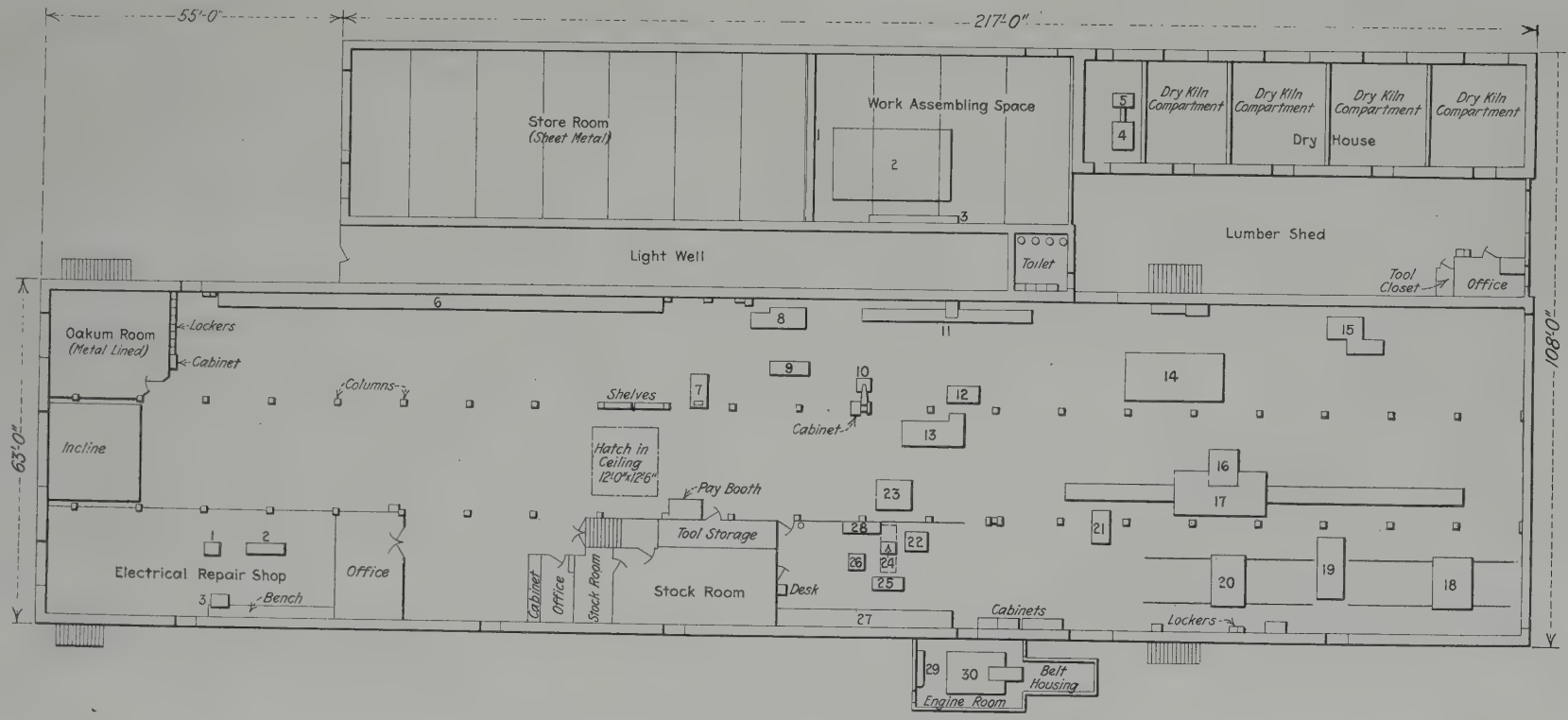
Key No.	Description	Size
13	Moulding Machine	
14	Planer	
15	Rip Saw	
16	Blower Fan	50" Dia.
17	Planer	
18	Lumber Truck	
19	Band Saw	
20	Lumber Truck	
21	Mortising Machine	
22	Cutter and Grinder	
23	Planer	
24	Saw Filer	

CARPENTER SHOP EQUIPMENT—Continued

Key No.	Description	Size
25	Grindstone	3'—6" Dia.
26	Saw Grinder	
27	Work Bench	
28	Work Bench	
29	Work Bench	
30	Steam Engine	175 H.P.

ELECTRICAL SHOP EQUIPMENT LIST

Key No.	Description	Size
1	Drill Press	18" Table
2	Lathe	12"
3	Electric Motor	7½ H.P.



CARPENTER AND ELECTRICAL REPAIR SHOP

Sparrow's Point Plant—Bethlehem Shipbuilding Corporation

BOILER SHOP—EQUIPMENT LIST

Key No.	Description	Size
1–2	*Coal Forge*	
3–4	*Bending Slabs*	5′—0″x5′—0″
5	*Vertical Plate Rolls*	1¾″ *Plate*
6–7	*Oil Furnace*	1 *Burner*
8	*Portable Hyd. Riveter*	1⅝″ *Rivets*
9	*Bending Rolls*	8″ *Dia.* x 8′—0″
10	*Anvil*	
11	*Radial Countersinking Mach.*	15′—0″ *Rad.*
12	*Radial Drill*	44″ *Rad.*
13	*Radial Drill*	6′—0″ *Rad.*
14	*Shear*	⅝″ *Plate*
15	*Drill Press*	4′—6″ *Rad.*
16	*Punch*	2″ *Hole*
17	*Radial Drill*	12′—0″ *Rad.*
18	*Punch*	1½″ *Hole*
19	*Steel Pressure Blower*	3.47oz. Per □″
20	*Plate Planer*	16′—0″ Stroke
21	*Drill Press*	*Dia. Work* 12″
22	*Comb. Punch and Shear*	*Shear* ⅜″
23	*D. C. Motor*	75 *H.P.*
24	*Oil Pump*	
25	*Pressure Oil Tank*	2′—8″x7′—0″
26	*Double Grinder*	
27	*Double Angle Shear*	4″x4″x⅜″
28	*Oil Furnace*	1 *Burner*
29	*Oil Furnace*	7 *Burners*

BOILER SHOP—EQUIPMENT LIST—Continued

Key No.	Description	Size
30	*Hydraulic Riveter*	1⅝″ *Rivets*
31–32	*Coal Forges*	
33–34	*Bending Slabs*	
35	*Hydraulic Press*	120 *Ton*
36	*Shear*	1½″ *Plate*
37	*Flanging Clamp*	12′—9″ *Long*
38	*Hot Punch*	15/16″ *Hole*
39	*Comb. Punch and Shear*	1⅝″ *Dia. Bolts*
40	*Motor*	50 *H.P.*
41	*Boiler Shell Drill*	18′ *Dia. Boiler*
42–44	*Coal Forges*	
45	*Anvil*	
46–48	*Bending Slabs*	
49	*Steam Hammer*	250#—300#
50	*Rivet and Bolt Machine*	1¼″
51	*Rivet and Bolt Machine*	2″
52–53	*Oil Furnaces*	2 *Burners*
54	*Rivet Rumbler*	
55	*Platform Scale*	
56	*Steel Pressure Blower*	3.47oz. Per □″
58	*Grinder*	
59	*Bolt Cutter*	1″ to 2½″
60	*Threading Machine*	2″
61	*Turret Lathe*	2″
62	*Engine Lathe*	16″ *Swing*
63	*Drill Press*	12″ *D. Plate*

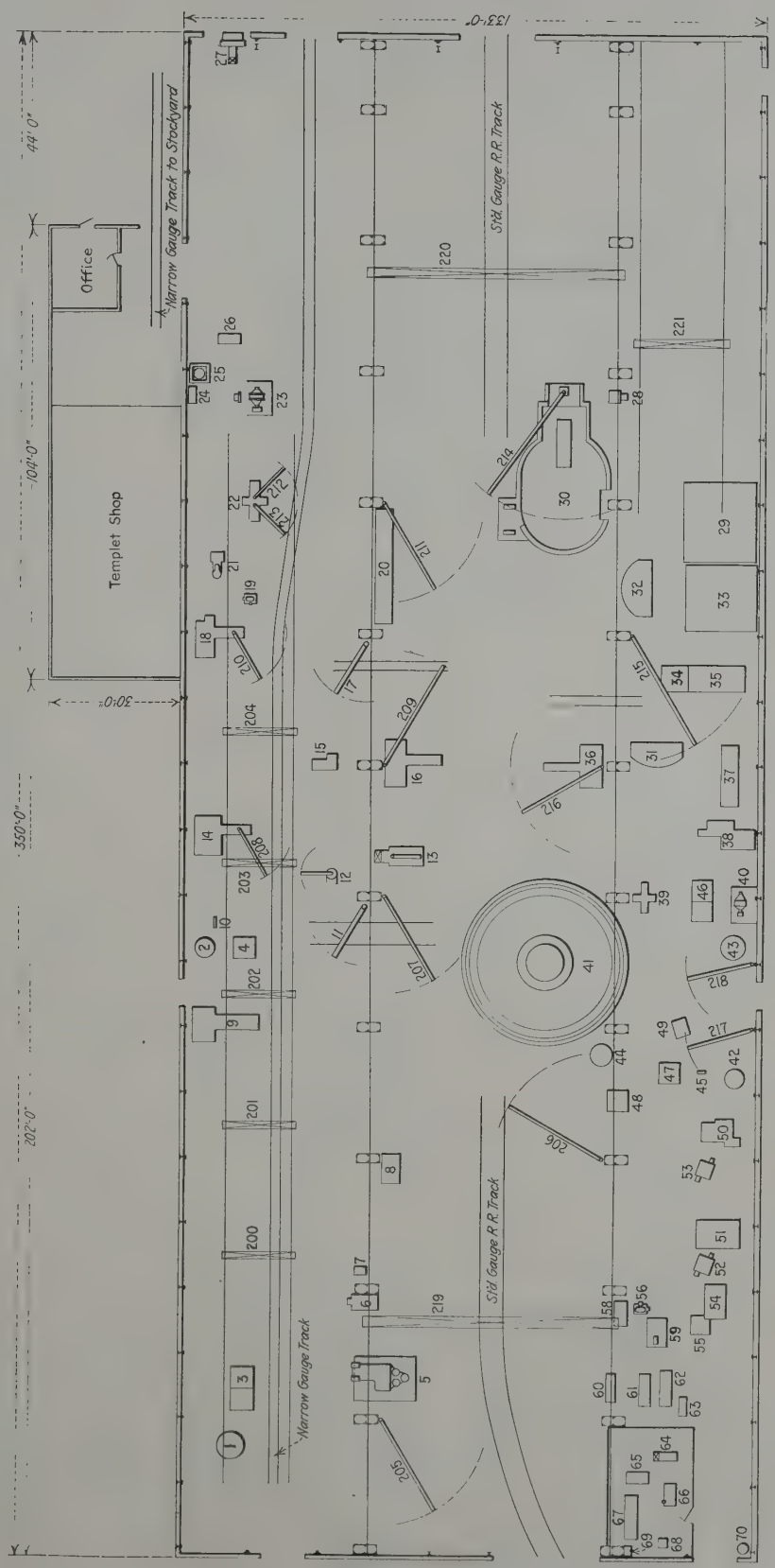
See Opposite Page for Layout of Shop

BOILER SHOP—EQUIPMENT LIST—Continued

Key No.	Description	Size
64	*Power Hack Saw*	
65	*Shaper*	6″ *Stroke*
66	*Work Bench*	
67	*Machine Lathe*	20″ *Swing*
68	*Double Grinder*	
69	*Windlass for Lifting Doors*	
70	*Air Tank*	

BOILER SHOP—CRANE LIST

Key No.	Type	Operation	No.
200–201	*Bridge*	*Hand*	2
202–204	*Bridge*	*Hand*	3
205–206	*Jib*	*Hand*	2
207	*Jib*	*Hand*	1
208	*Jib*	*Hand*	1
209	*Jib*	*Hand*	1
210	*Jib*	*Hand*	1
211	*Jib*	*Hand*	1
212–213	*Jib*	*Hand*	2
214	*Jib*	*Hand*	1
215	*Jib*	*Hand*	1
216	*Jib*	*Hand*	1
217–218	*Jib*	*Hand*	2
219	*Bridge*	*Electrical*	1
220	*Bridge*	*Electrical*	1
221	*Bridge*	*Electrical*	1



BOILER SHOP

Sparrow's Point Plant—Bethlehem Shipbuilding Corporation

See Opposite Page for List of Equipment

MAIN FLOOR—EQUIPMENT LIST

Key No.	Description	Size
1	*Fan Heating System*	
3	*Test Pump*	
4–5	*Racks*	
6–9	*Work Benches*	
10–11	*Sensitive Drill Presses*	
12	*Laying Out Table*	
13	*Drill Press*	24″
14	*Work Bench*	
15	*Freight Elevator*	4 *Ton*
16	*Tool Grinder*	
17	*Erecting Platens*	3—15′x36′
18	*Hydraulic Press*	96″—400 *Ton*
19	*Emery Grinder*	24″ *Dia.* 4″ *Face*
20	*Grindstone*	
21	*Shaper*	16″
22	*Revolving Tool Table*	
23	*Platen*	
24	*Screw Cutting Eng. Lathe*	33″x27′—0″
25–26	*Radial Drill*	5′—0″ *Rad.*
27	*Turret Lathe*	2″x24″
28–31	*Engine Lathes*	20″x10′—6″
32–35	*Engine Lathes*	20″x14′—0″
36–37	*Engine Lathes*	21″x14′—0″
38	*Engine Lathes*	21″x18′—0″
39–42	*Screw C'ting Eng. Lathes.*	30″x12′—0″
43	*Revolving Tool Table*	
44	*Table*	
45	*Storage Bins*	
46	*Fuse Panel*	
47	*Arbor Press*	
48	*Screw C'ting Eng. Lathe.*	30″x17′—6″
49	*Engine Lathe*	30″x19′—6″
50–52	*Engine Lathes*	21″x14′—0″
53–54	*Engine Lathes*	19″x10′—0″
55–56	*Screw Cutting Eng. Lathes*	16″x10′—0″
57–60	*Engine Lathes*	19″x12′—0″
61	*Panel*	
62	*Fan Heating System*	
63	*Stock Rack*	
64–65	*Revolving Tool Tables*	
66–67	*Turret Lathes*	2¼″x24″

MAIN FLOOR—EQUIPMENT LIST—Continued

Key No.	Description	Size
68	*Engine Lathe*	21″x12′—0″
69–70	*Engine Lathes*	19″x12′—0″
71–72	*Screw Cutting Lathes*	20″x17′—0″
73	*Screw Cutting Lathe*	24″x18′—0″
74–75	*Lathes*	16″x8′—0″
76	*Screw Cutting Lathe*	20″x12′—0″
77	*Screw Cutting Lathe*	22″x12′—0″
78	*Engine Lathe*	20″x12′—0″
79	*Turret Lathe*	26″x10′—0″
80	*Vertical Slotter*	36″
81	*Rack*	
82	*Hack Saw*	
83	*Centering Lathe*	5″x2′—8″
84	*Speed Lathe*	12″x6′—0″
85–86	*Engine Lathe*	19″x8′—6″
87	*Platen*	10′—0″x5′—0″
88	*Platen*	13′—2″x26′—2′
89	*Fuse Panel*	
90	*Planer*	16′x16′x40′
91	*Revolving Tool Table*	
92	*Key Seater*	48″ *Stroke*
93	*Boring and Turning Mill.*	25′—0″
94	*Card Rack*	
95	*Shaper*	26″ *Stroke*
96–107	*Revolving Tool Tables*	
108	*Rack*	
109	*Racks*	
110	*Storage Rack*	
111	*Double-Head Shaper*	26″ *Stroke*
112	*Shaper*	24″ *Stroke*
113	*Planer*	48″x48″x14′—0″
114	*Planer*	24″x24″x8′—0″
115	*Boring and Facing Post Mill*	6½″
116	*Planer*	60″x60″x15′—9″
117–118	*Crank Shapers*	24″ *Stroke*
119	*Planer*	30″x30″x12′—0″
120	*Planer*	36″x36″x12′—0″
121	*Vertical Slotter*	12″ *Stroke*
122	*Crank Slotting Mach.*	12″ *Stroke*
123	*Crank Slotting Mach.*	15″ *Stroke*

MAIN FLOOR—EQUIPMENT LIST—Continued

Key No.	Description	Size
124	*Crank Slotting Mach.*	24″ *Stroke*
125	*Horiz. Boring & Fac'g Mach.*	
126	*Shaper*	24″ *Stroke*
127	*Planer*	36″x36″x9′—6″
128	*Radius Table*	
129	*Wet Tool Grinder*	
130	*Single Head Bolt Cutter.*	4″
131	*Single Head Bolt Cutter.*	4″
132	*Single Head Bolt Cutter.*	2″
133	*Radial Drill*	5′—0″
134	*Radial Drill*	5′—0″
135	*Lathe*	54″x36′—0″
136	*Radial Drill*	8′—0″
137	*Radial Drill*	7′—0″
138	*Drill Press*	36″ *Dia. WK.*
139	*Dry Tool Grinder*	
140–141	*Radial Drills*	5′—0″
142	*Drill Press*	24″
143	*Drill Press*	36″
144	*Vert. Milling Mach.*	40″x20″
145	*Upright Drill Press*	24″
146	*Heavy Duty Eng. Lathe*	60″x62′—0″
147	*Revolving Tool Table*	
148	*Engine Lathe*	48″x50′—0″
149	*Engine Lathe*	48″x21′—6″
150	*Vert. Boring Mill*	
151	*Side Head Boring Mill*	36″x44″
152–153	*Vert. Bor. & Turn Mills*	62″
154	*Boring & Turning Mill*	72″
155	*Work Bench*	
156	*Tables*	
157	*Univ. Turret Scr. Cutting Mach.*	1½″x10″
158	*Univ. Turret Scr. Cutting Mach.*	3¼″x29″
159	*Univ. Turret Scr. Cutting Mach.*	2½″x29″
160	*Transformer*	
161	*Vert. Boring Mach.*	10′—0″
162	*Reaming Lathe*	20″x5′—0″
163	*Work Bench*	
164	*Vert. Boring Mill*	36″
165	*Erecting Platen*	15′—0″x108′—0″
166	*Work Bench*	

(*Continued on next page*)

MAIN FLOOR—EQUIPMENT LIST—Continued

Key No.	Description	Size
167	*Horiz. Boring Mill*	5'—0"
168	*Horiz. Boring Mill*	5'—0"
169–170	*Platen*	
171	*Dry Grinder*	
172	*Swing Grinder*	
173	*Grinder&Polishing Mach.*	
174	*Grinder*	
175	*Bench*	
176	*Safety Emery Grinder*	
177	*Strap Polishing Mach.*	
178	*Drying Oven*	

MAIN FLOOR—EQUIPMENT LIST—Continued

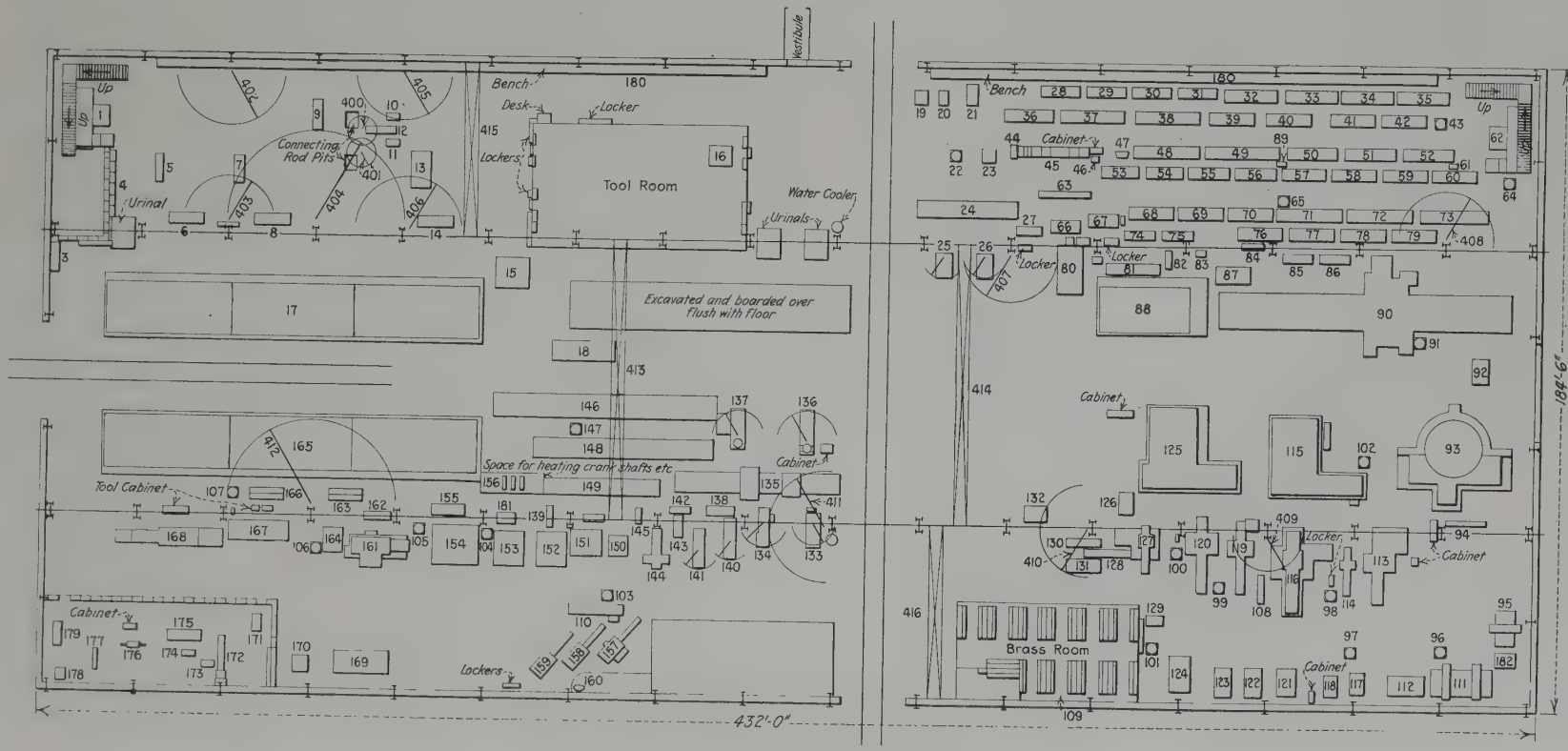
Key No.	Description	Size
179	*Double Dry Grinder*	
180	*Vise Bench*	
181	*Wet Tool Grinder*	
182	*Back Geared Shaper*	25" Stroke

MAIN FLOOR—CRANE LIST

Key No.	Type	Operation	No.
400–401	*Davit*	*Hand*	2
402	*Jib*	*Hand*	1
403	*Jib*	*Hand*	1
404	*Jib*	*Hand*	1

MAIN FLOOR—CRANE LIST—Continued

Key No.	Type	Operation	No.
405	*Jib*	*Hand*	1
406	*Jib*	*Hand*	1
407–408	*Jib*	*Hand*	2
409	*Jib*	*Hand*	1
410	*Jib*	*Hand*	1
411	*Jib*	*Hand*	1
412	*Jib*	*Hand*	1
413	*Bridge*	*Electric*	1
414	*Bridge*	*Electric*	1
415	*Bridge*	*Electric*	1
416	*Bridge*	*Electric*	1



MACHINE SHOP—MAIN FLOOR

Sparrow's Point Plant—Bethlehem Shipbuilding Corporation

GALLERY—EQUIPMENT LIST

Key No.	Description	Size
183–202	*Work Benches*	
203–212	*Work Tables*	
213–218	*Vise Benches*	
219–221	*Laying Out Tables*.....	
222 223	*Valve Testing Tables*....	
224	*Chipping Table*.....	
225–226	*Revolving Tool Tables*..	
227–239	*Tool Racks*	
240–244	*Stock Racks*	
245	*Hyd. Valve Seat Press*..	½ *Ton*
246	*Radial Drill*	5′—0″ *Rad.*
247	*Drill Press*	36″
248	*Key Seat Milling Mach*..	
249	*Key Seater*	
250	*Nut Facing Machine*....	
251	*Semi-Univ. Radial Drill.*	5′—0″ *Rad.*
252	*Drill Press*	32″
253–254	*Engine Lathe*	19″x5′—0″
255–257	*Engine Lathe*	21″x7′—6″
258–259	*Engine Lathe*	17″x4′—0″
260	*Screw Cut. Eng. Lathe*..	24″x14′—0″
261–262	*Screw Cut. Eng. Lathe*..	16″x8′—0″
263	*Screw Cut. Eng. Lathe*..	18″x15′—0″
264	*Boring Mill*	34″x42″
265	*Side Head Boring Mill*..	36″x44″

GALLERY– EQUIPMENT LIST—Continued

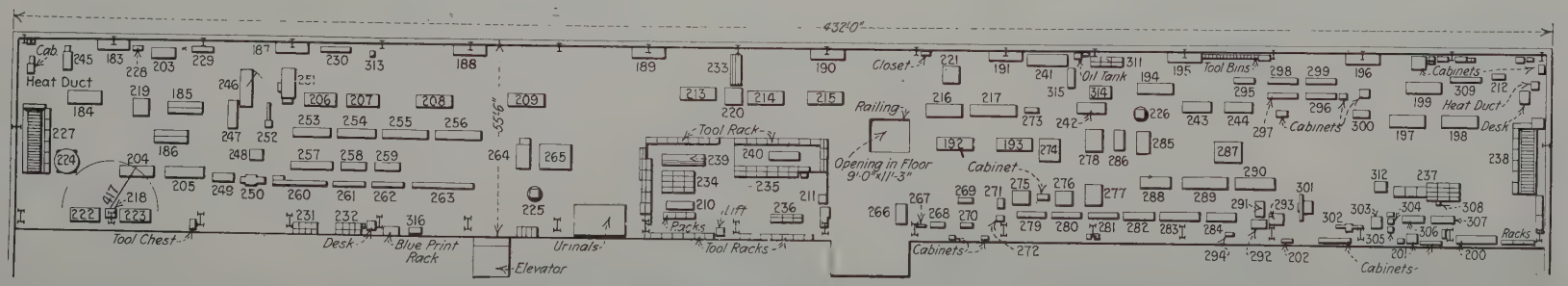
Key No.	Description	Size
266	*Wet Tool Grinder*	
267	*Double Grinder*	
268	*Drill Press*	26″
269	*Drill Press*	22½″
270	*Drill Press*	20″
271–272	*Sensitive Drill*	
273	*Arbor Press*	
274	*Plain Milling Machine*...	
275–276	*Milling Machine*	1½″
277	*Plain Milling Machine*...	
278	*Univ. Milling Machine*...	
279	*Screw Cutting Lathe*...	15″x6′—0″
280–281	*Engine Lathe*	18″x8′—0″
282	*Scr. Cutting Lathe*.....	18″x8′—0″
283	*Engine Lathe*	21″x6′—0″
284	*Scr. Cutting Lathe*.....	16″x4′—2″
285	*Crank Shaper*	20″ *Stroke*
286	*Auto. Spur Gear Cutter*..	
287	*Auto. Bevel Gear Cutter*.	
288	*Scr. Cutting Lathe*.....	16″x8′—0″
289	*Scr. Cutting Lathe*.....	16″x12′—0″
290	*Scr. Cutting Lathe*.....	20″x10′—0″
291	*Shaper*	16″ *Stroke*
292	*Drill Press*	24″
293	*Univ. Grinder*	

GALLERY—EQUIPMENT LIST—Continued

Key No.	Description	Size
294	*High Speed Press*.....	
295	*Univ. Monitor Lathe*....	14″
296–297	*Univ. Monitor Lathe*....	18″
298–299	*Univ. Monitor Lathe*....	20″
300	*Upright Drill Press*.....	24″
301	*Univ. Grinder*	
302	*Univ. Grinder*	
303	*Twist Drill Grinder*.....	
304	*Grinder*	
305	*Drill Grinder*	
306	*Lathe*	14″x2′—4″
307	*Lathe*	16″x26″
308	*Tool Grinder*	
309	*Cast Iron Facing Block*..	
311	*Stock Rack*	
312	*Cutter & Tool Grinder*..	
313	*Sensitive Drill Press*....	
314	*Centering Machine*	6″—2 *Spindle*
315	*Power Hack Saw*	
316	*Dry Tool Grinder*	

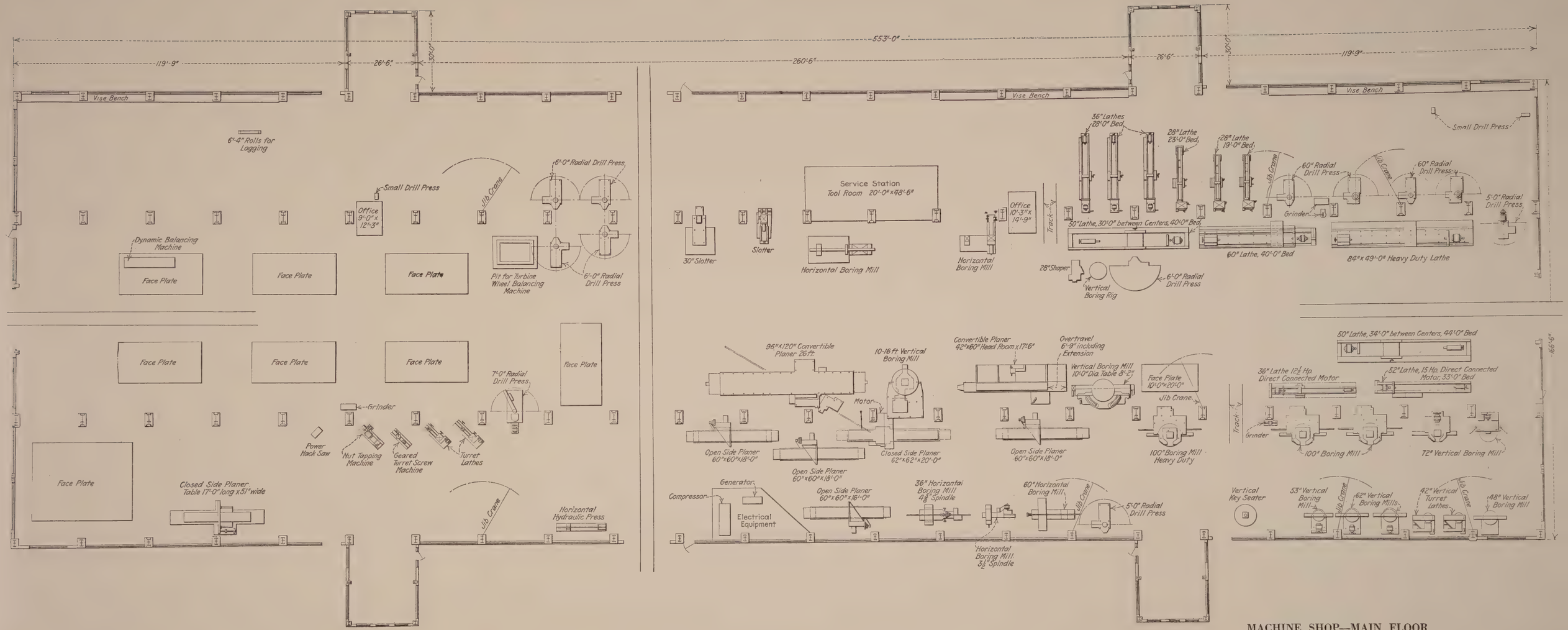
GALLERY—CRANE LIST

Key No.	Type	Operation	No.
417	*Jib*	*Hand*.....	1
418	*Bridge*	*Electric*.....	1



MACHINE SHOP—GALLERY

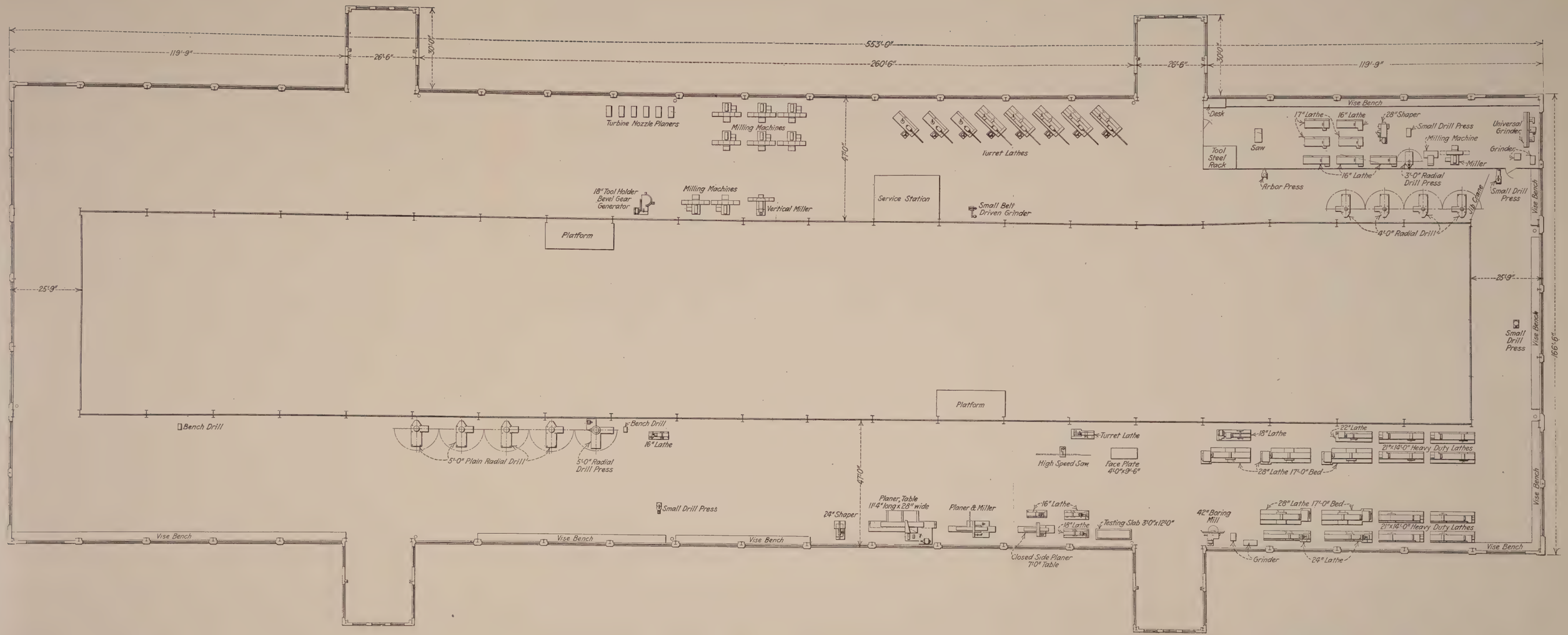
Sparrow's Point Plant– Bethlehem Shipbuilding Corporation



MACHINE SHOP—MAIN FLOOR

Alameda Yard of Union Iron Works — Bethlehem Shipbuilding Corporation

PLATE II



MACHINE SHOP—GALLERY

Alameda Yard of Union Iron Works

Bethlehem Shipbuilding Corporation

PLATE III

BLACKSMITH SHOP—EQUIPMENT LIST

Key No.	Description	Size
1	*Steam Hammer*	1100#
2	*Trimming Press*	
3	*Steam Hammer*	1000#
4	*Trimming Press*	60" *Stroke*
5	*Steam Hammer*	3000#
6	*Steam Hammer*	2000#
7	*Trimming Press*	
8	*Air Elec. Hammer*	800#
9	*Steam Hammer*	2500#
10	*Forging Machine*	4"
11	*Forging Machine*	2½"
12	*Hot Saw & Burring Mach.*	
13	*Steam Hammer*	1100#
14	*Centrifugal Air Compressor*	8800 *Cu. Ft.*
15	*Steam Hyd. Forging Press*	500 *T.*

BLACKSMITH SHOP—EQUIPMENT LIST—Continued

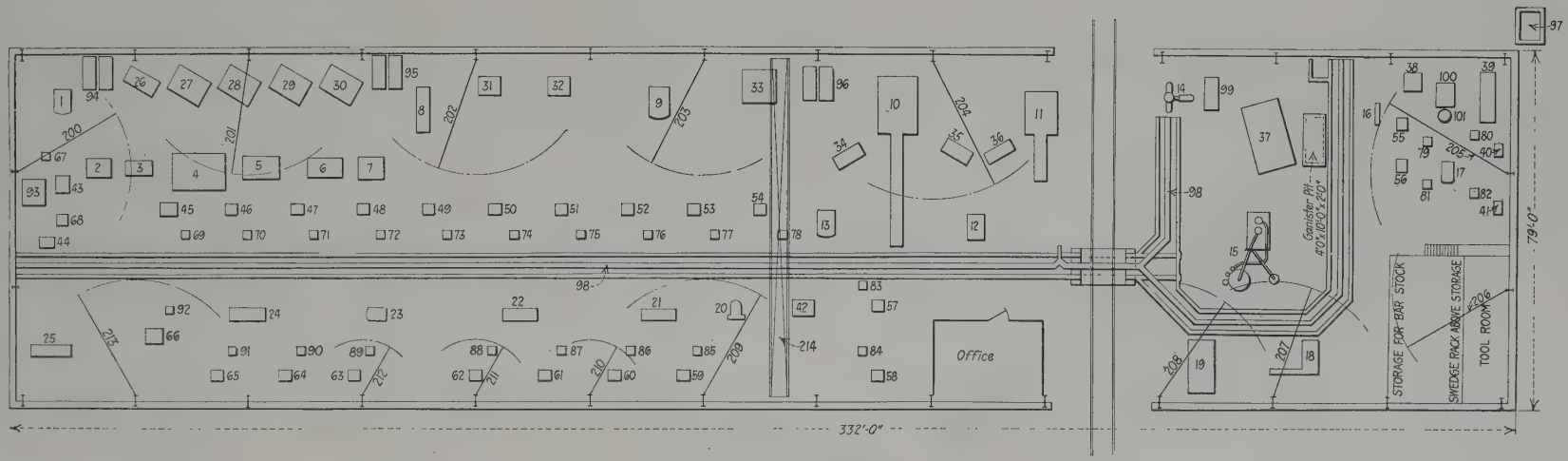
Key No.	Description	Size
16	*Emery Grinder*	#2
17	*Steam Hammer*	600#
18	*Shearing Machine*	
19	*Shearing Machine*	5" *Dia.*
20	*Air Hyd. Press*	20 *T.*
21–22	*Air Elec. Hammer*	250#
23	*Steam Hammer*	600#
24	*Air Elec. Hammer*	350#
25	*Air Elec. Hammer*	500#
26–36	*Oil Furnaces*	1 *Burner*
37	*Oil Furnace*	2 *Burners*
38–42	*Oil Furnaces*	1 *Burner*
43 to 66	*Oil Forges*	1 *Burner*
67 to 92	*Anvils*	300#
93 to 96	*Tool Rack*	
97	*Boiler Blow-Off Pit*	

BLACKSMITH SHOP—EQUIPMENT LIST—Continued

Key No.	Description	Size
98	*Air Piping*	
99–100	*Water Tank*	
101	*Oil Tank*	

BLACKSMITH SHOP—CRANE LIST

Key No.	Type	Operation	No.
200–202	*Jib*	*Hand*	3
203	*Jib*	*Hand*	1
204	*Jib*	*Hand*	1
205–206	*Jib*	*Hand*	2
207	*Jib*	*Hand*	1
208	*Jib*	*Hand*	1
209	*Jib*	*No Hoist*	1
210–212	*Jib*	*No Hoist*	3
213	*Jib*	*Hand*	1
214	*Bridge*	*Electric*	1



BLACKSMITH SHOP

Sparrow's Point Plant—Bethlehem Shipbuilding Corporation

FABRICATING SHOP NO. 1—EQUIPMENT LIST

Key No.	Description	Size
1	*Bending Blocks*	5′x5′
3	*Bending Blocks*	
4	*Bending Blocks*	
5	*Oil Furnace*	72″x11′—0″x9′—0″
6	*Winch*	
7	*Hyd. Bending Press*	
8	*Oil Furnace*	65′—2″x6′—4½″x4′—9½″
9	*Oil Furnace*	
10	*Air-Elect. Hammer*	350#
11	*Vert. Punch and Shear*	
12	*Oil Forge*	
13–14	*Coke Forges*	
15	*Platen*	10′—0″x16′—0″
16	*Auto, Feed Friction Saw*	
17	*Metal Bin*	
18	*Radial Countersink Drill.*	15′—3″ *Rad.*
19	*Horizontal Punch*	
20	*Coping Machine*	
21	*Vertical Punch*	48″ *Throat*
22	*Single Vertical Punch*	48″ *Throat*
23	*Horizontal Punch*	
24	*Service Panel*	
25	*Planer*	
26–27	*Radial Countersink Drill*	15′—3″ *Rad.*
28	*Electric Winch*	1½ *Tons*
29	*Planer*	
30–31	*"D" Head Shapers*	26″ *Stroke*

FABRICATING SHOP NO. 1—EQUIPMENT LIST—Continued

Key No.	Description	Size
32	*Single Vertical Punch*	54″ *Throat*
33	*Rotary Shear*	¾″ *Plate*
34	*Large Rolls*	
35	*Hyd. Manhole Punch*	
36	*Double Vert. Punch*	60″ *Throat*
37	*Double Vert. Punch*	33″ *Throat*
38	*Grinder*	
39	*Elevator*	
40	*Single Vertical Punch*	54″ *Throat*
41	*Electric Winch*	
42	*Double Vertical Punch*	33″ *Throat*
43	*Double Vertical Punch*	54″ *Throat*
44	*S'gle Vert. Shear & Punch*	60″ *Throat*
45	*Mangle Rolls*	
46	*Gate Shears*	10′—0″
47	*Comb. Punch and Shear*	40″ *Throat*
48	*Single Vertical Punch*	48″ *Throat*
49	*Radial Drill*	5′—0″ *Rad.*
50	*Single Vertical Punch*	
51	*Single Vertical Punch*	
52	*Horizontal Punch*	
53	*Single Vertical Punch*	
54	*Single Vertical Punch*	
55	*Platen*	5′—0″x5′—0″
56	*Angle Shears*	
57	*Single Vertical Punch*	48″ Throat
58	*Hydraulic Press*	

FABRICATING SHOP NO. 1—EQUIPMENT LIST—Continued

Key No.	Description	Size
59	*Grinder*	
60–61	*Grinders*	
62	*Cold Press*	
63	*Multiple Drill*	
64	*Radial Drill*	
65	*Angle Shears*	
66	*Platen*	5′—0″x10′—0″
67	*Electric Winch*	1½ *Tons*
68	*Platen*	5′—0″x5′—0″
69–70	*Coke Forges*	
71	*Oil Furnace*	
72	*Air-Electric Hammer*	
73	*Beveling Machine*	
74	*Furnace*	
75	*Electric Hoist*	1½ *Tons*
76–81	*Oil Burning Forges*	
100	*Blower*	
101	*Blower*	6150 F.A.P.M.
102	*Oil Furnace*	2′—9″x5′—5″

FABRICATING SHOP NO. 1—CRANE LIST

Key No.	Type	Operation	No.
200–212	*Jib*	*Hand*	13
213	*Jib*	*Hand*	1
214–215	*Jib*	*Hand*	2
216–217	*Jib*	*Hand*	2

(Continued on next page)

FABRICATING SHOP NO. 1—CRANE LIST
Continued

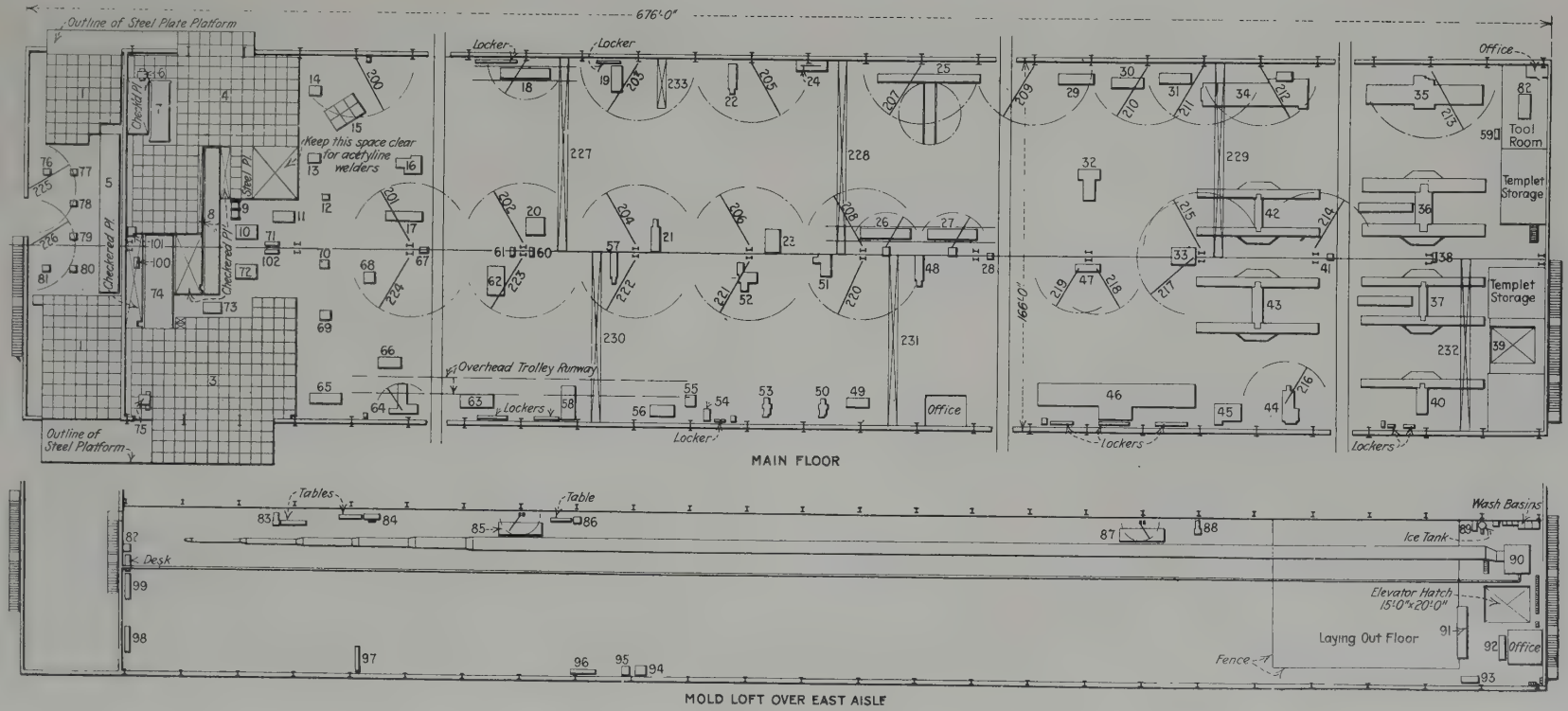
Key No.	Type	Operation	No.
218–219	*Jib*	*Hand*	2
220–224	*Jib*	*Hand*	5
225–226	*Jib*	*Hand*	2
227–229	*Bridge*	*Electric*	3
230–232	*Bridge*	*Electric*	3
233	*Wall*	*Electric*	1

MOLD LOFT—EQUIPMENT LIST

Key No.	Description	No.
82	*Switchboard Panel*	1
83	*Band Saw*	1
84	*Planer*	1
85	*Radial Drill*	1
86	*Circular Saw*	1
87	*Radial Drill*	1

MOLD LOFT—EQUIPMENT LIST—Continued

Key No.	Description
88	*Band Saw*
89	*Grindstone*
90	*Blower*
91	*Line Table*
92–93	*Table*
94–95	*Portable Racks*
96–99	*Work Benches*



FABRICATING SHOP NO. 1 AND MOLD LOFT

Sparrow's Point Plant—Bethlehem Shipbuilding Corporation

PLATE AND ANGLE SHOP—EQUIPMENT LIST

Key No.	Description	Size
1	*Punch*	30″ *Throat*
2	*Shear*	30″ *Throat*
3	*Punch*	20″ *Throat*
4	*Shear*	20″ *Throat*
5	*Grinder*	
6	*Power Hack Saw*	12″
7	*Drill Press*	
8	*Lathe*	18″ *D. Face Plate*
9	*Shaper*	16″ *Stroke*
10	*Grinder*	2—20″ *D. Wheels*
11	*Hyd. Accumulator*	
12	*Triplex Pump*	
13	*Steam Pump*	
14	*Punch*	
15	*Bender*	
16	*Radial Countersink*	16′ *Swing*
17	*Radial Drill*	4′ *Swing*
18	*Radial Drill*	4′ *Swing*
19	*Horizontal Drill*	
20	*Punch and Shear*	
21	*Angle Shear*	24″ *Throat*
22	*Hor. Bending Press*	
23	*Angle Shear*	12″ *Throat*
24	*Punch*	24″ *Throat*
25	*Punch*	24″ *Throat*
26	*Angle Shear*	6″ *Angles*

PLATE AND ANGLE SHOP—EQUIPMENT LIST—Continued

Key No.	Description	Size
27	*Cold Press*	10″ *Channels*
28	*Hyd. Joggler*	250 *Tons (Vert.)*
29	*Oil Furnace*	
30	*Angle Planer*	6″ *Angles*
31	*Spot Welder*	
32	*Bending Blocks*	
33	*Winch*	
34	*Angle Furnace*	
35	*Pump*	
36	*Blower*	
37	*Angle Beveler*	8″ *Channels*
38	*Bending Blocks*	
39	*Punch*	18″ *Throat*
40	*Punch*	18″ *Throat*
41	*Winch*	
42	*Punch*	1″ Holes in ⅝″ Plates
43	*Horizontal Punch*	
44	*Punch*	1″ Holes in ¾″ Plates
45	*Punch*	¾″ Holes in ⅜″ Plates
46	*Friction Saw*	54″ *Dia.*
47	*Switchboard*	
48	*Radial Countersink*	13′ *Swing*
49	*Pneumatic Riveter*	36″ *Throat*
50	*Pneumatic Riveter*	36″ *Throat*
51	*Bending Blocks*	
52	*Plate Furnace*	

PLATE AND ANGLE SHOP—EQUIPMENT LIST—Continued

Key No.	Description	Size
53	*Bending Blocks*	
54	*Forge*	
55	*Winch*	
56	*Punch*	48″ *Throat*
57	*Punch*	48″ *Throat*
58	*Punch*	48″ *Throat*
59	*Radial Drill*	7′ *Swing*
60	*Radial Drill*	7′ *Swing*
61	*Gate Shear*	¾″ *Plate*
62	*Punch*	36″ *Throat*
63	*Punch*	36″ *Throat*
64	*Punch*	24″ *Throat*
65	*Hyd. Manhole Punch*	250 *Tons*
66	*Hyd. Keel Bender*	500 *Tons*
67	*Bending Rolls*	*Top Roll* 20″ D.
68–69–70	*Rollers*	
71	*Punch*	36″ *Throat*
72	*Punch*	36″ *Throat*
73	*Punch*	36″ *Throat.*
74	*Punch*	36″ *Throat*
75	*Punch*	36″ *Throat*
76	*Punch*	36″ *Throat*
77	*Shear*	36″ *Throat*
78	*Shear*	36″ *Throat*
79–80–81	*Rollers*	

(*Continued on next page*)

PLATE AND ANGLE SHOP—EQUIPMENT LIST—Continued

Key No.	Description	Size
82	*Punch*	30″ *Throat*
83	*Punch*	30″ *Throat*
84	*Shear*	24″ *Throat*
85	*Rotary Shear*	48″ *Throat*
86	*Punch*	
87	*Punch*	
88	*Bending Rolls*	*Rolls* 12″ *D.*
89–90–91	*Rollers*	
92	*Punch*	48″ *Throat*
93	*Punch*	48″ *Throat*

PLATE AND ANGLE SHOP—EQUIPMENT LIST—Continued

Key No.	Description	Size
94	*Punch*	
95	*Emery Grinder*	
96	*Drill Grinder*	
97	*Shear*	24″ *Blade*
98	*Plate Planers*	45′ *Plate*
99	*Plate Planers*	45′ *Plate*
100	*Plate Planers*	22′ *Plate*
101	*Radial Countersink*	16′ *Swing*
102	*Radial Countersink*	16′ *Swing*
103	*Radial Countersink*	16′ *Swing*

PLATE AND ANGLE SHOP—EQUIPMENT LIST—Continued

Key No.	Description	Size
104	*Radial Countersink*	16′ *Swing*
105	*Scarphing Machine*	16′ *Plates*
106	*Scarphing Machine*	9′ *Plates*

PLATE AND ANGLE SHOP—CRANE LIST

Key No.	Type	Operation	No.
201–206	15 *Ton-Bridge*	*Electric*	6
207–210	5 *Ton-Wall*	*Electric*	4
211	*Bridge*	*Hand*	1
212–242	3 *and* 5 *Ton-Jib*	*Electric*	31

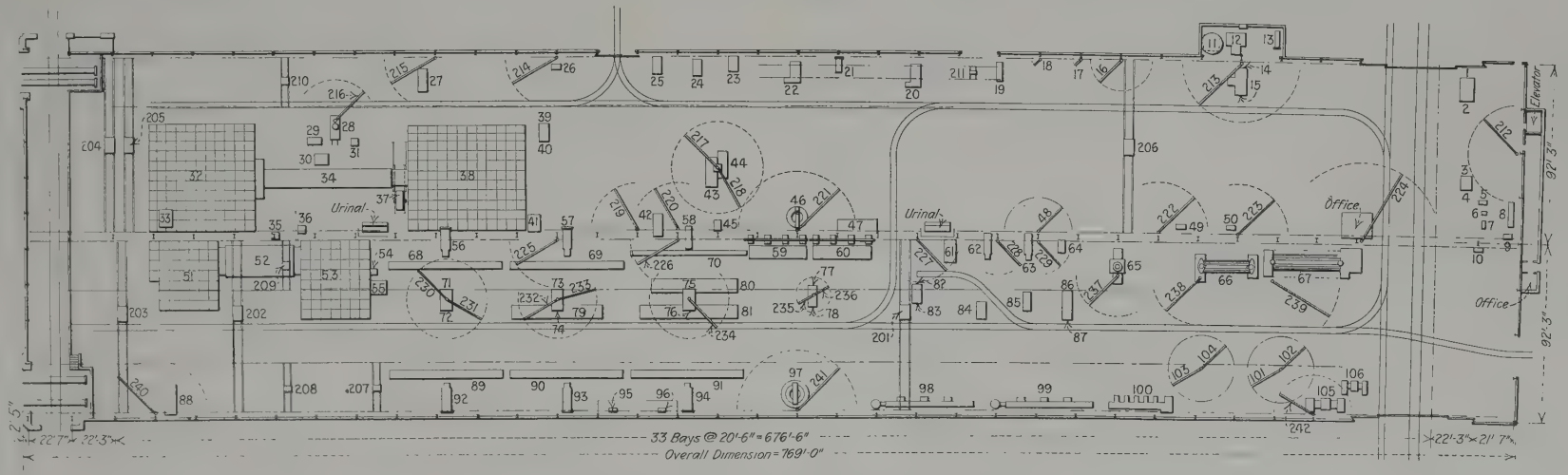
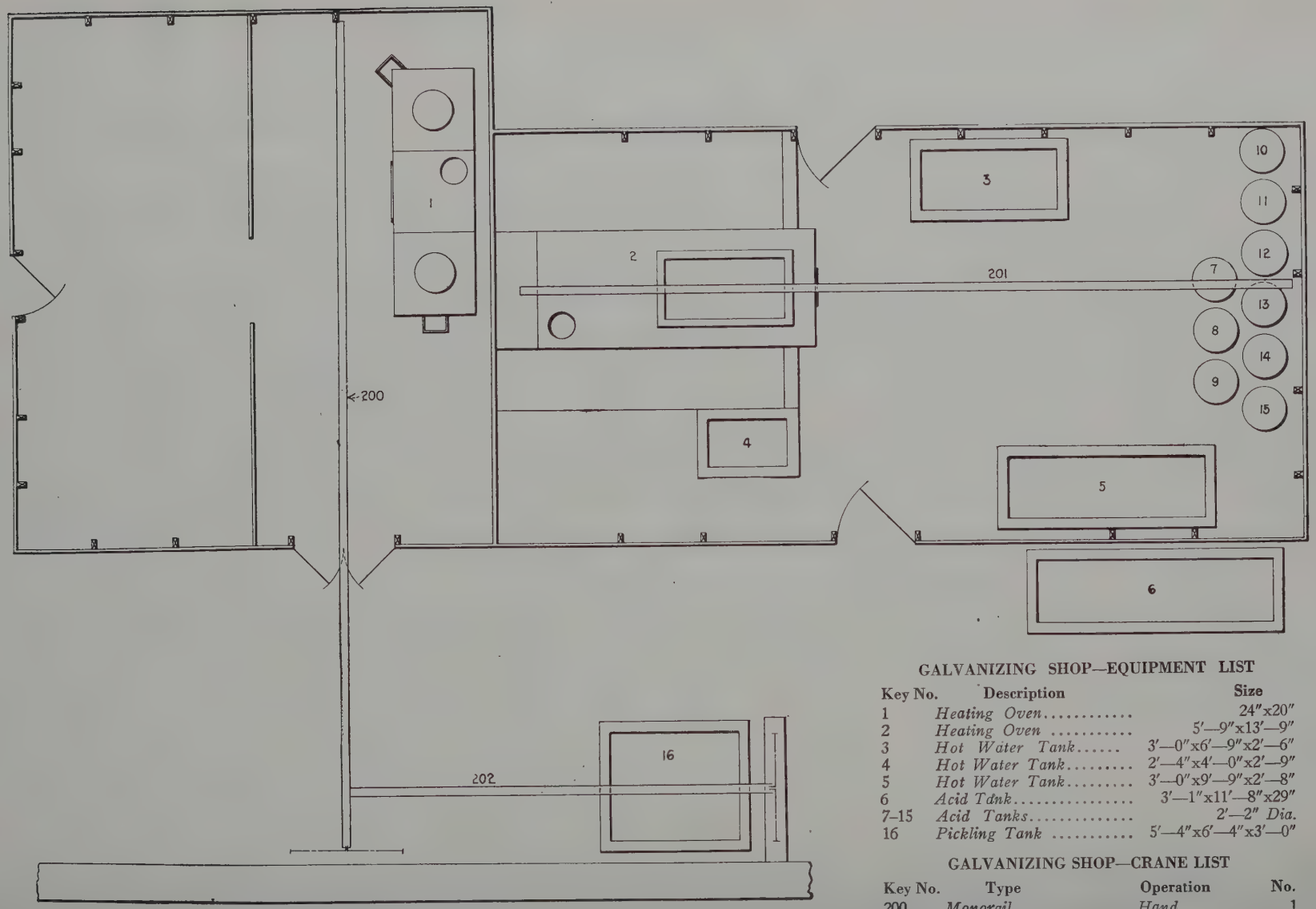


PLATE AND ANGLE SHOP
Fore River Plant—Bethlehem Shipbuilding Corporation



GALVANIZING SHOP

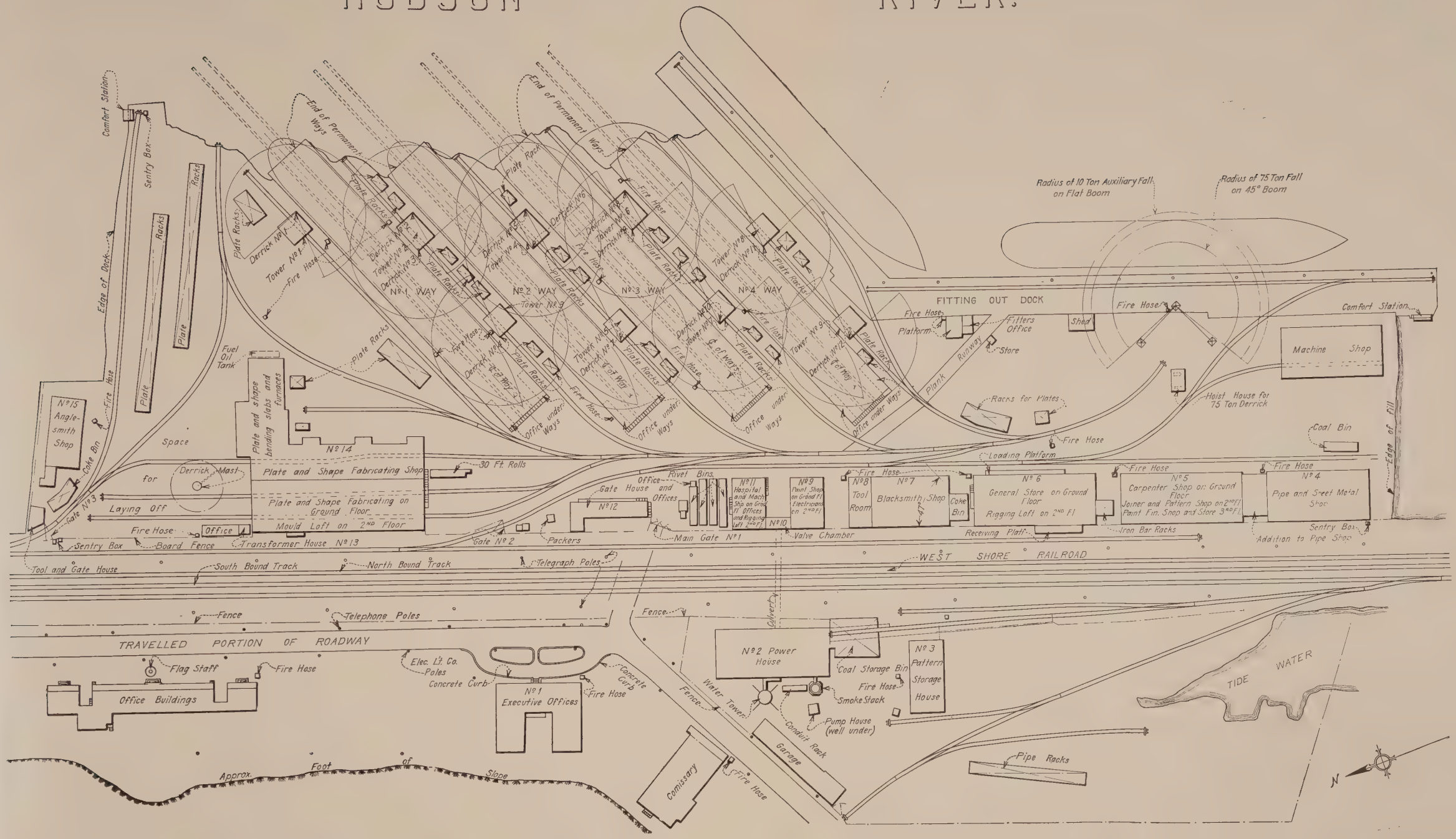
Sparrow's Point Plant—Bethlehem Shipbuilding Corporation

GALVANIZING SHOP—EQUIPMENT LIST

Key No.	Description	Size
1	*Heating Oven*	24″x20″
2	*Heating Oven*	5′—9″x13′—9″
3	*Hot Water Tank*	3′—0″x6′—9″x2′—6″
4	*Hot Water Tank*	2′—4″x4′—0″x2′—9″
5	*Hot Water Tank*	3′—0″x9′—9″x2′—8″
6	*Acid Tdnk*	3′—1″x11′—8″x29″
7–15	*Acid Tanks*	2′—2″ *Dia.*
16	*Pickling Tank*	5′—4″x6′—4″x3′—0″

GALVANIZING SHOP—CRANE LIST

Key No.	Type	Operation	No.
200	*Monorail*	*Hand*	1
201	*Monorail*		1
202	*Monorail*		1



LAYOUT OF YARD

Newburgh Shipyards, Newburgh, N. Y.

PLATE IV

SHIP'S RIGGING AND CARGO HANDLING GEAR

A TREATISE

DESCRIBING AND ILLUSTRATING

MASTS, DERRICK POSTS, BOOMS AND THEIR FITTINGS
BOOM TABLES AND OUTRIGGERS, ROPE, BLOCKS AND WINCHES

BY

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SPECIALLY PREPARED

FOR

THE SHIPBUILDING CYCLOPEDIA

Foreword

In the following treatment of ship's rigging and cargo handling gear requirements, only those methods are dwelt upon which, through continued application and resultant satisfaction, have come to be adopted as standard. So many deviations in detail have found their way into modern practice, that, for practical reasons, no attempt has been made to classify them all.

For the sake of added efficiency and unanimity, it is believed that a standardization of practice, even as to details, based upon the best results produced under given conditions, should be adopted. For where a diversity of opinions on the part of shipbuilders finds expression in the working plans, a great amount of time is often lost and unnecessary expense incurred which would be obviated through the adoption of standard fittings. The value of uniformity in this connection will be readily appreciated in considering the subject of our proposed Merchant Marine. Contracts will necessarily be let out to many yards, and, therefore, a system of centralization and standardizing of materials would seem to be both logical and urgent from the standpoint of efficiency and economy.

The subjects hereunder treated are dealt with in their natural sequence, and, as before stated, only those items are covered which have stood the test of efficiency, economy and durability.

In eliminating the many items of doubtful utility, and laying stress upon the essential, vital points, it is hoped that some benefit will accrue particularly to the novice, on whose visualization and discernment the future of the shipbuilding industry will largely depend.

Reverting again to the Merchant Marine, the most economic program consistent with good practice must be inaugurated if we are to compete favorably with our foreign rivals, and maintain the prestige upon the high seas to which we are entitled by virtue of our natural resources and geographical location. Thus, economy in construction is a vitally essential factor, the primary requisite, and it has been the writer's aim in the presentation of this subject to dispense with the more burdensome and costly equipment in every case where the adoption of more economical fittings have been justified through long usage and satisfactory results.

A. H. HAAG.

Ship's Rigging and Cargo Handling Gear

INTRODUCTORY

THE HANDLING OF CARGO aboard ship is a subject which is often given too little attention. The length of a ship's stay in port depends largely upon the loading and unloading facilities; and, therefore, no effort should be spared in designing equipment to operate most effectively.

There are three distinct classes of cargo vessels, each of which requires loading and unloading facilities to suit its particular needs. Ships carrying fixed or definite cargoes, as the products of a particular trade, can with comparative ease provide for the installation of suitable and efficient cargo handling gear. Ships carrying bulk cargo, such as oil, ore, coal, grain, etc., require special machinery for each kind of material, much of which is installed on the wharves, although in some instances it is part of the vessel's equipment. Ships, known as "tramps," carrying miscellaneous cargoes, require handling gear that is more difficult to establish because of the various uses to which it is subjected. In addition to the above methods, cargo is sometimes handled by trucks through ports in the ship's sides or over gang planks from the decks, as in the case of harbor and river steamers, and sometimes freight and passenger vessels.

In the following pages the various kinds of fittings, booms, masts, ropes, blocks and equipment in general are described, with a view to assisting those engaged in the preparation and development of plans for cargo handling equipment. The writer has made a study of this subject for many years, and has endeavored to place at the disposal of those interested, methods which have been accepted as standard, after time and practice have justified their adoption by the shipbuilding industry.

Standardized Equipment

DURING THE PERIOD when our shipbuilding activities were limited to a comparatively few yards, little or no economic pressure was brought to bear in the interests of standardized equipment. However, with the rapid rise and expansion of the shipbuilding industry in this country, it has become imperative that if we are to compete on anything like an equal basis with foreign markets, economic necessity demands that equipment, particularly as regards cargo handling gear, and deck fittings in general, must be standardized in so far as practicable and consistent with safety and efficiency, thus reducing to the lowest possible minimum the cost of installation and upkeep.

One of the most important factors in determining the commercial value of a vessel is the facility and speed with which its equipment will permit of the loading and discharge of its cargo. To this end, therefore, it is essential that complete harmony and co-operation be established among all the shipyards of the country, to the exclusion of individual preferment, selfish interest and intercompetitive efforts, towards the realization and establishment of a common standard of equipment.

In the presentation of the following pages, limited though they are in the treatise of the vitally important subject which they embody, it is the intention and hope of the writer that full cognizance will be taken of cargo handling equipment as a very potent factor in the economic operation of all vessels, and that we should, therefore, avail ourselves of the most expeditious means of loading and discharging cargo, so as not to lose while in port the advantage gained in transportation.

Masts

MASTS are constructed in various ways:—the two strake in and out type, with angle bar stiffeners; the two strake, one strake within the other, with angle bar stiffeners; the two strake flush type, with Tee-bar seam straps and angle bar stiffeners; the three strake flush type, with Tee-bar seam straps; and the three strake in and out type, with angle bar stiffeners. A typical mast plating plan, together with sections of the various types of masts, is illustrated on page 342.

There is a growing tendency to dispense with angle bar stiffeners, compensating therefor by increasing the thickness of plating. The diameter of a mast, thickness of plating, straps, doublers, riveting, etc., should conform to the rules of the Classification Societies.

For determining the length of a mast, a good rule to follow is to take the distance above the deck at which the boom is stepped (whether stepped on a derrick table or directly to the mast; this distance usually being about 8 feet 6 inches) plus the length of the boom, at which point the hounds are located, plus about three feet above the hounds to the top of the mast. In determining the length of a mast in this manner a good lead for the topping lift is arrived at.

The maximum diameter of a mast is usually carried up just above the point of the mast at which the boom is stepped; and in the case of where a derrick or boom table is fitted around the mast, to a point just above the derrick table. From this point it is then carried in a fair curve to the top of the mast.

Method of Laying Out the Curvature of a Mast

A METHOD for obtaining the curvature of a mast as shown on page 350 is as follows: Through the base line draw a center line perpendicular to the base. At the intersection of the base and center line strike an arc of a circle representing the maximum diameter of the mast, on a scale of at least three inches to the foot, preferably full size. Intersect the arc at a distance out from the center line representing the diameter at the top of the mast. The distance between the base line and the line representing the diameter at the top of the mast, then, represents the vertical distance for which the mast is curved. Make a scale to fit this length. The diameter at the butts of the plating, or any diameter along the curved portion, can then be laid off, and accurately determined. Sometimes the portion of the mast below decks is tapered toward the heel. However, this practice has been almost entirely abandoned, and the mast is usually made parallel whether carried one or two decks below. A bulb angle should be riveted to the deck in the way of mast openings to provide a backing for the wedging.

During the war a great many vessels had hinged masts. One of the most common types is illustrated on page 344. This was done in order to obtain low visibility. This type of mast, however, was found very impracticable, owing to the loss of time in raising and lowering the same and dis-

connecting the rigging, together with the numerous fittings and equipment required. It is now almost entirely dispensed with.

Raking of Masts

IT IS CONSIDERED desirable to set the masts plumb on a cargo carrier for the following reasons: it dispenses with offsetting the derrick table, it eliminates considerable bevelling of angles, particularly those in way of the mast openings at the decks, and it allows one to go aloft on the mast with more safety and ease. Masts on passenger vessels are raked more for appearance than anything else, the usual practice is to rake the fore mast about ⅜" to the foot, the smoke stack about 7/16" to the foot and the mainmast about ½" to the foot.

Mast Ladders

FOR GOING ALOFT on a mast, the most economical practice is to fit an iron ladder riveted to the mast by angle bar clips, as illustrated on page 342. The practice of fitting ladder rungs directly to the mast is no longer in favor, it having proved very costly, owing to the number of rivets required, and the amount of work expended on the rungs themselves. Preference is given by some operators to the fitting of ratlines on the shrouds. However, the fitting of a ladder is considered the best practice aboard a cargo carrier.

Derrick Posts or King Posts

DERRICK POSTS, sometimes called "King Posts," are built up either of plating, as shown on page 342, or constructed of pipe. In many cases they are constructed similar to a mast, usually of the two plate in and out strake construction, as illustrated on page 342. In many instances the derrick post is also utilized as a ventilator, in which case the mushroom type of ventilator is generally used, although sometimes a cowl is fitted. Sometimes a slide is fitted in the post, so as to regulate the ventilation below decks. A detail of this slide is illustrated on page 342.

Topmasts (Wood and Steel)

TOPMASTS are ordinarily constructed of wood, chiefly of spruce. Sometimes, however, they are made of steel. There are three types of topmasts: the fixed, the housing and the telescoping, all of which are illustrated on page 345. On vessels navigating rivers where low bridges are encountered, either the housing or the telescoping topmasts are fitted. However, the fixed topmast is by far the most desirable in all other instances.

In determining the height of a topmast the requirements of the wireless antenna should not be lost sight of. Each end of the antenna is supplied with a safety link, designed to break when undue stress is placed on the antenna, such as a violent movement of the mast due to an explosion, or the mast vibrating excessively due to its being subjected to a heavy strain in the handling of cargo, or when the vessel is at sea in a heavy blow. Should the safety link give way, approximately five feet is added to the length of the antenna, causing the same to drop fifteen or twenty feet. Therefore, the height of the topmast should be designed so that the antenna clears the top of the smokestack by at least twenty feet. Topmasts, although sometimes curved, are usually made with a straight taper.

Crow's Nest

ON A GREAT MANY VESSELS crow's nests are fitted on the foremast. There are numerous ways of constructing a crow's nest. One of the most economical and satisfactory types is illustrated on page 343. The height of a crow's nest varies from 3 feet 6 inches to 4 feet 6 inches. The crow's nest is either located below the masthead light or above the hounds, depending on the height of the mast.

Derrick or Boom Tables

WHERE THE SPACE between hatches permits, a derrick table is built around the mast. However, a derrick table is only necessary where more than two booms are required on each side of the mast, or where it is desired to set winches parallel to the center line of the ship. Where there are more than two booms on each side of a mast a derrick table is provided. The width of a derrick table is determined by the number of booms required. In cases where an exceptionally wide table is fitted it is supported by stanchions, and sometimes plated over and used as a deck locker for blocks, ropes, etc. Tables of ordinary size are usually bracketed to the mast, as illustrated on page 343.

Upper Tables or Outriggers

WHEN DERRICK TABLES are fitted around the mast at the deck, it is necessary to provide an upper table or outrigger to which the topping lift pad-eyes are connected. The pad-eyes for topping lift blocks should be located directly above the boom pivots on the derrick table. Sometimes the upper table is so constructed as to provide connections for the shrouds and headstays in addition to the topping lifts. This type of table is illustrated on page 338.

Booms (Wood and Steel)

BOOMS up to a capacity of about ten tons are usually made of wood, chiefly of Oregon pine, although occasionally they are made of steel. Booms above fifteen tons capacity are practically all constructed of steel, probably the most common being of pipe construction. The plate and channel type is also a good construction. Expensive forged bands can be dispensed with, by replacing them with pad-eyes. Various types of steel booms are illustrated on page 341.

Mast Fittings

A WIDE DIVERGENCE of opinions among shipbuilders has resulted in the production of a large variety of mast fittings. The shrouds and stays in some instances are connected to the mast by looping them around the mast, as indicated on page 343. At other times they are shackled to a band at the hounds, or to an individual pad riveted on the mast.

Probably the most economical way to secure the shrouds and headstays is obtained by riveting double clips to the mast, with a liner in between the clips to get the proper bearing, as shown on page 332, the advantage being that the clips can be riveted to the mast while the mast is under construction, thus obviating delays which might be occasioned through not having forgings and castings ready.

Likewise, means for riveting the topping lift pad-eyes are provided by riveting double angles to the mast, while the mast is under construction, as shown on page 332. Where no derrick table is provided, the boom supports or pivot bearings are secured to angles riveted to the mast in a similar manner, as illustrated on page 333.

It will readily be seen that by providing suitable means for making connections to the mast as described above, that the mast can be entirely completed and the fittings applied afterwards. Also when replacing any of the fittings at a later date access may always be had for making a suitable riveted connection, which otherwise would necessitate taps.

When an upper table is provided, the topping lift pad-eyes are riveted to the table. Provision is also made for connecting the main shrouds and headstays to brackets, as illustrated on page 338.

Topmast Fittings

TOPMAST FITTINGS usually consist of a band to which the wireless antenna is attached. This band is also provided with a lug for securing the gantline block. Sometimes an additional band is added as a connection for the signal halyard, the other end of which is secured to the smokestack. It was formerly customary to fit a spring stay between the foremast and the mainmast, but due to its close proximity to the wireless antenna, affecting the proper functioning of the same, its use has been almost entirely discontinued.

Boom Fittings

BOOM FITTINGS on a circular wood boom consist of a goose-neck fitted at the heel or foot of the boom, with an eye-bolt near the goose-neck for securing the block bail. At the upper end of the boom there are fitted one, two or three bands. When there is more than one band, the bands are spaced from six to seven feet apart. The outer band is usually fitted so that it shoulders on a reinforcing band, as illustrated on page 333. The inner bands are made in halves, and bear against half rounds secured to the boom, as shown on page 333. The number of bands required for a boom is determined by the class of cargo carried, the operating company usually specifying the number required.

The pivot bearing is sometimes designed with a connection for the lead block, as illustrated on page 336. In the case of the boom being stepped on a table, a pad-eye with a link is riveted to the table to which to shackle the lead block, as illustrated on page 343. In the case of a heavy lift boom a pad-eye is provided on deck for the lead block, as illustrated on page 338.

The fittings for the heavy lift boom, as illustrated on page 338, consist of a goose-neck, sometimes called a "Pacific Iron" at the lower end. At the upper end there are either bands or pad-eyes, depending upon the construction of the boom, to which are connected the vangs, topping lift and hoisting blocks. A heavy lift boom is usually stepped on a pedestal riveted to the deck.

Boom Stowage (Wood and Steel)

STOWAGE ARRANGEMENTS for light lift booms are illustrated on page 337. Where the booms are of such length that they extend over the top of the poop, bridge or forecastle decks, the chock is bolted directly to the deck, or sometimes to a clip riveted to the bounding angle. When they clear the deck erections, a boom rest is provided to which the boom chock is secured, as illustrated on page 337. Boom rests are usually located between the hatches, and at a height which will make the boom stow parallel with the sheer of the ship.

Heavy lift steel booms are sometimes lashed in chocks on deck; other times they are stowed vertically against the mast, as illustrated on page 346.

Rigging Fittings on Deck

THE MAIN SHROUDS are set up with turnbuckles connected to a chain plate, which is riveted to the sheer strake, or sometimes to the deck close to the sheer strake. When preventer stays are used, chain plates should be fitted to the sheer strake in a similar manner. The backstay is fitted with a turnbuckle secured, like the shrouds, to the sheer strake. The headstays are set up with turnbuckles secured sometimes by shackling them direct to the stem bar, the stem bar being carried up sufficiently far for this purpose. At other times they are connected to a pad-eye so designed as to take both the topmast stay and fore-stay. Otherwise they are connected independently to individual pad-eyes located on deck close to the stem bar.

In addition to the chain plates, the other deck fittings consist of pad-eyes for securing the vang or guy tackles to the deck, with cleats near by for belaying them, both of which should always be located clear of the hatches, near the side of the vessel. Sometimes they are located on top of the bulwark channel. There should also be provided lashing ring pads along the bulwark and along the hatch coamings for lashing deck loads. For the topping lift purchase a pad-eye is provided on the deck, so located that the lead from the topping lift block at the mast will clear the obstructions on the mast. Close to this pad-eye there is provided a cleat for belaying the topping lift. Sometimes a cleat is riveted to the mast, at other times to the mast table, as conditions may warrant, for belaying the topping lift. If no manila purchase is provided, the topping lift is brought down to a snatch block at the deck, and a deck hook is provided under which the rope is passed before it is belayed on the cleat. A detail of deck hook is illustrated on page 337.

Rigging Fittings Attached to Ropes

OPEN THIMBLES are used when the strain on the rope is not excessive. Particulars of this type are given on page 349, fig. 11. The opening in the thimble provides a means for securing the shackle link, hook, or other connection. For splicing wire rope around thimbles where heavy stresses are encountered, a solid cast iron thimble is used, for which particulars are given on page 349, fig. 9. There is sometimes substituted in lieu of the open and cast iron thimble a wire rope socket, either closed or open. This type of connection, when properly made, is found far superior to a rope spliced around a thimble. Tests have shown that the splice will pull out when tested to 65 per cent of the strength of the rope, while in the case of a wire rope socket connection, properly made, tests have demonstrated the rope to break, while the connection remained intact.

There are various types of turnbuckles in use. That known as the pipe or sleeve turnbuckle is considered one of the best for ship use. Particulars are given on page 347, figs. 1 and 2. The threads are protected from exposure to the elements, and a very neat appearance is effected. The open type of turnbuckle is sometimes used aboard ship. However, it is more adaptable for use ashore.

For ropes that are required to be made portable, a pelican hook is fitted to the turnbuckle. Pelican hooks are illustrated on page 349, fig. 12.

Rigging fittings usually consist of steel forgings, although when good steel castings are procurable they are frequently substituted.

Ship's Blocks (Wood and Steel)

THE VARIOUS KINDS of block connections are illustrated on page 351. Each manufacturer apparently has his own idea concerning the particular design as well as the strength of the connection. It is, therefore, necessary to design fittings to which blocks are connected to suit the particular design of block ordered. It is also important in designing fittings to make allowances to provide for sufficient clearances. Should it be necessary to replace a block with another make, the shackle of which might be somewhat larger, it is best accomplished by providing a fitting with a link welded in.

Of the block fittings illustrated on page 351, the most common are the blocks fitted with shackles. The use of blocks fitted with hooks should be restricted, particularly for work aloft. The tendency has been to use blocks fitted with shackles rather than with hooks, for although a little more time is required there is an added insurance against accidents.

Ordinarily there are two kinds of wood blocks used aboard ship, viz., the block with round shell and the wide mortised block, the shell of which is cross-bolted or riveted. Wide mortised blocks are used where greater strength is required, also permitting the use of a larger rope for the same diameter sheave. All steel parts on wood blocks should be well galvanized.

Winches, Location of

THERE ARE VARIOUS TYPES OF WINCHES used in handling cargo aboard ship. One of the most common types used is the single gear and single drum with one winch-head on the outboard side. When there is sufficient deck space winches fitted with two winch-heads are used, as there are some classes of cargo where a number of whips can be operated from one hatch, and both the hoisting drum and each of the winch-heads can be brought into use to good advantage.

Winches that are used for heavy loads and warping winches which are subjected to severe strains are generally compound geared.

The location of the winches is a matter which should be freely discussed by the shipbuilder, ship operator, ship master and the winch manufacturer. An arrangement of winches which has been found very practicable for certain classes of cargo and which has been extensively adopted where two booms are fitted on each side of a mast, is to locate the winches close together in an athwartship direction but with sufficient space between them to allow their operation by either one man to a winch or by one man to two winches.

In connection with the above it is noted that in some ports the labor organizations do not permit one man to operate more than one winch, but where possible it is desirable that one man should control both winches, which may be accomplished by extending the levers and brakes for the purpose. It is also advisable to provide sufficient clearance for a one-man passage between the hatch coamings and the winches. This arrangement usually brings the winches within the line of the outside of the hatches and allows an unbroken space for loading deck cargo.

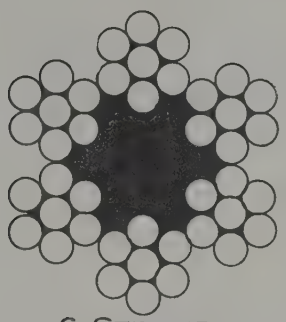
One winch is usually required for each boom, but where a heavy lift boom is used, the hoisting drums of two winches are brought into play except where the ship is fitted with double drum winches. One winch is used for the topping lift and the other for the hoisting rope.

The majority of ships built in this country are fitted with two booms of about five tons capacity on the forward and after side of each mast. In some cases the larger ships have one boom of from twenty-five to thirty-five ton capacity in addition to the five-ton booms. When handling cargo with five-ton booms, one boom is usually guyed down over the center of the hatch, the other being guyed down over the side of the vessel so that the cargo whip or hoist will clear the vessel's side from eight feet to twelve feet, depending upon the class of cargo handled.

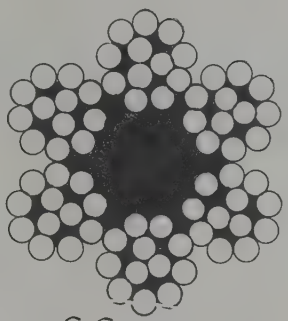
In handling loads up to about three tons a single whip is used on each boom. These whips are brought together at the lower end and made fast by connecting them to a ring or shackle on which is secured a cargo hook, barrel hooks, bale hooks, net or any other device for the particular kind of cargo to be handled. When discharging cargo a load is lifted from the hold of the vessel by the whip from the boom over the hatch and after it is clear of the hatch coaming it is swung outboard by hauling in with the whip from the outboard boom and slacking away on the whip from the inboard boom. This operation, of course, is reversed when loading the vessel. This system for handling cargo is considered a very efficient one for certain classes of cargo. It is, however, advantageous some times to work the whips independently. In this case the load is lifted from the vessel's hold and then hauled outboard by a line made fast to the load as the whip is slacked away. For the heavier loads, from three to five tons, it is usually necessary to substitute a three-part tackle in place of the single whip.

For the booms of twenty-five to thirty-five tons capacity a tubular or channel and plate boom is used which is stepped on deck. An eight-part fall for hoisting is ordinarily fitted; also an eight-part topping lift. When lifting a load out of the hold the heavy boom is guyed down securely over the center of the hatch. The load is then hoisted until high enough to clear the hatch coaming and the bulwark. The load is then swung outboard by slacking away on one vang purchase and hauling in on the other with the aid of the winch head.

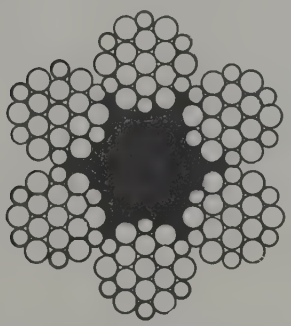
Table 1—Construction of
Various Types of Wire Rope
with Hemp Centers



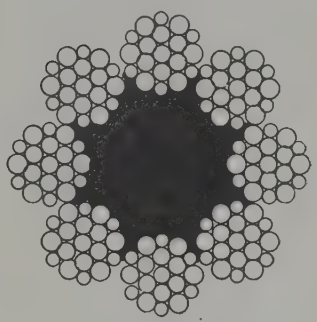
6 STRANDS
7 WIRES PER STRAND



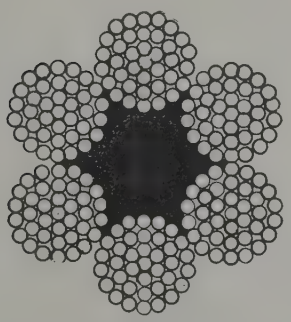
6 STRANDS
12 WIRES PER STRAND



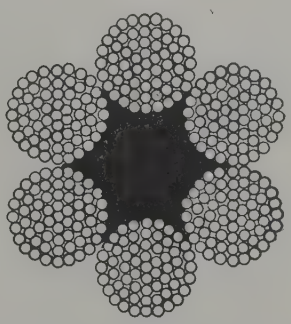
6 STRANDS
19 WIRES PER STRAND



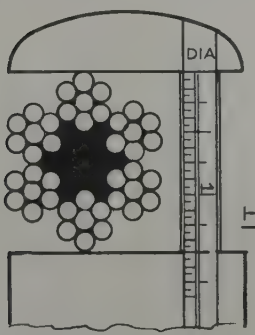
8 STRANDS
19 WIRES PER STRAND



6 STRANDS
37 WIRES PER STRAND

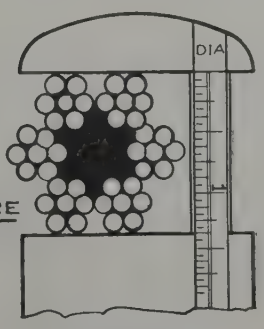


6 STRANDS
61 WIRES PER STRAND



THE RIGHT WAY

HOW TO MEASURE
WIRE ROPE



THE WRONG WAY

ROPE PARTICULARS

Table 2—Plow Steel Transmission, Haulage or Standing Rope

6-Strands—7 Wires to the Strands—1 Hemp Core

Diameter in Inches	Circumference in Inches	Proper Working Load in Tons of 2000 Lbs	Approx. Strength in Tons of 2000 Lbs.	Approx. Weight per Foot in Lbs.	Dia. of Sheave Based on Ship Practice in Inches [2]
1½	4¾	16.4	82	3.55	
1⅜	4¼	14.4	72	3	
1¼	4	12	60	2.45	22-24
1⅛	3½	9.4	47	2	20-22
1	3	7.6	38	1.58	18-20
⅞	2¾	6.2	31	1.20	16-18
¾	2¼	4.6	23	.89	14-16
11/16	2⅛	3.6	18	.75	
⅝	2	3.2	16	.62	12-14
9/16	1¾	2.4	12	.50	
½	1½	2	10	.39	10-12
7/16	1¼	1.4	7	.30	
⅜	1⅛	1.2	5.9	.22	
5/16	1	.88	4.4	.15	
9/32	⅞	.68	3.4	.12½	

Table 3—Extra Strong Plow Steel Transmission, Haulage or Standing Rope

6-Strands—7 Wires to the Strand—1 Hemp Core

Diameter in Inches	Circumference in Inches	Proper Working Load in Tons 2000 Lbs	Approx. Strength in Tons of 2000 Lbs.	Approx. Weight per Foot in Lbs.	Dia. of Sheave Based on Ship Practice in Inches
1½	4¾	18	90	3.55	
1⅜	4¼	16	79	3	
1¼	4	13	67	2.45	22-24
1⅛	3½	10	52	2	20-22
1	3	8.4	42	1.58	18-20
⅞	2¾	6.6	33	1.20	16-18
¾	2¼	5	25	.89	14-16
11/16	2⅛	4	20	.75	
⅝	2	3.5	17½	.62	12-14
9/16	1¾	2.6	13	.50	
½	1½	2.2	11	.39	10-12
7/16	1¼	1.5	7¾	.30	
⅜	1⅛	1.3	6½	.22	

Table 4—Standard Plow Steel Hoisting Rope

6-Strands—19 Wires to the Strand—1 Hemp Core

Diameter in Inches	Circumference in Inches	Proper Working Load in Tons of 2000 Lbs	Approx. Strength in Tons of 2000 Lbs	Approx. Weight per Foot in Lbs.	Dia. of Sheave Based on Ship Practice in Inches [4]
2¼	8⅝	55	275	11.95	
2½	7⅞	46	229	9.85	
2¼	7⅛	37	186	8	
2	6¼	28	140	6.3	
1⅞	5¾	25	127	5.55	
1¾	5½	22	112	4.85	
1⅝	5	19	94	4.15	
1½	4¾	16	82	3.55	
1⅜	4¼	14	72	3	
1¼	4	12	58	2.45	22-24
1⅛	3½	9.4	47	2	20-22
1	3	7.6	38	1.58	18-20
⅞	2¾	5.8	29	1.20	16-18
¾	2¼	4.6	23	.89	14-16
⅝	2	3.1	15.5	.62	12-14
9/16	1¾	2.4	12.3	.50	
½	1½	2	10	.39	10-12
7/16	1¼	1.6	8	.30	
⅜	1⅛	1.15	5.75	.22	
5/16	1	.76	3.8	.15	
¼	¾	.53	2.65	.10	

Table 5—Extra Strong Plow Steel Hoisting Rope

6-Strands—19 Wires to the Strand—1 Hemp Core

Diameter in Inches	Circumference in Inches	Proper Working Load in Tons of 2000 Lbs	Approx. Strength in Tons of 2000 Lbs.	Approx. Weight per Foot in Lbs.	Dia. of Sheave Based on Ship Practice in Inches [3]
2¼	8⅝	63	315	11.95	
2½	7⅞	53	263	9.85	
2¼	7⅛	42	210	8	
2	6¼	33	166	6.30	
1⅞	5¾	30	150	5.55	
1¾	5½	27	133	4.85	
1⅝	5	22	110	4.15	
1½	4¾	20	98	3.55	
1⅜	4¼	17	84	3	
1¼	4	14	69	2.45	22-24
1⅛	3½	11	56	2	20-22
1	3	9	45	1.58	18-20
⅞	2¾	7	35	1.20	16-18
¾	2¼	5.3	26.3	.89	14-16
⅝	2	3.8	19	.62	12-14
9/16	1¾	2.9	14.5	.50	
½	1½	2.4	12.1	.39	10-12
7/16	1¼	1.9	9.4	.30	
⅜	1⅛	1.35	6.75	.22	
5/16	1	.9	4.50	.15	
¼	¾	.63	3.15	.10	

ROPE PARTICULARS

Table 6—Special Flexible Plow Steel Hoisting Rope

6-STRANDS-37 WIRES TO THE STRAND— 1 HEMP CORE

DIAMETER IN INCHES	CIRCUMFERENCE IN INCHES	PROPER WORKING LOAD IN TONS OF 2000 LBS.	APPROX. STRENGTH IN TONS OF 2000 LBS.	APPROX. WEIGHT PER FOOT IN LBS.	6 DIA. OF SHEAVE BASED ON SHIP PRACTICE IN INCHES
2¾	8⅝	53	265	11.95	
2½	7⅞	43	214	9.85	
2¼	7⅛	35	175	8.	
2	6¼	26	130	6.30	
1⅞	5¾	23.8	119	5.55	
1¾	5½	22	108	4.85	
1⅝	5	18	90	4.15	
1½	4¾	16	80	3.55	
1⅜	4¼	14	68	3.	
1¼	4	11	55	2.45	22-24
1⅛	3½	9	44	2.	20-22
1	3	7	35	1.58	18-20
⅞	2¾	5	27	1.20	16-18
¾	2¼	4	21	.89	14-16
⅝	2	3	14	.62	12-14
9/16	1¾	2.3	11.5	.50	
½	1½	1.85	9.25	.39	10-12
7/16	1¼	1.4	7.2	.30	
⅜	1⅛	1.	5.1	.22	

Table 7—Special Flexible, Extra Strong Plow Steel Hoisting Rope

6-STRANDS-37 WIRES TO THE STRAND— 1 HEMP CORE

DIAMETER IN INCHES	CIRCUMFERENCE IN INCHES	PROPER WORKING LOAD IN TONS OF 2000 LBS	APPROX. STRENGTH IN TONS OF 2000 LBS.	APPROX. WEIGHT PER FOOT IN LBS	7 DIA. OF SHEAVE BASED ON SHIP PRACTICE IN INCHES
2¾	8⅝	55	278	11.95	
2½	7⅞	45	225	9.85	
2¼	7⅛	37	184	8	
2	6¼	27	137	6.30	
1⅞	5¾	25	125	5.55	
1¾	5½	23	113	4.85	
1⅝	5	19	95	4.15	
1½	4¾	17	84	3.55	
1⅜	4¼	14	71	3	
1¼	4	11	58	2.45	22-24
1⅛	3½	9.2	46	2	20-22
1	3	7.4	37	1.58	18-20
⅞	2¾	5.8	29	1.20	16-18
¾	2¼	4.6	23	.89	14-16
⅝	2	3.2	16	.62	12-14
9/16	1¾	2.5	12.50	.50	
½	1½	1.9	9.75	.39	10-12
7/16	1¼	1.5	7.50	.30	
⅜	1⅛	1.06	5.30	.22	

Table 8—Extra Special Flexible Hoisting Rope

6-STRANDS-61 WIRES TO THE STRAND— 1 HEMP CORE

PLOUGH STEEL

DIAMETER IN INCHES	CIRCUMFERENCE IN INCHES	PROPER WORKING LOAD IN TONS OF 2000 LBS.	APPROX. STRENGTH IN TONS OF 2000 LBS	APPROX. WEIGHT PER FOOT IN LBS.	8 REMARKS
3¼	10¼	70	350	16.60	RECOMMENDED FOR DREDGING PURPOSES
3	9½	62	310	14.20	
2¾	8⅝	53	265	11.95	
2½	7⅞	43	214	9.85	
2¼	7⅛	35	175	8.00	
2	6¼	26	130	6.30	

EXTRA STRONG PLOUGH STEEL

3¼	10¼	74	370	16.60	RECOMMENDED FOR DREDGING PURPOSES
3	9½	65	325	14.20	
2¾	8⅝	56	278	11.95	
2½	7⅞	45	225	9.85	
2¼	7⅛	37	184	8.00	
2	6¼	27	137	6.30	

Table 9—Extra Flexible Plow Steel Hoisting Rope

8-STRANDS—19 WIRES TO THE STRAND— 1 HEMP CORE

DIAMETER IN INCHES	CIRCUMFERENCE IN INCHES	PROPER WORKING LOAD IN TONS OF 2000 LBS	APPROX. STRENGTH IN TONS OF 2000 LBS	APPROX. WEIGHT PER FOOT IN LBS	9 DIA. OF SHEAVE BASED ON SHIP PRACTICE IN INCHES
1½	4¾	14.8	74	3.19	
1⅜	4¼	12.8	64	2.70	
1¼	4	10.4	52	2.20	22-24
1⅛	3½	8.6	43	1.80	20-22
1	3	6.6	33	1.42	18-20
⅞	2¾	5.2	26	1.08	16-18
¾	2¼	4	20	.80	14-16
⅝	2	2.8	14	.56	12-14
9/16	1¾	2.32	11.6	.45	
½	1½	1.74	8.7	.35	10-12
7/16	1¼	1.38	6.90	.27	
⅜	1⅛	1.02	5.12	.20	
5/16	1	.67	3.35	.13	
¼	¾	.45	2.25	.09	

ROPE PARTICULARS

Table 10—Extra Flexible, Extra Strong Plow Steel Hoisting Rope

8-STRANDS—19 WIRES TO THE STRAND—1 HEMP CORE

DIAMETER IN INCHES	CIRCUMFERENCE IN INCHES	PROPER WORKING LOAD IN TONS OF 2000 LBS.	APPROX STRENGTH IN TONS OF 2000 LBS.	APPROX WEIGHT PER FOOT IN LBS.	DIA. OF SHEAVE BASED ON SHIP PRACTICE IN INCHES [10]
1½	4¾	16	80	3.19	
1⅜	4¼	13	68	2.70	
1¼	4	11	56	2.20	22-24
1⅛	3½	9.2	46	1.80	20-22
1	3	7.2	36	1.42	18-20
⅞	2¾	5.6	28	1.08	16-18
¾	2¼	4.4	22	.80	14-16
⅝	2	3	15	.56	12-14
9/16	1¾	2.4	12	.45	
½	1½	1.9	9.5	.35	10-12

Table 11—Crucible Cast Steel Transmission, Haulage or Standing Rope

6-STRANDS—7 WIRES TO THE STRAND—1 HEMP CORE

DIAMETER IN INCHES	CIRCUMFERENCE IN INCHES	PROPER WORKING LOAD IN TONS OF 2000 LB	APPROX STRENGTH IN TONS OF 2000 LBS.	APPROX WEIGHT PER FOOT IN LBS.	DIA. OF SHEAVE BASED ON SHIP PRACTICE IN INCHES [11]
1½	4¾	12.6	63	3.55	
1⅜	4¼	10.6	53	3.	
1¼	4	9.2	46	2.45	22-24
1⅛	3½	7.4	37	2.	20-22
1	3	6.2	31	1.58	18-20
⅞	2¾	4.8	24	1.20	16-18
¾	2¼	3.7	18.6	.89	14-16
1/16	2⅛	3.1	15.4	.75	
⅝	2	2.6	13	.62	12-14
9/16	1¾	2.	10	.50	
½	1½	1.5	7.7	.39	10-12
7/16	1¼	1.1	5.5	.30	
⅜	1⅛	.92	4.6	.22	
5/16	1	.70	3.5	.15	
9/32	⅞	.50	2.5	.12½	

Table 12—Standard Crucible Cast Steel Hoisting Rope

6-STRANDS—19 WIRES TO THE STRAND—1 HEMP CORE

DIAMETER IN INCHES	CIRCUMFERENCE IN INCHES	PROPER WORKING LOAD IN TONS OF 2000 LBS.	APPROX STRENGTH IN TONS OF 2000 LBS.	APPROX WEIGHT PER FOOT IN LBS.	DIA. OF SHEAVE BASED ON SHIP PRACTICE IN INCHES
2¾	8⅝	42.2	211	11.95	
2½	7⅞	34	170	9.85	
2¼	7⅛	26.6	133	8	
2	6¼	21.2	106	6.30	
1⅞	5¾	19	96	5.55	
1¾	5½	17	85	4.85	
1⅝	5	14.4	72	4.15	
1½	4¾	12.8	64	3.55	
1⅜	4¼	11.2	56	3	
1¼	4	9.4	47	2.45	22-24
1⅛	3½	7.6	38	2	20-22
1	3	6	30	1.58	18-20
⅞	2¾	4.6	23	1.20	16-18
¾	2¼	3.5	17.5	.89	14-16
⅝	2	2.5	12.5	.62	12-14
9/16	1¾	2	10	.50	
½	1½	1.68	8.4	.39	10-12
7/16	1¼	1.30	6.5	.30	
⅜	1⅛	.96	4.8	.22	
5/16	1	.62	3.1	.15	
¼	¾	.44	2.2	.10	

Table 13—Extra Strong Crucible Cast Steel Transmission, Haulage or Standing Rope

6-STRANDS—7 WIRES TO THE STRAND—1 HEMP CORE

DIAMETER IN INCHES	CIRCUMFERENCE IN INCHES	PROPER WORKING LOAD IN TONS OF 2000 LBS.	APPROX STRENGTH IN TONS OF 2000 LBS.	APPROX WEIGHT PER FOOT IN LBS.	DIA. OF SHEAVE BASED ON SHIP PRACTICE IN INCHES
1½	4¾	14.6	73	3.55	
1⅜	4¼	12.6	63	3	
1¼	4	10.8	54	2.45	22-24
1⅛	3½	8.6	43	2	20-22
1	3	7	35	1.58	18-20
⅞	2¾	5.6	28	1.20	16-18
¾	2¼	4.2	21	.89	14-16
1/16	2⅛	3.3	16.7	.75	
⅝	2	2.9	14.5	.62	12-14
9/16	1¾	2.2	11	.50	
½	1½	1.8	8.85	.39	10-12
7/16	1¼	1.25	6.25	.30	
⅜	1⅛	1.05	5.25	.22	
5/16	1	.79	3.95	.15	
9/32	⅞	.59	2.95	.12½	

ROPE PARTICULARS

Table 14—Standard Extra Strong Crucible Cast Steel Hoisting Rope

6-Strands—19 Wires to the Strand—1 Hemp Core.

Diameter in Inches	Circumference in Inches	Proper Working Load in Tons of 2000 Lbs.	Approx. Strength in Tons of 2000 Lbs.	Approx. Weight Per Foot in Lbs.	Dia. of Sheave Based on Ship Practice in Inches [14]
2¾	8⅝	48.6	243	11.95	
2½	7⅞	40	200	9.85	
2¼	7⅛	32	160	8	
2	6¼	24.6	123	6.3	
1⅞	5¾	22.4	112	5.55	
1¾	5½	19.8	99	4.85	
1⅝	5	16.6	83	4.15	
1½	4¾	14.6	73	3.55	
1⅜	4¼	12.8	64	3	
1¼	4	10.6	53	2.45	22-24
1⅛	3½	8.6	43	2	20-22
1	3	6.80	34	1.58	18-20
⅞	2¾	5.20	26	1.20	16-18
¾	2¼	4.04	20.2	.89	14-16
⅝	2	2.80	14	.62	12-14
9/16	1¾	2.24	11.2	.50	
½	1½	1.84	9.2	39	10-12
7/16	1¼	1.45	7.25	.30	
⅜	1⅛	1.06	5.30	.22	
5/16	1	.70	3.50	.15	
¼	¾	.49	2.43	.10	

Table 15—Special Flexible Crucible Cast Steel Hoisting Rope

6-Strands—37 Wires to the Strand—1 Hemp Core.

Diameter in Inches	Circumference in Inches	Proper Working Load in Tons of 2000 Lbs.	Approx. Strength in Tons of 2000 Lbs.	Approx. Weight Per Foot in Lbs.	Dia. of Sheave Based on Ship Practice in Inches [15]
2¾	8⅝	40	200	11.95	
2½	7⅞	32	160	9.85	
2¼	7⅛	25	125	8	
2	6¼	21	105	6.30	
1⅞	5¾	18.8	94	5.55	
1¾	5½	17	84	4.85	
1⅝	5	14	71	4.15	
1½	4¾	12	63	3.55	
1⅜	4¼	11	55	3	
1¼	4	9	45	2.45	22-24
1⅛	3½	7	34	2	20-22
1	3	6	29	1.58	18-20
⅞	2¾	5	23	1.20	16-18
¾	2¼	3.5	17.5	.89	14-16
⅝	2	2.2	11.2	.62	12-14
9/16	1¾	1.9	9.5	.50	
½	1½	1.45	7.25	.39	10-12
7/16	1¼	1.1	5.5	.30	
⅜	1⅛	.84	4.2	.22	

Table 16—Extra Special Flexible Hoisting Rope

6-Strands—61 Wires to the Strand—1 Hemp Core

Crucible Cast Steel

Diameter in Inches	Circumference in Inches	Proper Working Load in Tons of 2000 Lbs.	Approx. Strength in Tons of 2000 Lbs.	Approx. Weight Per Foot in Lbs.	Remarks
3¼	10¼	56	280	16.60	Recommended for Dredging Purposes
3	9½	48	240	14.20	
2¾	8⅝	40	200	11.95	
2½	7⅞	32	160	9.85	
2¼	7⅛	25	125	8.00	
2	6¼	21	105	6.30	

Extra Strong Crucible Cast Steel

3¼	10¼	63	315	16.60	Recommended for Dredging Purposes
3	9½	55	275	14.20	
2¾	8⅝	47	233	11.95	
2½	7⅞	37	187	9.85	
2¼	7⅛	30	150	8.00	
2	6¼	23	117	6.30	

Table 17—Special Flexible, Extra Strong Crucible Cast Steel Hoisting Rope

6-Strands—37 Wires to the Strand—1 Hemp Core

Diameter in Inches	Circumference in Inches	Proper Working Load in Tons of 2000 Lbs.	Approx. Strength in Tons of 2000 Lbs.	Approx. Weight Per Foot in Lbs.	Dia. of Sheave Based on Ship Practice in Inches
2¾	8⅝	47	233	11.95	
2½	7⅞	37	187	9.85	
2¼	7⅛	30	150	8	
2	6¼	23	117	6.30	
1⅞	5¾	21.2	106	5.55	
1¾	5½	19	95	4.85	
1⅝	5	16	79	4.15	
1½	4¾	14	71	3.55	
1⅜	4¼	12	61	3	
1¼	4	10	50	2.45	22-24
1⅛	3½	8	39	2	20-22
1	3	6.4	32	1.58	18-20
⅞	2¾	5	25	1.20	16-18
¾	2¼	3.8	19	.89	14-16
⅝	2	2.5	12.6	.62	12-14
9/16	1¾	2.1	10.5	.50	
½	1½	1.65	8.25	.39	10-12
7/16	1¼	1.27	6.35	.30	
⅜	1⅛	.93	4.65	.22	

ROPE PARTICULARS

Table 18—Extra Flexible Crucible Cast Steel Hoisting Rope

8 Strands—19 wires to the Strand—1 Hemp Core

Diameter in Inches	Circumference in Inches	Proper Working Load in Tons of 2000 Lbs.	Approx. Strength in Tons of 2000 Lbs.	Approx. Weight per Foot in Lbs.	18 Dia. of Sheave Based on Ship Practice in Inches
1½	4¾	11.6	58	3.19	
1⅜	4¼	10.2	51	2.70	
1¼	4	8.4	42	2.20	22-24
1⅛	3½	6.8	34	1.80	20-22
1	3	5.2	26	1.42	18-20
⅞	2¾	4	20	1.08	16-18
¾	2¼	3.06	15.3	.80	14-16
⅝	2	2.18	10.9	.56	12-14
9/16	1¾	1.74	8.7	.45	
½	1½	1.46	7.3	.35	10-12
7/16	1¼	1.14	5.7	.27	
⅜	1⅛	.84	4.2	.20	
5/16	1	.55	2.75	.13	
¼	¾	.36	1.80	.09	

Table 19—Extra Flexible, Extra Strong Crucible Cast Steel Hoisting Rope

8 Strands—19 wires to the Strand—1 Hemp Core

Diameter in Inches	Circumference in Inches	Proper Working Load in Tons of 2000 Lbs.	Approx. Strength in Tons of 2000 Lbs.	Approx. Weight per Foot in Lbs.	19 Dia. of Sheave Based on Ship Practice in Inches
1½	4¾	13	66	3.19	
1⅜	4¼	11	57	2.70	
1¼	4	9.4	47	2.20	22-24
1⅛	3½	7.6	38	1.80	20-22
1	3	5.	29.7	1.42	18-20
⅞	2¾	4.6	23	1.08	16-18
¾	2¼	3.5	17.6	.80	14-16
⅝	2	2.5	12.4	.56	12-14
9/16	1¾	2	10.1	.45	
½	1½	1.6	8	.35	10-12
7/16	1¼	1.26	6.30	.27	
⅜	1⅛	.93	4.66	.20	
5/16	1	.61	3.05	.13	
¼	¾	.40	2.02	.09	

Table 20—Galvanized Crucible Cast Steel Yacht Rigging or Guy Rope

6-Strands—7 Wires to the Strand—1 Hemp Core

Diameter in Inches	Circumference in Inches	Cir. of Manila Rope of Equal Strength	Approx. Strength in Tons of 2000 Lbs.	Approx. Weight per Foot in Lbs.	20 Remarks
1¼	4	13	42	2.45	Seldom used for Hoisting Rope for Dia. of Sheave see Tables for Hoisting Rope
1 3/16	3¾	12	38	2.21	
1⅛	3½	11	34	2	
1 1/16	3¼	10	31	1.77	
1	3	9	28	1.58	
⅞	2¾	8½	22	1.20	
13/16	2½	8	19	1.03	
¾	2¼	7	16.8	.89	
⅝	2	6	11.7	.62	
9/16	1¾	5¼	9	.50	
½	1½	4¾	7	.39	
9/32	1⅜	4½	6	.34	
7/16	1¼	4¼	5	.30	
⅜	1⅛	3¾	4.2	.22	
5/16	1	3	3.2	.15	

Table 21—Flexible Galvanized Crucible Cast Steel Yacht Rope

6-Strands—19 Wires to the Strand—1 Hemp Core

Diameter in Inches	Circumference in Inches	Cir. of Manila Rope of Equal Strength	Approx. Strength in Tons of 2000 Lbs.	Approx. Weight per Foot in Lbs	21 Dia. of Sheave Based on Ship Practice in Inches
1¼	4	13	42	2.45	22-24
1 3/16	3¾	12	38	2.21	
1⅛	3½	11	34	2	20-22
1 1/16	3¼	10	31	1.77	
1	3	9	28	1.58	18-20
⅞	2¾	8½	22	1.20	16-18
13/16	2½	8	19	1.03	
¾	2¼	7	16.8	.89	14-16
⅝	2	6	11.7	.62	12-14
9/16	1¾	5¼	9	.50	
½	1½	4¾	7	.39	10-12
9/32	1⅜	4½	6	.34	
7/16	1¼	4¼	5	.30	
⅜	1⅛	3¾	4.2	.22	
5/16	1	3	3.2	.15	

ROPE PARTICULARS

Table 22—Galvanized Iron and Crucible Cast Steel Running Rope

6-STRANDS-12 WIRES TO THE STRAND-7 HEMP CORES

DIAMETER IN INCHES	CIRCUMFERENCE IN INCHES	APPROX WEIGHT PER FOOT IN LBS.	APPROXIMATE STRENGTH IN TONS OF 2000 LBS.		DIA OF SHEAVE BASED ON SHIP PRACTICE IN INCHES [22]
			IRON	CAST STEEL	
1 1/16	3 1/4	1.18	10.1	22.5	
1	3	1.05	8.7	19.5	18-20
7/8	2 3/4	.80	6.9	15.5	16-18
13/16	2 1/2	.68	6	13.5	
3/4	2 1/4	.59	5.1	11.5	14-16
5/8	2	.42	3.6	8	12-14
9/16	1 3/4	.33	2.8	6.5	
1/2	1 1/2	.26	2.2	5	10-12
7/16	1 1/4	.20	1.7	3.9	
3/8	1 1/8	.14	1.3	2.85	
5/16	1	.10	.82	1.98	

Table 23—Galvanized Iron Ship's Rigging or Guy Rope

6 STRANDS-7 OR 12 WIRES TO THE STRAND-1 HEMP CORE

DIAMETER IN INCHES	CIRCUMFERENCE IN INCHES	CIR OF MANILA ROPE OF EQUAL STRENGTH	APPROX STRENGTH IN TONS OF 2000 LBS.	APPROX WEIGHT PER FOOT IN LBS.	REMARKS [23]
1 3/4	5 1/2	11	42	4.85	SELDOM USED FOR HOISTING ROPE FOR DIA OF SHEAVE SEE TABLES FOR HOISTING ROPE
1 11/16	5 1/4	10 1/2	38	4.42	
1 5/8	5	10	35	4.15	
1 1/2	4 3/4	9 1/2	30	3.55	
1 7/16	4 1/2	9	28	3.24	
1 3/8	4 1/4	8 1/2	26	3	
1 1/4	4	8	23	2.45	
1 3/16	3 3/4	7 1/2	19	2.21	
1 1/8	3 1/2	6 1/2	18	2	
1 1/16	3 1/4	6	16.1	1.77	
1	3	5 3/4	14.1	1.58	
7/8	2 3/4	5 1/4	11.1	1.20	
13/16	2 1/2	5	9.4	1.03	
3/4	2 1/4	4 3/4	7.8	.89	
5/8	2	4 1/2	5.7	.62	
9/16	1 3/4	3 3/4	4.46	.50	
1/2	1 1/2	3	3.39	.39	
7/16	1 1/4	2 1/2	2.35	.30	
3/8	1 1/8	2 1/4	1.95	.22	
5/16	1	2	1.42	.15	
9/32	7/8	1 3/4	1.20	.125	
1/4	3/4	1 1/2	.99	.09	
7/32	5/8	1 1/4	.79	.063	
3/16	1/2	1 1/8	.61	.04	

Table 24—Standard Iron Hoisting Rope

6-STRANDS-19 WIRES TO THE STRAND-1 HEMP CORE

DIAMETER IN INCHES	CIRCUMFERENCE IN INCHES	PROPER WORKING LOAD IN TONS OF 2000 LBS	APPROX STRENGTH IN TONS OF 2000 LBS.	APPROX WEIGHT PER FOOT IN LBS.	DIA. OF SHEAVE BASED ON SHIP PRACTICE IN INCHES
2 3/4	8 5/8	22.2	111	11.95	
2 1/2	7 7/8	18.4	92	9.85	
2 1/4	7 1/8	14.4	72	8	
2	6 1/4	11	55	6.30	
1 7/8	5 3/4	10	50	5.55	
1 3/4	5 1/2	8.8	44	4.85	
1 5/8	5	7.6	38	4.15	
1 1/2	4 3/4	6.6	33	3.55	
1 3/8	4 1/4	5.6	28	3	
1 1/4	4	4.56	22.8	2.45	22-24
1 1/8	3 1/2	3.72	18.6	2	20-22
1	3	2.90	14.5	1.58	18-20
7/8	2 3/4	2.36	11.8	1.20	16-18
3/4	2 1/4	1.70	8.5	.89	14-16
5/8	2	1.20	6.	.62	12-14
9/16	1 3/4	.94	4.7	.50	
1/2	1 1/2	.78	3.9	.39	10-12
7/16	1 1/4	.58	2.9	.30	
3/8	1 1/8	.48	2.4	.22	
5/16	1	.30	1.5	.15	
1/4	3/4	.22	1.1	.10	

Table 25—Iron Transmission, Haulage or Standing Rope

6-STRANDS-7 WIRES TO THE STRAND-1 HEMP CORE

DIAMETER IN INCHES	CIRCUMFERENCE IN INCHES	PROPER WORKING LOAD IN TONS OF 2000 LBS	APPROX STRENGTH IN TONS OF 2000 LBS.	APPROX WEIGHT PER FOOT IN LBS.	DIA OF SHEAVE BASED ON SHIP PRACTICE IN INCHES
1 1/2	4 3/4	6.4	32	3.55	
1 3/8	4 1/4	5.6	28	3	
1 1/4	4	4.6	23	2.45	22-24
1 1/8	3 1/2	3.8	19	2	20-22
1	3	3	15	1.58	18-20
7/8	2 3/4	2.4	12	1.20	16-18
3/4	2 1/4	1.7	8.8	.89	14-16
11/16	2 1/8	1.5	7.3	.75	
5/8	2	1.2	6	.62	12-14
9/16	1 3/4	.96	4.8	.50	
1/2	1 1/2	.74	3.7	.39	10-12
7/16	1 1/4	.52	2.6	.30	
3/8	1 1/8	.44	2.2	.22	
5/16	1	.34	1.7	.15	
9/32	7/8	.24	1.2	.12 1/2	

ROPE PARTICULARS

Table 26—Served Plow Steel Wire Hoisting Rope

5-STRANDS - 19 WIRES TO THE STRAND - 1 HEMP CORE

DIAMETER IN INCHES BEFORE SERVING	APPROX. DIAMETER AFTER SERVING WITH MARLINE	APPROX. CIRCUM. AFTER SERVING WITH MARLINE	PROPER WORKING LOAD IN TONS OF 2000 LBS.	APPROX. STRENGTH IN TONS OF 2000 LBS.	APPROX. WEIGHT PER FOOT IN LBS.	DIA. OF SHEAVE BASED ON SHIP PRACTICE IN INCHES [26]
1 3/4	2 1/8	6 5/8	22	112	4.88	
1 5/8	2	6 1/4	19	94	4.19	
1 1/2	1 7/8	5 7/8	16	82	3.60	
1 3/8	1 3/4	5 1/2	14	72	3.06	
1 1/4	1 5/8	5 1/8	12	58	2.52	22-24
1 1/8	1 1/2	4 3/4	9.50	47	2.07	20-22
1	1 3/8	4 5/16	7.60	38	1.66	18-20
7/8	1 1/4	3 7/8	5.80	29	1.29	16-18
3/4	1 1/8	3 1/2	4.60	23	1.12	14-16
5/8	1	3 1/8	3.10	15.5	.80	12-14
9/16	7/8	2 3/4	2.40	12.3	.60	
1/2	3/4	2 3/8	2.00	10.0	.49	10-12
7/16	11/16	2 1/4	1.60	8.00	.40	
3/8	5/8	2	1.15	5.75	.36	
5/16	9/16	1 3/4	0.76	3.80	.26	
1/4	1/2	1 1/2	0.53	2.65	.21	

Table 27—Served Crucible Cast Steel Wire Rope

5-STRANDS-7 WIRES TO THE STRAND - 1 HEMP CORE

DIAMETER IN INCHES BEFORE SERVING	APPROX. DIAMETER AFTER SERVING WITH MARLINE	APPROX. CIRCUM. AFTER SERVING WITH MARLINE	PROPER WORKING LOAD IN TONS OF 2000 LBS.	APPROX. STRENGTH IN TONS OF 2000 LBS.	APPROX. WEIGHT PER FOOT IN LBS.	DIA. OF SHEAVE BASE ON SHIP PRACTICE IN INCHES [27]
1	1 1/8	4 5/16	6.20	31	1.66	18-20
7/8	1 1/4	3 7/8	4 80	24	1.29	16-18
3/4	1 1/8	3 1/2	3 70	18.6	1.12	14-16
5/8	1	3 1/8	2.60	13.0	.80	12-14
1/2	3/4	2 3/8	1.50	7.7	.49	10-12
3/8	5/8	2	0.92	4.6	.36	

Table 28—Served Crucible Cast Steel Wire Hoisting Rope

5-STRANDS - 19 WIRES TO THE STRAND - 1 HEMP CORE

DIAMETER IN INCHES BEFORE SERVING	APPROX. DIAMETER AFTER SERVING WITH MARLINE	APPROX. CIRCUM. AFTER SERVING WITH MARLINE	PROPER WORKING LOAD IN TONS OF 2000 LBS.	APPROX. STRENGTH IN TONS OF 2000 LBS.	APPROX. WEIGHT PER FOOT IN LBS.	DIA. OF SHEAVE BASED ON SHIP PRACTICE IN INCHES [28]
1 3/4	2 1/8	6 5/8	17.0	85	4.88	
1 5/8	2	6 1/4	14.4	72	4.19	
1 1/2	1 7/8	5 7/8	12.8	64	3.60	
1 3/8	1 3/4	5 1/2	11.6	56	3.06	
1 1/4	1 5/8	5 1/8	9.4	47	2.52	22-24
1 1/8	1 1/2	4 3/4	7.60	38	2.07	20-22
1	1 3/8	4 5/16	6.00	30	1.66	18-20
7/8	1 1/4	3 7/8	4.60	23	1.29	16-18
3/4	1 1/8	3 1/2	3.50	17.5	1.12	14-16
5/8	1	3 1/8	2.50	12.5	.80	12-14
9/16	7/8	2 3/4	2.00	10.0	.60	
1/2	3/4	2 3/8	1.68	8.4	.49	10-12
7/16	11/16	2 1/4	1.30	6.5	.40	
3/8	5/8	2	0.96	4.8	.36	
5/16	9/16	1 3/4	0.62	3.1	.26	
1/4	1/2	1 1/2	0.44	2.2	.21	

Table 29—Served, Extra Strong Cast Steel Wire Hoisting Rope

5-STRANDS - 19 WIRES TO THE STRAND - 1 HEMP CORE

DIAMETER IN INCHES BEFORE SERVING	APPROX. DIAMETER AFTER SERVING WITH MARLINE	APPROX. CIRCUM. AFTER SERVING WITH MARLINE	PROPER WORKING LOAD IN TONS OF 2000 LBS.	APPROX. STRENGTH IN TONS OF 2000 LBS.	APPROX. WEIGHT PER FOOT IN POUNDS	DIA. OF SHEAVE BASED ON SHIP PRACTICE IN INCHES [29]
1 3/4	2 1/8	6 5/8	19.8	99	4.88	
1 5/8	2	6 1/4	16.6	83	4.19	
1 1/2	1 7/8	5 7/8	14.6	73	3.60	
1 3/8	1 3/4	5 1/2	13.0	64	3.06	
1 1/4	1 5/8	5 1/8	11.06	53	2.52	22-24
1 1/8	1 1/2	4 3/4	8.60	43	2.07	20-22
1	1 3/8	4 5/16	6.80	34	1.66	18-20
7/8	1 1/4	3 7/8	5.20	26	1.29	16-18
3/4	1 1/8	3 1/2	4.04	20.2	1.12	14-16
5/8	1	3 1/8	2.80	14.0	.80	12-14
9/16	7/8	2 3/4	2.24	11.2	.60	
1/2	3/4	2 3/8	1.84	9.2	.49	10-12
7/16	11/16	2 1/4	1.45	7.25	.40	
3/8	5/8	2	1.06	5.30	.36	
5/16	9/16	1 3/4	0.70	3.50	.26	
1/4	1/2	1 1/2	0.49	2.43	.21	

ROPE PARTICULARS

Table 30—Common Lay, Three Strand Manila Rope
Approximate Gross Weight and Strength

Name & Size in Circumference	Approx. Diameter	Approximate Length & Weight Standard Coil		Approximate Tensile Strength New Manila Rope	Length of Rope in One Pound	Weight Per Foot in Pounds
		Feet	Pounds			
6 thd 9/16"	3/16 in.	3333	50	480	66'-8"	.015
6 thd .34"	1/4"	2750	50	620	55'-0"	.018
9 thd 1"	5/16"	1820	50	1000	36'-4"	.027
12 thd 1 1/8"	3/8"	1350	50	1275	27'-0"	.037
15 thd 1 13/32"	13/32"	1200	50	1600	24'-0"	.041
1 1/4 in.	7/16"	1200	65	1750	18'-6"	.054
1 3/8"	15/32"	1200	75	2100	16'-0"	.063
1 1/2"	1/2"	1200	90	2400	13'-4"	.075
1 3/4"	9/16"	1200	125	3150	9'-7"	.104
2"	5/8"	1200	160	4000	7'-6"	.133
2 1/4"	3/4"	1200	198	4700	6'-1"	.165
2 1/2"	13/16"	1200	234	5900	5'-1"	.195
2 3/4"	7/8"	1200	270	7000	4'-5"	.225
3"	1"	1200	324	8000	3'-8"	.270
3 1/4"	1 1/16"	1200	378	9500	3'-2"	.315
3 1/2"	1 1/8"	1200	432	10500	2'-9"	.360
3 3/4"	1 1/4"	1200	504	12500	2'-5"	420
4"	1 5/16"	1200	576	14000	2'-1"	.480

Table 31—Common Lay, Three Strand Manila Rope
Approximate Gross Weight and Strength

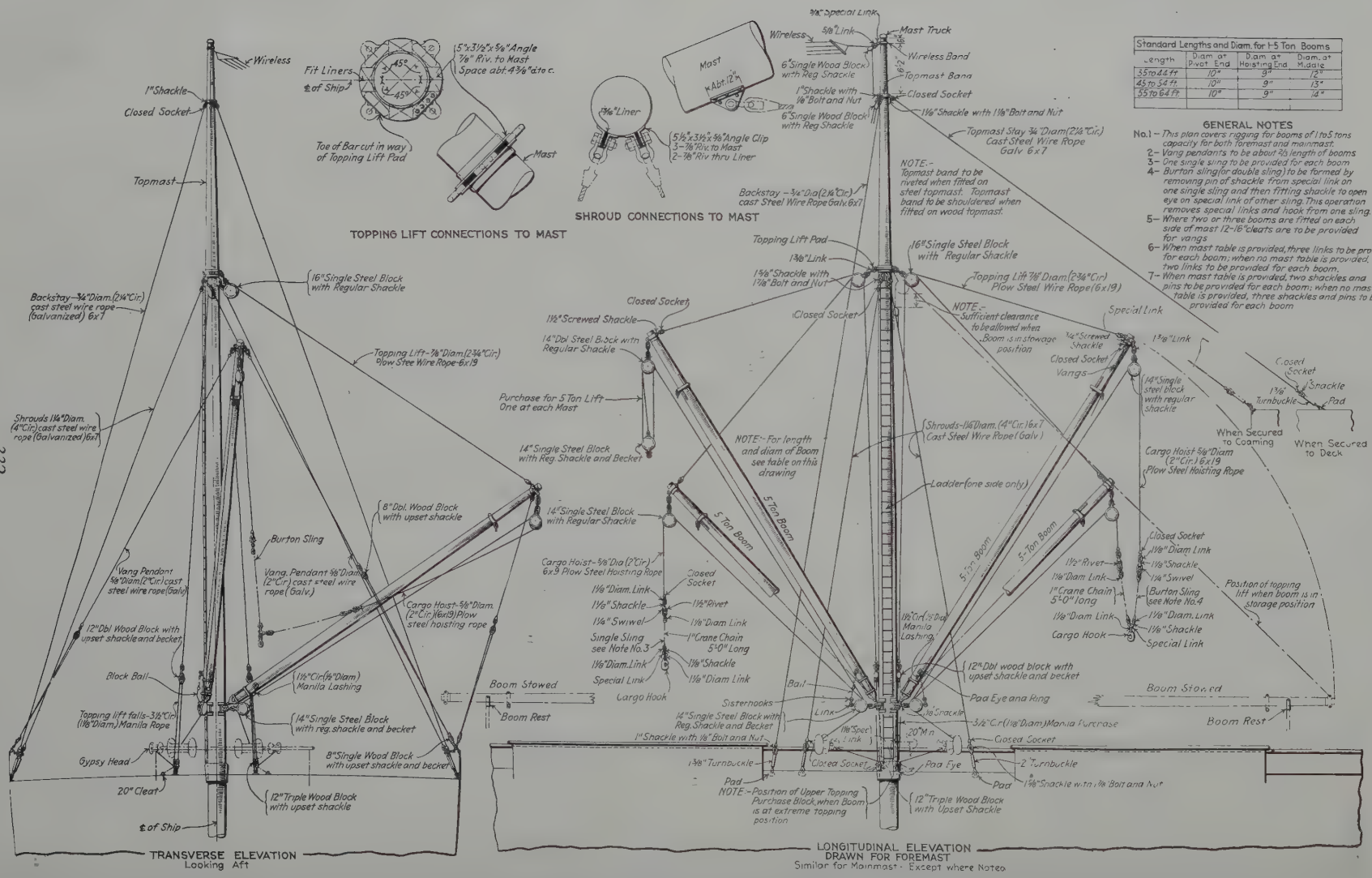
Name & Size in Circumference	Approx. Diameter	Approximate Length & Weight Standard Coil		Approximate Tensile Strength New Manila Rope	Length of Rope in One Pound	Weight Per Foot in Pounds
		Feet	Pounds			
4 1/4 in	1 3/8 in.	1200	648	16000	1'-10"	.540
4 1/2"	1 1/2"	1200	720	17500	1'-8"	.600
4 3/4"	1 9/16"	1200	800	19500	1'-6"	.667
5"	1 5/8"	1200	900	21500	1'-4"	.750
5 1/2"	1 3/4"	1200	1080	25500	1'-1"	.900
6"	2"	1200	1296	30000	11"	1.08
6 1/2"	2 1/8"	1200	1512	34000	9 1/2"	1.26
7"	2 1/4"	1200	1764	38000	8"	1.47
7 1/2"	2 1/2"	1200	2016	43500	7"	1.68
8"	2 5/8"	1200	2304	49000	6 1/4"	1.92
8 1/2"	2 7/8"	1200	2590	55000	5 1/2"	2.16
9"	3"	1200	2915	61000	5"	2.43
9 1/2"	3 1/8"	1200	3240	67000	4 1/2"	2.70
10	3 1/4"	1200	3600	73000	4"	3.00
11	3 11/16"	1200	4320	84000	3 11/32"	3.60
12	4"	1200	5184	95000	2 49/64"	4.32
13	4 11/32"	1200	6048	106000	2 17/64"	5.04
14	4 11/16"	1200	7050	115700	2 1/32"	5.88
15	5"	1200	8064	124200	1 25/32"	6.72

Table 32—Tensile Strength of Manila and Wire Rope Compared
Approximate Breaking Stress in Tons of 2000 Lbs.

Diameter in Inches	Wire Transmission Rope. One Hemp Core Surrounded By Six Strands of Seven Strands Each.				Average Quality New Manila Rope
	Iron	Crucible Cast Steel	Extra Strong Crucible Cast Steel	Plough Steel	
	Tons	Tons	Tons	Tons	Tons
2 3/4	...	...	...	...	26
2 1/2	...	...	...	...	21
2 1/4	...	...	...	...	17
2	...	...	...	...	13 1/2
1 3/4	...	...	...	...	11
1 5/8	...	...	...	...	9 1/2
1 1/2	32	63	73	82	8
1 3/8	28	53	63	72	7
1 1/4	23	46	54	60	6
1 1/8	19	37	43	47	5
1	15	31	35	38	4
7/8	12	24	28	31	3
3/4	8.8	18.6	21	23	2 1/4
5/8	6	13	14.5	16	1 1/2
9/16	4.8	10	11	12	1 1/4
1/2	3.7	7.7	8.85	10	1
7/16	2.6	5.5	6.25	7	3/4
3/8	2.2	4.6	5.25	5.9	1/2
5/16	1.7	3.5	3.95	4.4	3/8
9/32	1.2	2.5	2.95	3.4	3/10
1/4	...	...	...	...	1/4

Table 33—Tensile Strength of Manila and Wire Rope Compared
Approximate Breaking Stress in Tons of 2000 Lbs.

Diameter in Inches	Wire Hoisting Rope. One Hemp Core Surrounded By Six Strands of Nineteen Wires Each.				Average Quality New Manila Rope
	Iron	Crucible Cast Steel	Extra Strong Crucible Cast Steel	Plough Steel	
	Tons	Tons	Tons	Tons	Tons
2 3/4	111	211	243	275	26
2 1/2	92	170	200	229	21
2 1/4	72	133	160	186	17
2	55	106	123	140	13 1/2
1 3/4	44	85	99	112	11
1 5/8	38	72	83	94	9 1/2
1 1/2	33	64	73	82	8
1 3/8	28	56	64	72	7
1 1/4	228	47	53	58	6
1 1/8	18.6	38	43	47	5
1	14.5	30	34	38	4
7/8	11.8	23	26	29	3
3/4	8.5	17.5	20.2	23	2 1/4
5/8	6	12.5	14	15.5	1 1/2
9/16	4.7	10	11.2	12.3	1 1/4
1/2	3.9	8.4	9.2	10	1
7/16	2.9	6.5	7.25	8	3/4
3/8	2.4	4.8	5.30	5.75	1/2
5/16	1.5	3.1	3.50	3.8	3/8
9/32	...	...	...	...	3/10
1/4	1.1	2.2	2.43	2.65	1/4


Wireless
Fit Liners
℄ of Ship
5"x3½"x⅝" Angle 7/8" Riv. to Mast Space abt. 4⅜" c to c.
Toe of Bar cut in way of Topping Lift Pad
Mast
TOPPING LIFT CONNECTIONS TO MAST
⅞" Liner
5½"x3½"x⅝" Angle Clip 3-⅞" Riv. to Mast 2-⅞" Riv. thru Liner
SHROUD CONNECTIONS TO MAST
1" Shackle
Closed Socket
Topmast
Backstay-¾" Diam. (2¼" Cir.) cast steel wire rope (Galvanized) 6x7
16" Single Steel Block with Regular Shackle
Topping Lift-⅞" Diam. (2¾" Cir.) Plow Stee Wire Rope-6x19
Shrouds 1¼" Diam. (4" Cir.) cast steel wire rope (Galvanized) 6x7
Purchase for 5 Ton Lift One at each Mast
14" Single Steel Block with Reg. Shackle and Becket
8" Dbl. Wood Block with upset shackle
Burton Sling
Vang Pendant ⅝" Diam. (2" Cir.) cast steel wire rope (Galv.)
Vang. Pendant ⅝" Diam. (2" Cir.) cast steel wire rope (Galv.)
Cargo Hoist-⅝" Diam. (2" Cir. 6x19) Plow steel hoisting rope
12" Dbl Wood Block with upset shackle and becket
Block Ball
1½" Cir. (½" Diam) Manila Lashing
Topping lift falls-3½" Cir. (1⅛" Diam.) Manila Rope
14" Single Steel Block with reg. shackle and becket
Gypsy Head
8" Single Wood Block with upset shackle and becket
20" Cleat
12" Triple Wood Block with upset shackle
℄ of Ship
TRANSVERSE ELEVATION
Looking Aft
⅝" Special Link
Wireless
⅝" Link
Mast Truck
Mast
Abt. 12"
6" Single Wood Block with Reg. Shackle
Wireless Band
1" Shackle with ⅛" Bolt and Nut
Topmast Band
6" Single Wood Block with Reg. Shackle
Closed Socket
1⅛" Shackle with 1⅛" Bolt and Nut
Topmast Stay ¾" Diam. (2¼" Cir.) Cast Steel Wire Rope Galv 6x7
NOTE:- Topmast band to be riveted when fitted on steel topmast. Topmast band to be shouldered when fitted on wood topmast.
Backstay-¾" Dia. (2¼" Cir.) cast Steel Wire Rope Galv. 6x7
Topping Lift Pad
1⅜" Link
1⅝" Shackle with 1⅛" Bolt and Nut
16" Single Steel Block with Regular Shackle
Topping Lift ⅞" Diam. (2¾" Cir.) Plow Steel Wire Rope (6x19)
Closed Socket
NOTE:- Sufficient clearance to be allowed when Boom is in stowage position
Special Link
1⅜" Link
Closed Socket
1½" Screwed Shackle
14" Dbl Steel Block with Regular Shackle
¾" Screwed Shackle
Closed Socket
Vangs
14" Single steel block with regular shackle
Closed Socket
1⅜" Turnbuckle
Shackle
Pad
When Secured to Coaming
When Secured to Deck
Shrouds-1¼" Diam. (4" Cir.) 6x7 (Cast Steel Wire Rope Galv.)
NOTE:- For length and diam of Boom see table on this drawing
Cargo Hoist ⅝" Diam (2" Cir.) 6x19 Plow Steel Hoisting Rope
Ladder (one side only)
14" Single Steel Block with Regular Shackle
5 Ton Boom
5 Ton Boom
5 Ton Boom
5 Ton Boom
Cargo Hoist-⅝" Dia (2" Cir.) 6x9 Plow Steel Hoisting Rope
Closed Socket
1⅛" Diam. Link
1⅛" Shackle
1¼" Swivel
Single Sling see Note No. 3
1⅛" Diam. Link
Special Link
Cargo Hook
1½" Rivet
1⅛" Diam Link
1" Crane Chain 5'-0" Long
1⅛" Shackle
1⅛" Diam Link
Closed Socket
1⅛" Diam Link
1⅛" Shackle
1¼" Swivel
Burton Sling see Note No. 4
1⅛" Diam. Link
Cargo Hook
1⅛" Diam. Link
1⅛" Shackle
Special Link
Position of topping lift when boom is in storage position
1½" Cir. (½" Dia) Manila Lashing
12" Dbl wood block with upset shackle and becket
Pad Eye and Ring
Boom Stowed
Boom Rest
Bail
Sisterhooks
14" Single Steel Block with Reg. Shackle and Becket
⅛" Shackle
3½" Cir. (1⅛" Diam) Manila Purchase
1" Shackle with ⅛" Bolt and Nut
⅝" Spec. Ell. Link
20" Min
Closed Socket
1⅞" Turnbuckle
Closed Socket
Pad Eye
2" Turnbuckle
Pad
1⅛" Shackle with 1⅛" Bolt and Nut
NOTE:- Position of Upper Topping Purchase Block when Boom is at extreme topping position
12" Triple Wood Block with Upset Shackle
Boom Stowed
Boom Rest
LONGITUDINAL ELEVATION
DRAWN FOR FOREMAST
Similar for Mainmast - Except where Noted

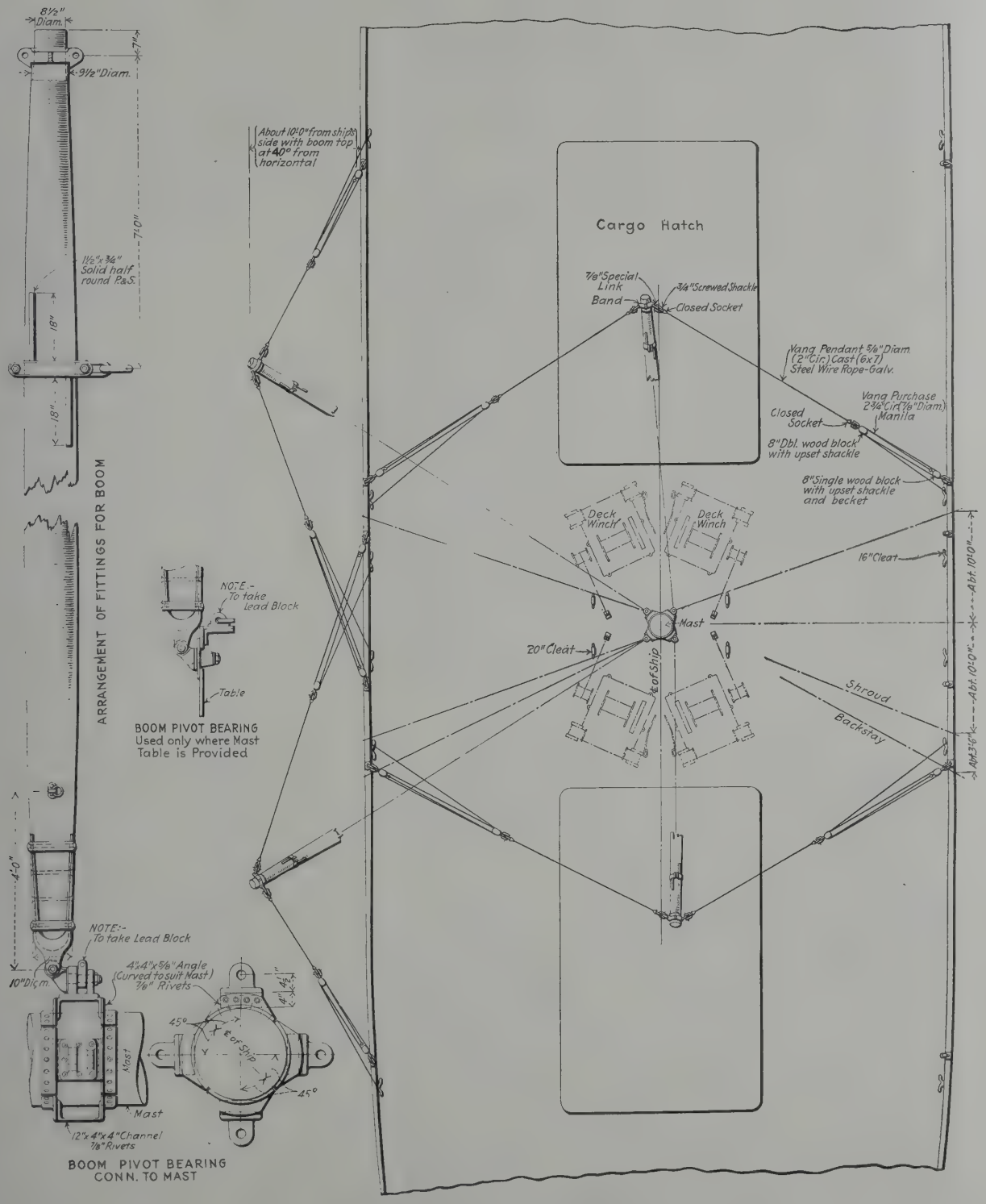
Standard Lengths and Diam. for 1-5 Ton Booms			
Length	Diam. at Pivot End	Diam. at Hoisting End	Diam. at Middle
35 to 44 ft	10"	9"	12"
45 to 54 ft	10"	9"	13"
55 to 64 ft	10"	9"	14"

GENERAL NOTES

No. 1 – This plan covers rigging for booms of 1 to 5 tons capacity for both foremast and mainmast.
2– Vang pendants to be about ⅔ length of booms
3– One single sling to be provided for each boom
4– Burton sling (or double sling) to be formed by removing pin of shackle from special link on one single sling and then fitting shackle to open eye on special link of other sling. This operation removes special links and hook from one sling.
5– Where two or three booms are fitted on each side of mast 12"-16" cleats are to be provided for vangs
6– When mast table is provided, three links to be provided for each boom; when no mast table is provided, two links to be provided for each boom.
7– When mast table is provided, two shackles and pins to be provided for each boom; when no mast table is provided, three shackles and pins to be provided for each boom

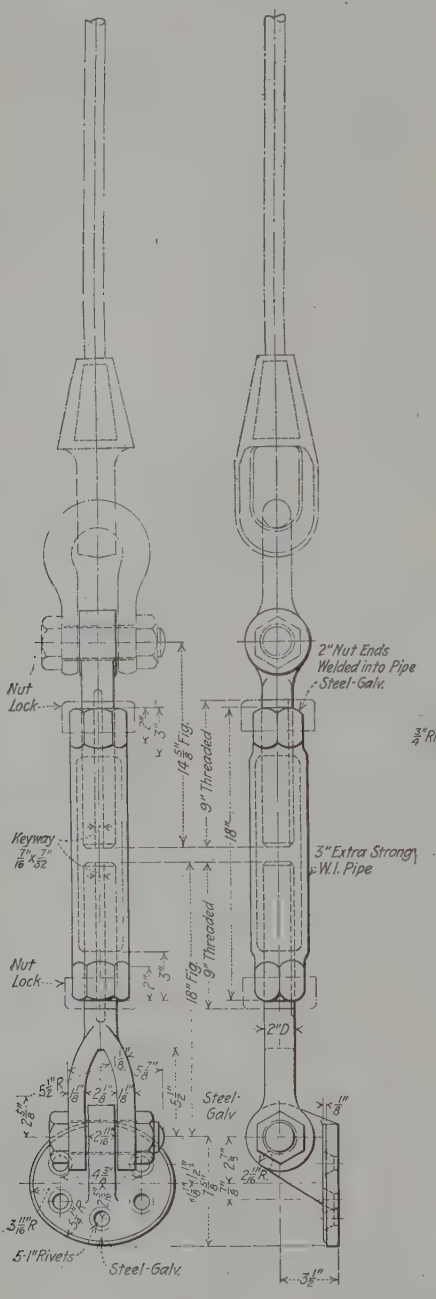
5-TON CARGO HANDLING GEAR

For Plan View, See Opposite Page. For Details, See Pages 334, 335, 336, 337.

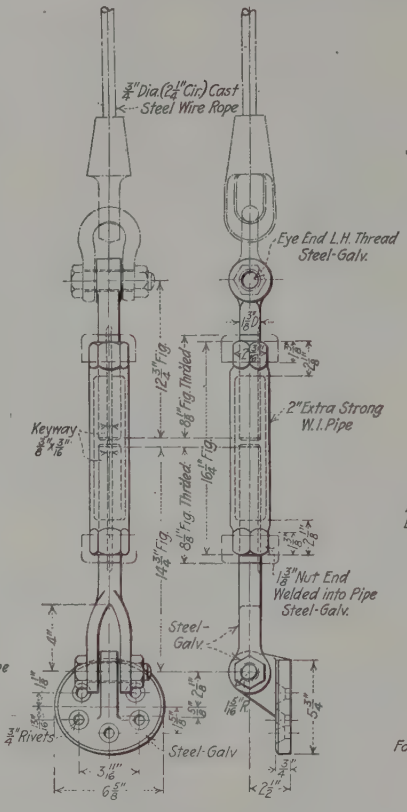


5 TON CARGO HANDLING GEAR

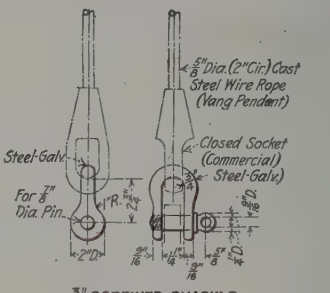
For Elevations, See Opposite Page. For Details, See Pages 334, 335, 336, 337.



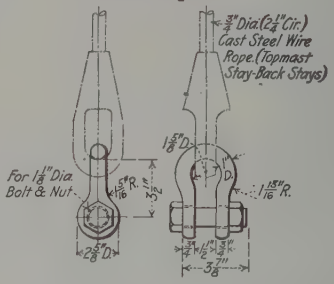
PAD AND TURNBUCKLE BODY AND EYE END



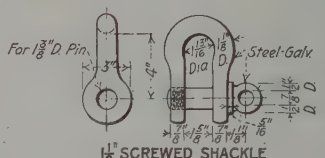
PAD AND TURNBUCKLE BODY AND EYE END



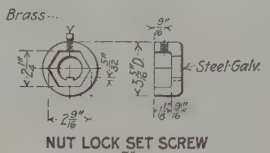
¾" SCREWED SHACKLE WITH SCREW PIN
For Vangs



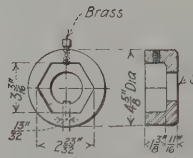
1" SHACKLE
For Topmast Stay, Back Stays & Gantline



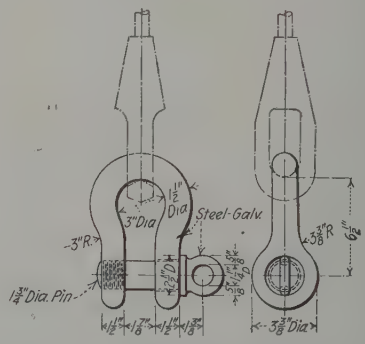
1⅜" SCREWED SHACKLE
For Shackle Band on Cargo Hoist Lead Block



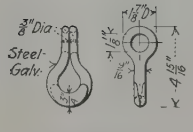
NUT LOCK SET SCREW
For 1⅜" Nut



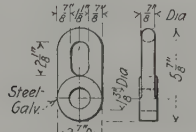
NUT LOCK SET SCREW
For 2" Nut



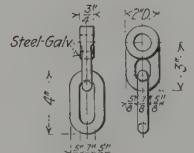
1½" SCREWED SHACKLE
For Topping Lift Connection to Band
For Cargo Hoist Connection to Band



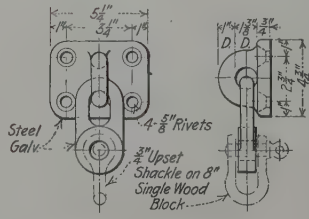
¾" SISTER HOOKS
For Block Bail



SPECIAL LINK
For Vangs



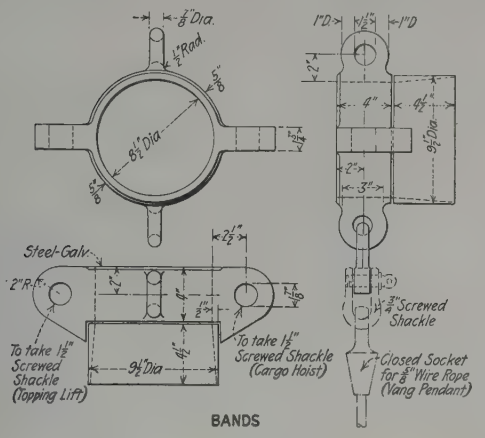
SPECIAL LINK
For Wireless Band



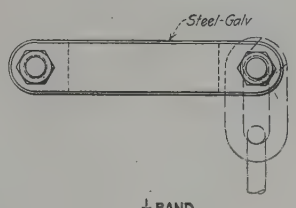
PAD EYE WITH SPECIAL LINK
Welded In for Vangs

DETAILS OF 5-TON CARGO HANDLING GEAR

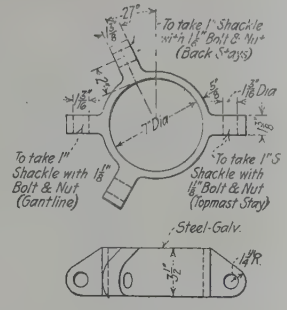
For Arrangement Plans, See Pages 332, 333


Steel-Galv.
To take 1½" Screwed Shackle (Topping Lift)
To take 1½" Screwed Shackle (Cargo Hoist)
1½" Screwed Shackle
Closed Socket for ⅝" Wire Rope (Vang Pendant)

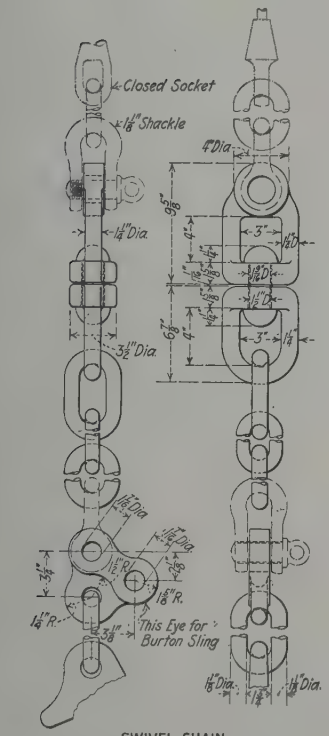
BANDS



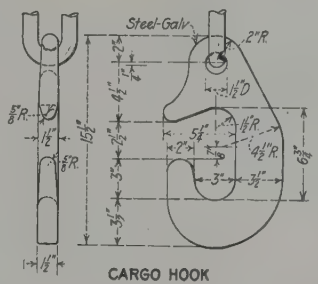
½ BAND



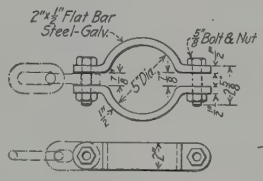
TOP MAST BAND



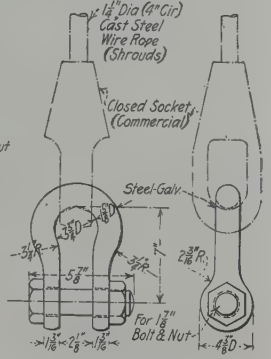
SWIVEL CHAIN
For Sling on Cargo Whip



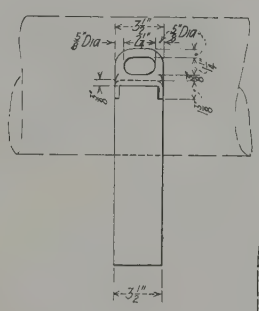
CARGO HOOK

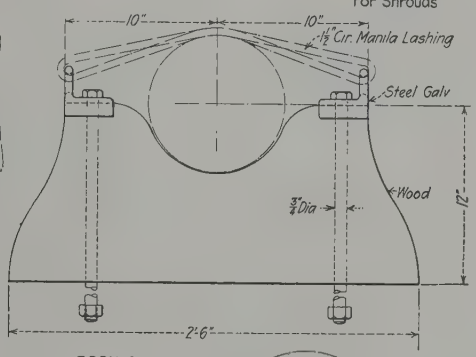


WIRELESS BAND

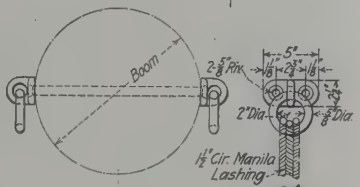


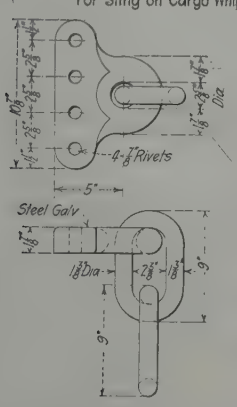
1⅝" SHACKLE
For Shrouds



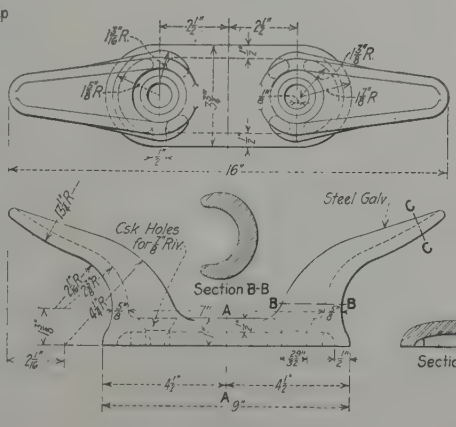


BOOM REST

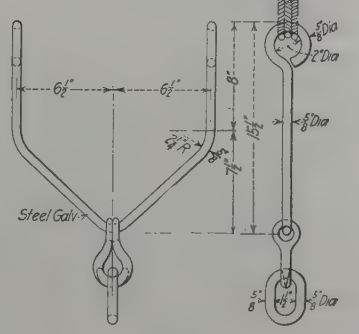




PAD-EYE FOR TOPPING LIFT



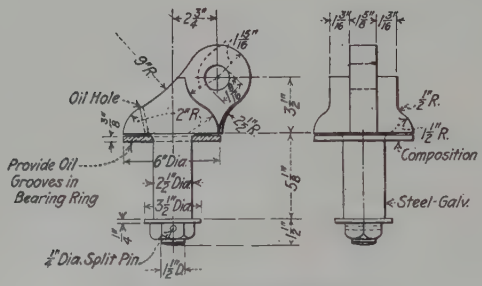
16" CLEAT



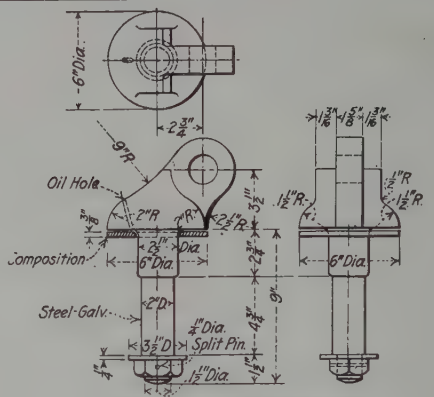
BLOCK BAIL

DETAILS OF 5-TON CARGO HANDLING GEAR

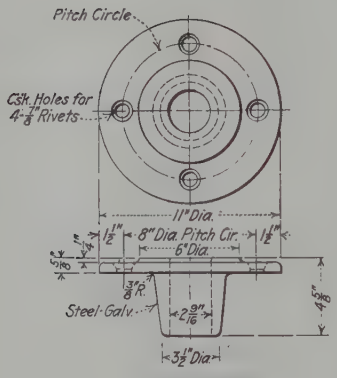
For Arrangement Plans. See Pages 332, 333



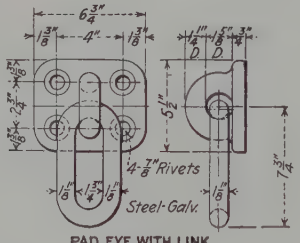
BOOM PIVOT AND BEARING RING
With Mast Table



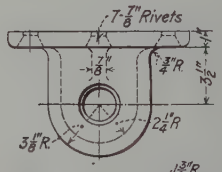
BOOM PIVOT AND BEARING RING

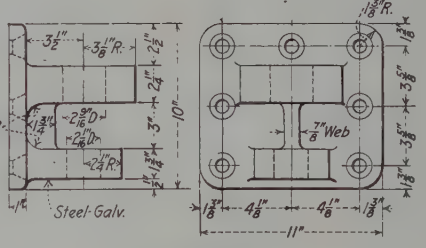


PIVOT BEARING
With Mast Table

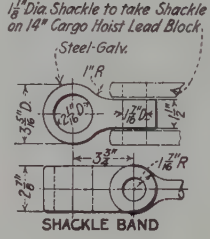


PAD EYE WITH LINK
WELDED IN

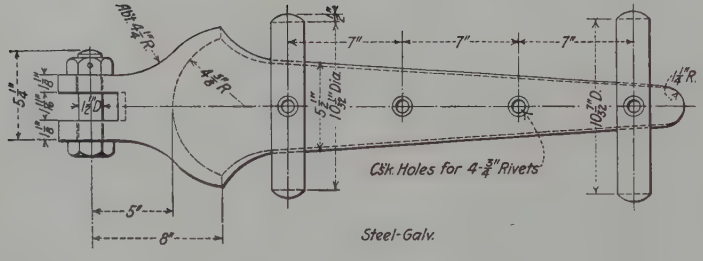


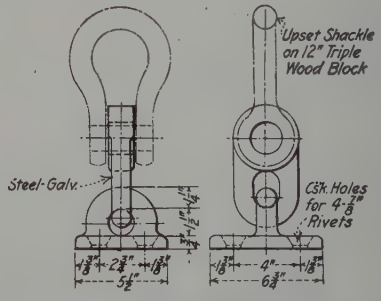


PIVOT BEARING

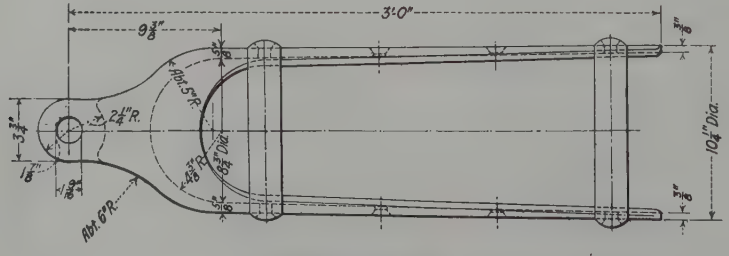


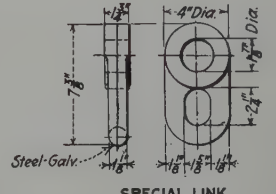
SHACKLE BAND





PAD EYE WITH SPECIAL LINK
Welded in-For Topping Lift Purchase Lower Block

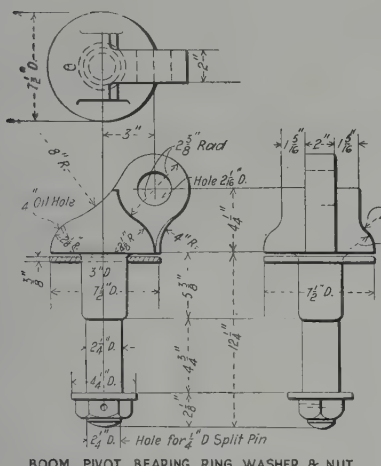




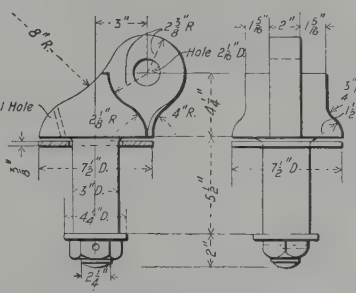
SPECIAL LINK
For Topping Lift Purchase Lower Block

DETAILS OF 5-TON CARGO HANDLING GEAR

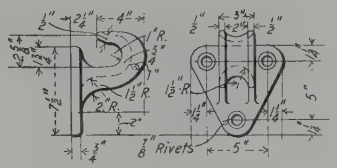
For Arrangement Plans, See Pages 332, 333

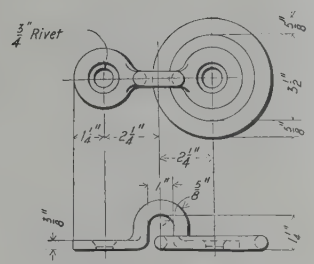


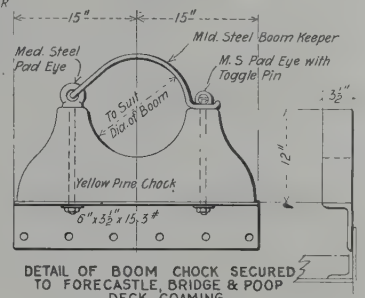
BOOM PIVOT BEARING RING WASHER & NUT

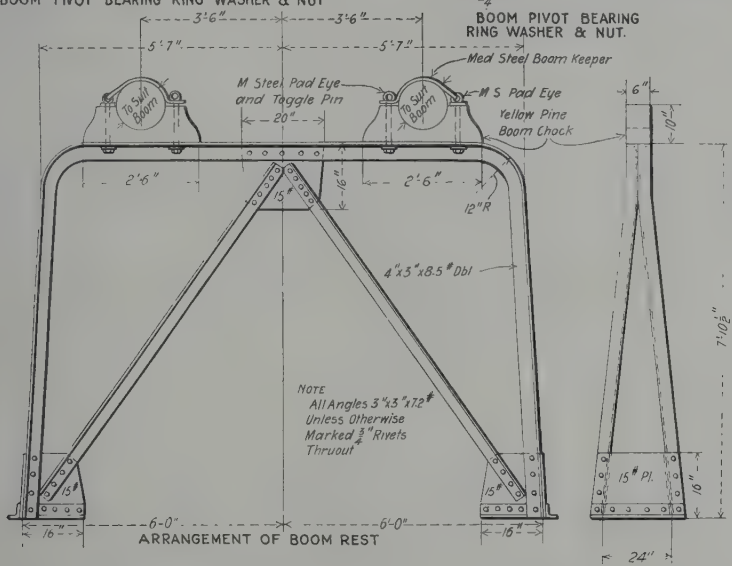


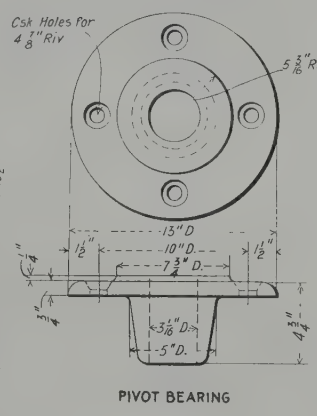
BOOM PIVOT BEARING RING WASHER & NUT.

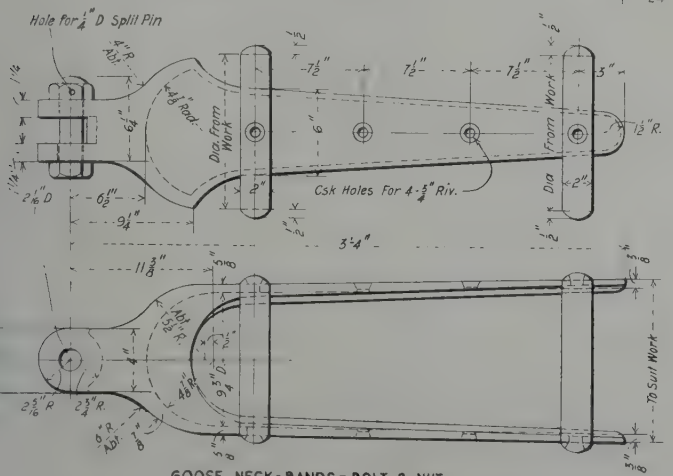


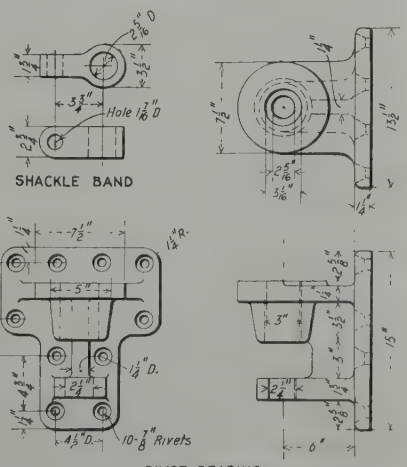



Mid. Steel Boom Keeper
Med. Steel Pad Eye
M. S Pad Eye with Toggle Pin
To Suit Dia. of Boom
Yellow Pine Chock
DETAIL OF BOOM CHOCK SECURED TO FORECASTLE, BRIDGE & POOP DECK COAMING

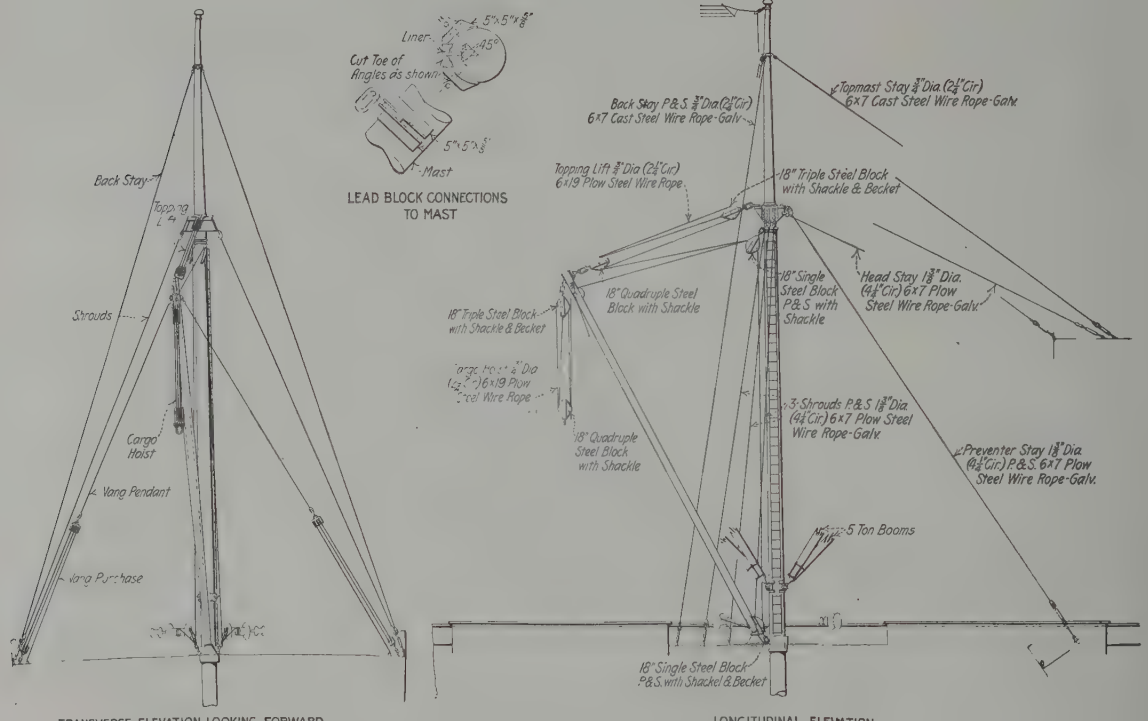


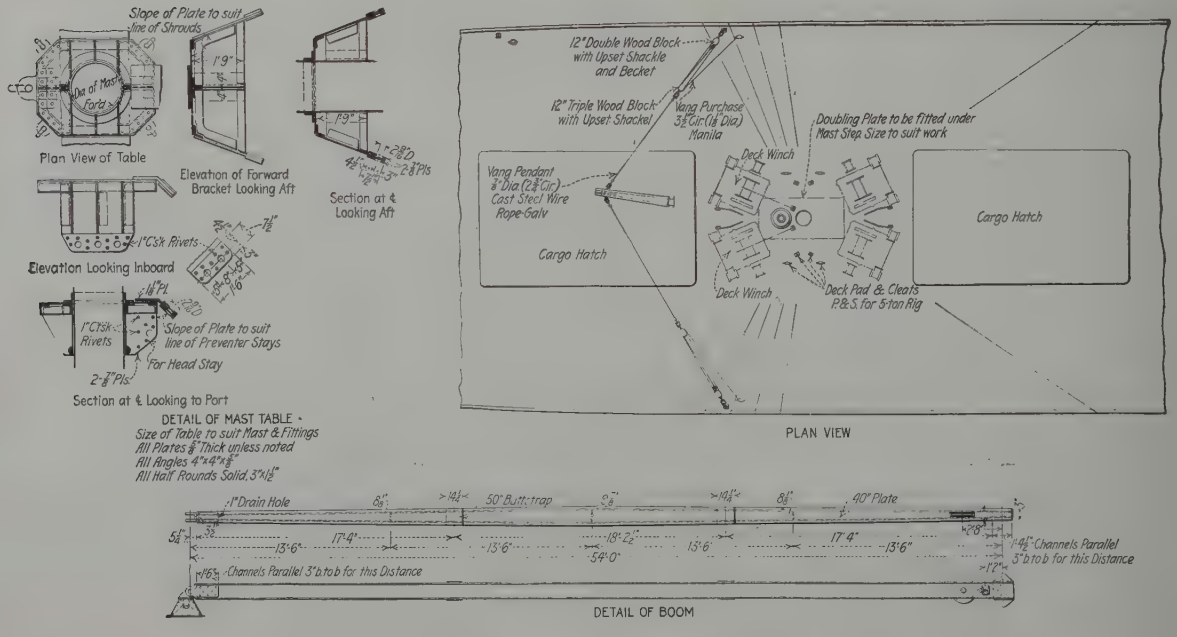






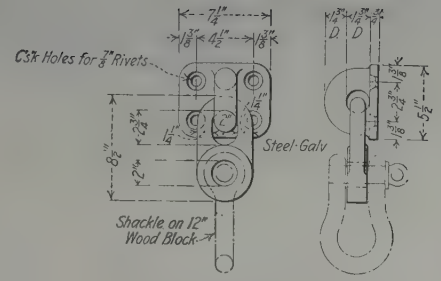
BOOM REST AND BOOM CHOCK, DECK HOOK AND LASHING PAD GOOSENECK, PIVOTS AND PIVOT BEARINGS FOR 6- TO 10-TON BOOMS


Back Stay
Topping Lift
Shrouds
Cargo Hoist
Vang Pendant
Vang Purchase
Liner
Cut Toe of Angles as shown
Mast
LEAD BLOCK CONNECTIONS TO MAST
Back Stay P.&S. Dia (Cir) 6x7 Cast Steel Wire Rope-Galv.
Topmast Stay Dia. (Cir) 6x7 Cast Steel Wire Rope-Galv.
Topping Lift Dia (Cir) 6x19 Plow Steel Wire Rope
18" Triple Steel Block with Shackle & Becket
18" Single Steel Block P.&S with Shackle
Head Stay Dia. (Cir) 6x7 Plow Steel Wire Rope-Galv.
18" Quadruple Steel Block with Shackle
18" Triple Steel Block with Shackle & Becket
3 Shrouds P.&S Dia. (Cir) 6x7 Plow Steel Wire Rope-Galv.
Preventer Stay Dia. (Cir.) P.&S. 6x7 Plow Steel Wire Rope-Galv.
5 Ton Booms
18" Single Steel Block P.&S. with Shackel & Becket
TRANSVERSE ELEVATION LOOKING FORWARD
LONGITUDINAL ELEVATION

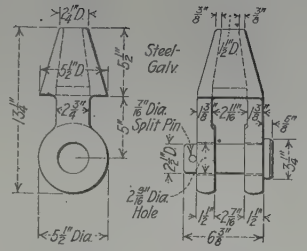

Slope of Plate to suit line of Shrouds
Dia of Mast Forld
Plan View of Table
Elevation of Forward Bracket Looking Aft
Section at ℄ Looking Aft
Elevation Looking Inboard
1" C'sk Rivets
Slope of Plate to suit line of Preventer Stays
For Head Stay
Section at ℄ Looking to Port
DETAIL OF MAST TABLE
Size of Table to suit Mast & Fittings
All Plates Thick unless noted
All Angles 4"x4"x
All Half Rounds Solid, 3"x
12" Double Wood Block with Upset Shackle and Becket
12" Triple Wood Block with Upset Shackel
Vang Purchase Cir. (Dia.) Manila
Doubling Plate to be fitted under Mast Step. Size to suit work
Vang Pendant Dia. (Cir) Cast Steel Wire Rope-Galv
Deck Winch
Cargo Hatch
Deck Pad & Cleats P.&S. for 5 ton Rig
PLAN VIEW
1" Drain Hole
50° Butt Strap
40" Plate
Channels Parallel 3" b to b for this Distance
Channels Parallel 3" D to b for this Distance
DETAIL OF BOOM

30-TON CARGO HANDLING GEAR

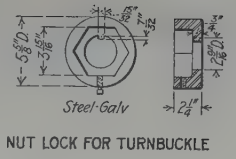
For Details, See Pages 339, 340



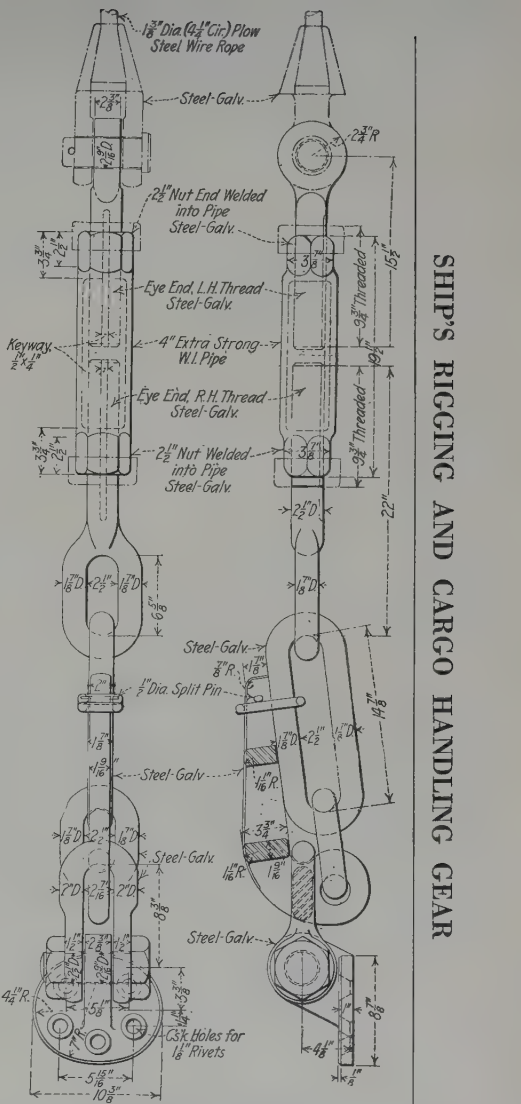
DECK PAD-EYE TO VANG PURCHASE
With Special Link Welded in
(For Vangs)



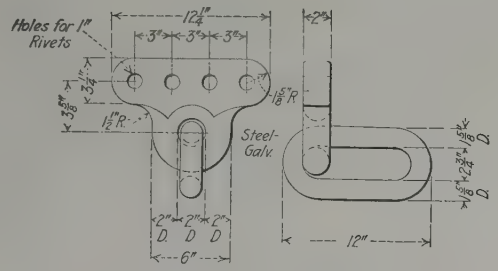
OPEN SOCKET WITH PIN



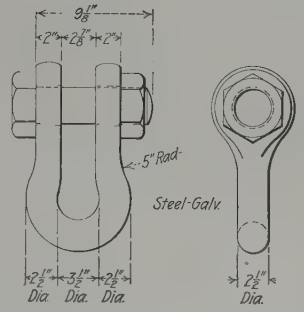
NUT LOCK FOR TURNBUCKLE


1 3/8" Dia. (4 1/4" Cir.) Plow Steel Wire Rope
Steel-Galv
2 1/2" Nut End Welded into Pipe Steel-Galv.
Eye End, L.H. Thread Steel-Galv.
4" Extra Strong W.I. Pipe
Keyway, 1/2" x 1 1/4"
Eye End, R.H. Thread Steel-Galv.
2 1/2" Nut Welded into Pipe Steel-Galv.
3 3/4" Threaded
1 1/2" Dia. Split Pin
C'sk. Holes for 1" Rivets

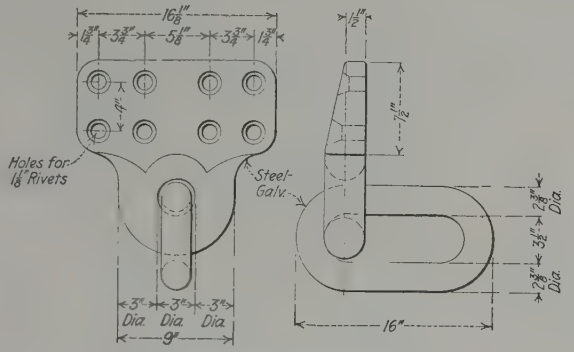
PAD AND TURNBUCKLE, PELICAN HOOK
SHACKLE AND LINKS



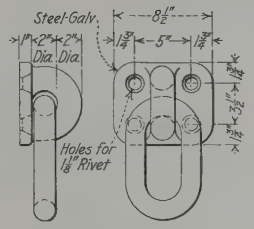
PAD-EYE WITH LINK WELDED IN
For Hoisting & Topping Lift Lead Blocks on Mast



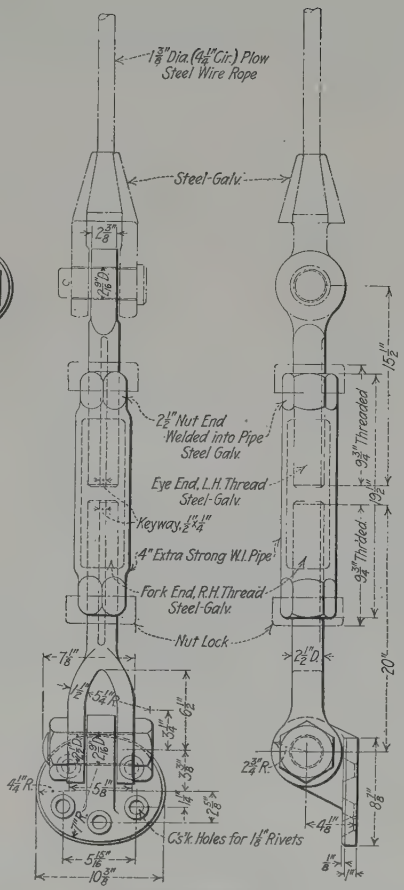
SHACKLE
For Connection to
Boom Head Fitting



PAD-EYE WITH LINK WELDED IN
To Take Topping Lift Block on Upper Mast Table

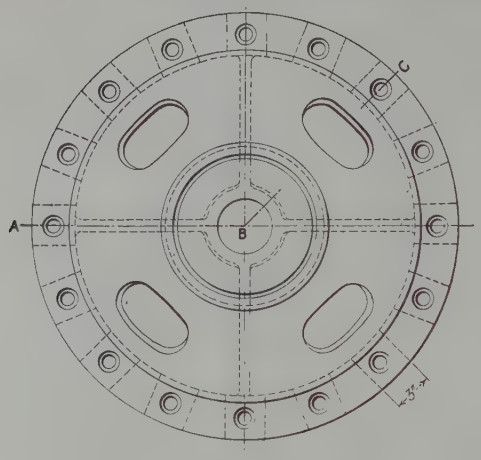


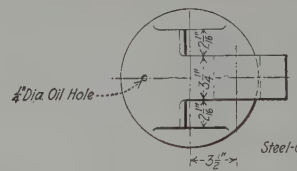
DECK PAD-EYE
For Lead Block at Deck

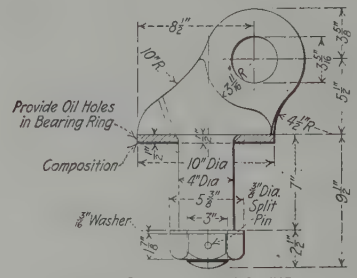

1 3/8" Dia. (4 1/4" Cir.) Plow Steel Wire Rope
Steel-Galv
2 1/2" Nut End Welded into Pipe Steel Galv.
Eye End, L.H. Thread Steel-Galv.
Keyway, 1/2" x 1 1/4"
4" Extra Strong W.I. Pipe
Fork End, R.H. Thread Steel-Galv.
Nut Lock
C'sk. Holes for 1 1/8" Rivets

PAD AND TURNBUCKLE
With Fork and Eye Ends

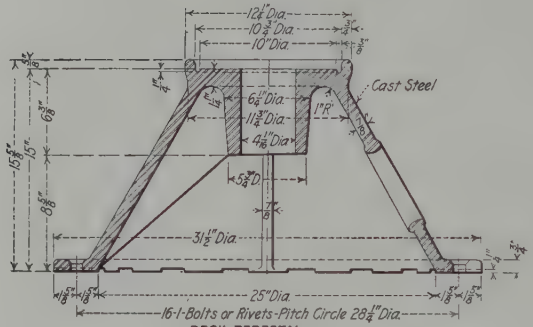
DETAILS OF 30-TON CARGO HANDLING GEAR
For Arrangement Plans, See Page 338



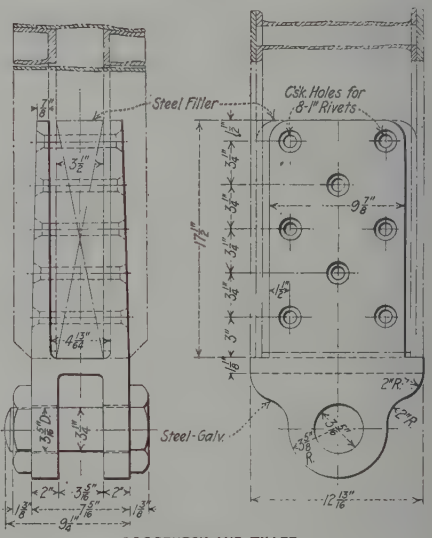




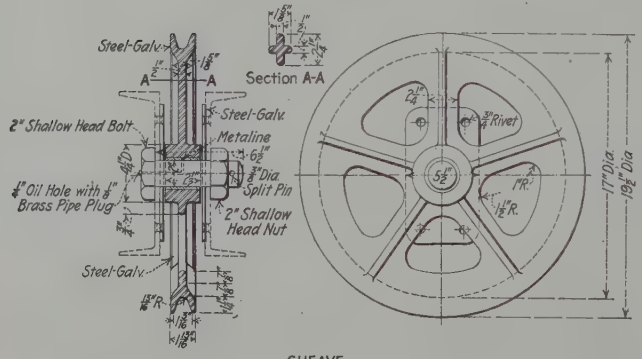
BOOM PIVOT AND BEARING RING



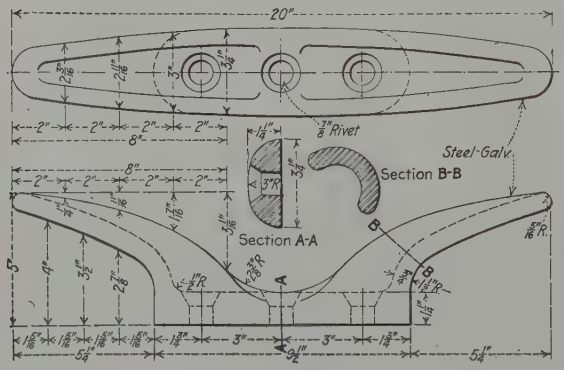
DECK PEDESTAL
Elevation Along A-B-C



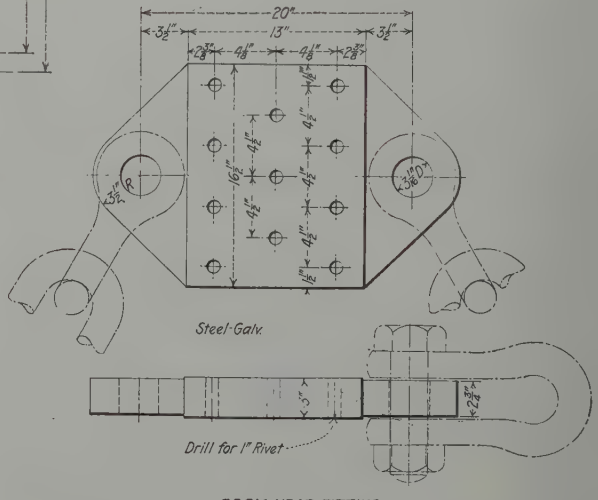
GOOSENECK AND FILLER



SHEAVE



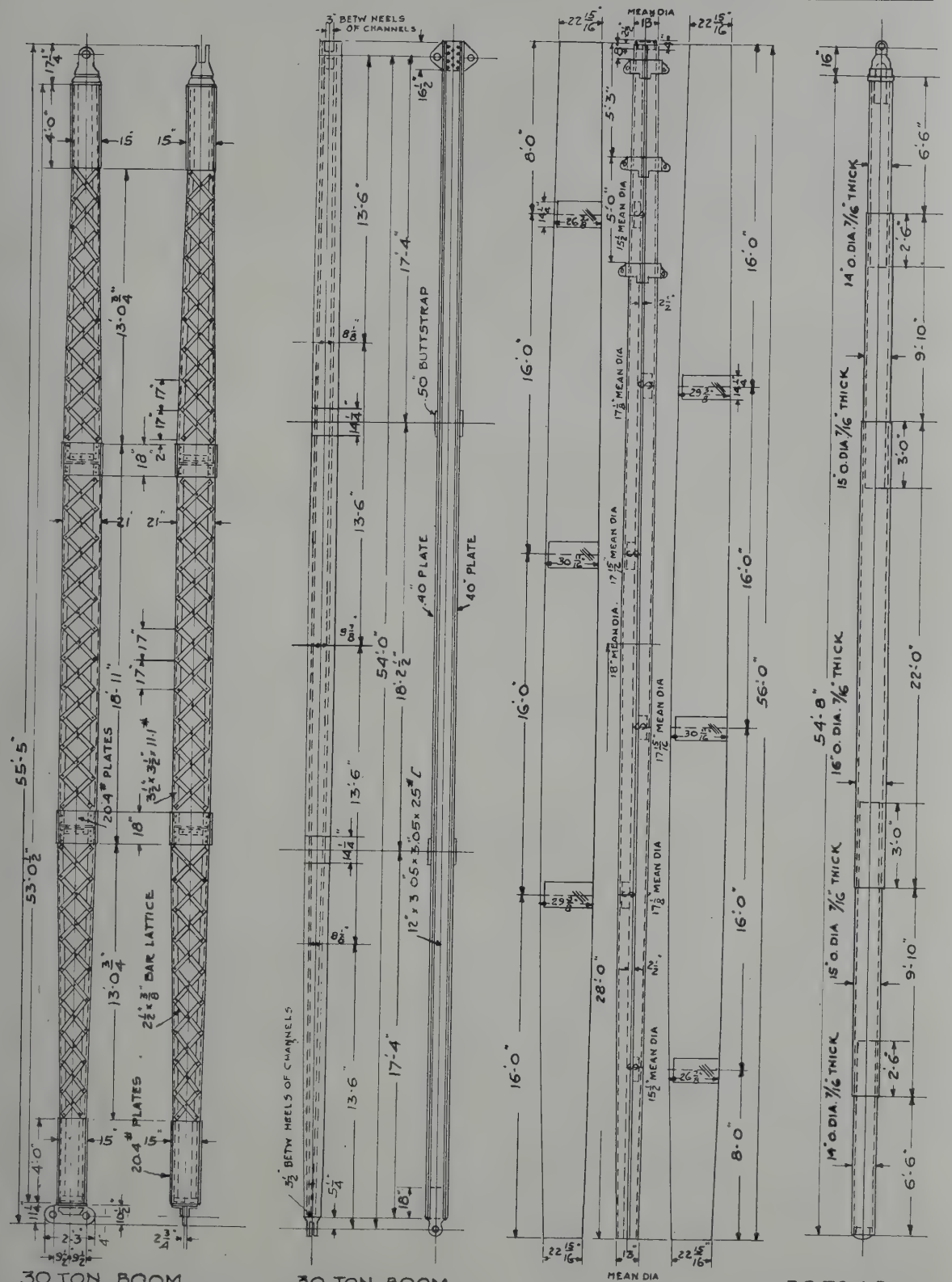
20" CLEAT



BOOM HEAD FITTING
For Connecting Hoisting and Topping Blocks to Boom

DETAILS OF 30-TON CARGO HANDLING GEAR

For Arrangement Plans, See Page 338



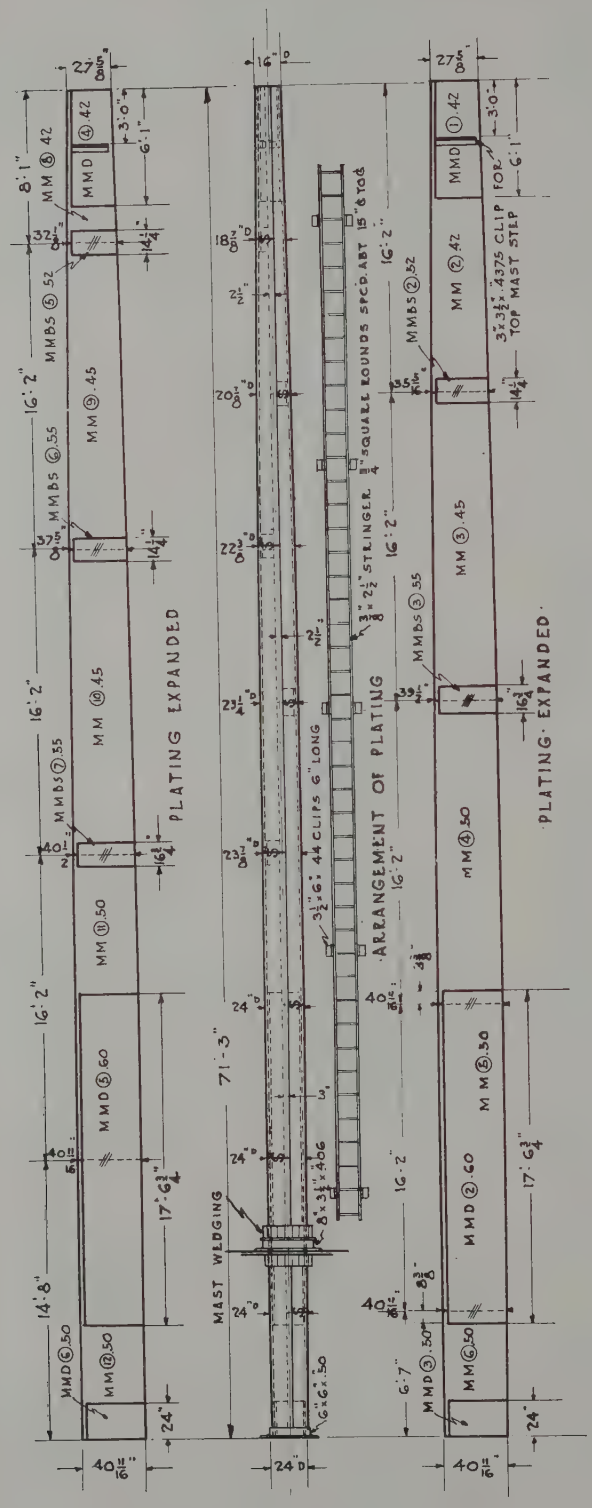
30 TON BOOM
ANGLE BAR & LATTICE
CONSTRUCTION

30 TON BOOM
CHANNEL BAR &
PLATE CONSTRUCTION

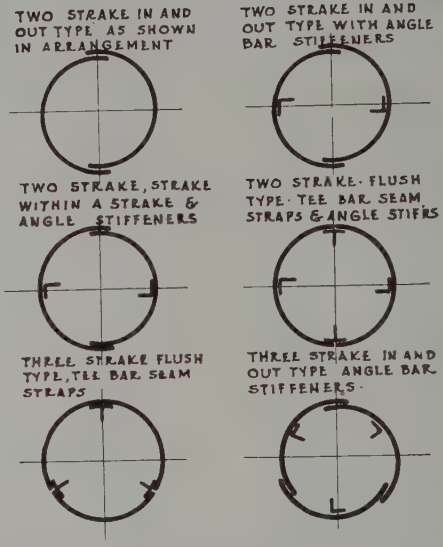
30 TON BOOM
PLATE CONSTRUCTION

30 TON BOOM
PIPE CONSTRUCTION

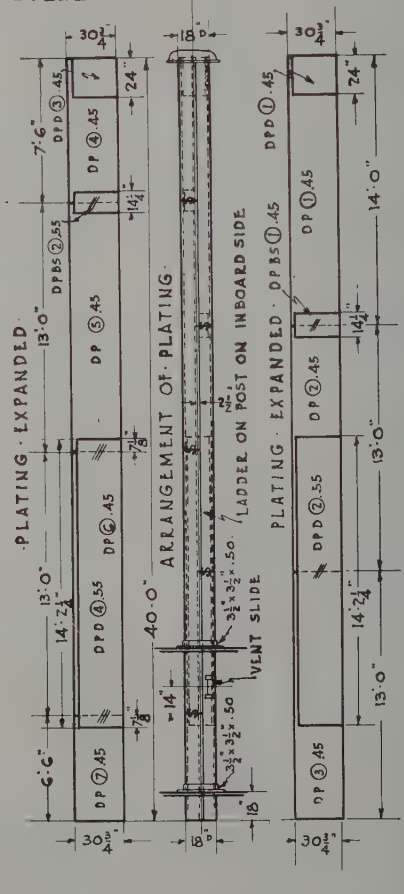
TYPICAL STEEL 30-TON BOOMS



ARRANGEMENT & DETAILS OF STEEL MAST PLATING

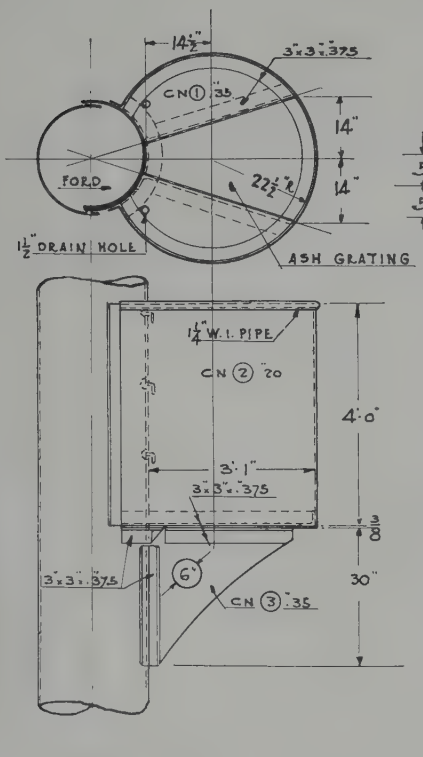

TWO STRAKE IN AND OUT TYPE AS SHOWN IN ARRANGEMENT
TWO STRAKE IN AND OUT TYPE WITH ANGLE BAR STIFFENERS
TWO STRAKE, STRAKE WITHIN A STRAKE & ANGLE STIFFENERS
TWO STRAKE FLUSH TYPE TEE BAR SEAM STRAPS & ANGLE STIFFS
THREE STRAKE FLUSH TYPE, TEE BAR SEAM STRAPS
THREE STRAKE IN AND OUT TYPE ANGLE BAR STIFFENERS

SECTIONS THRU VARIOUS TYPES OF STEEL PLATE MASTS

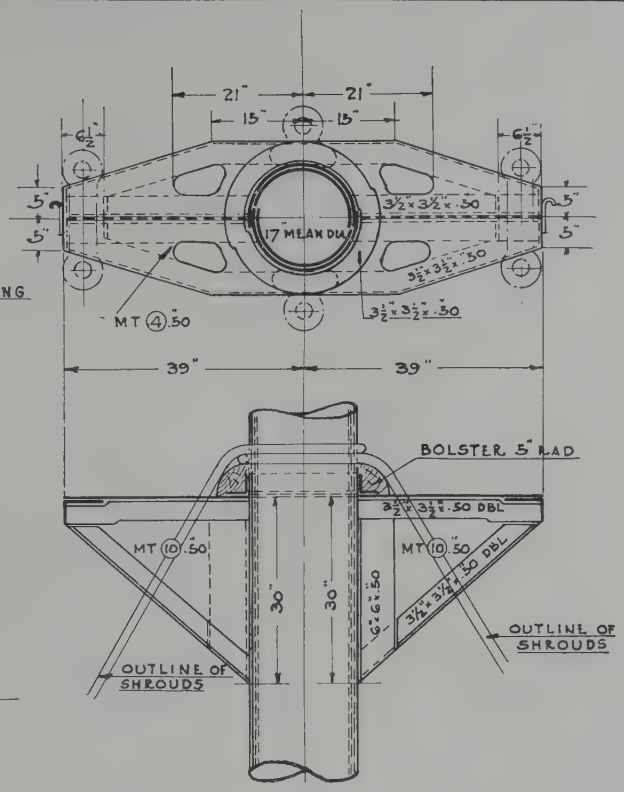


ARRANGEMENT & DETAILS OF DERRICK OR KING POST PLATING

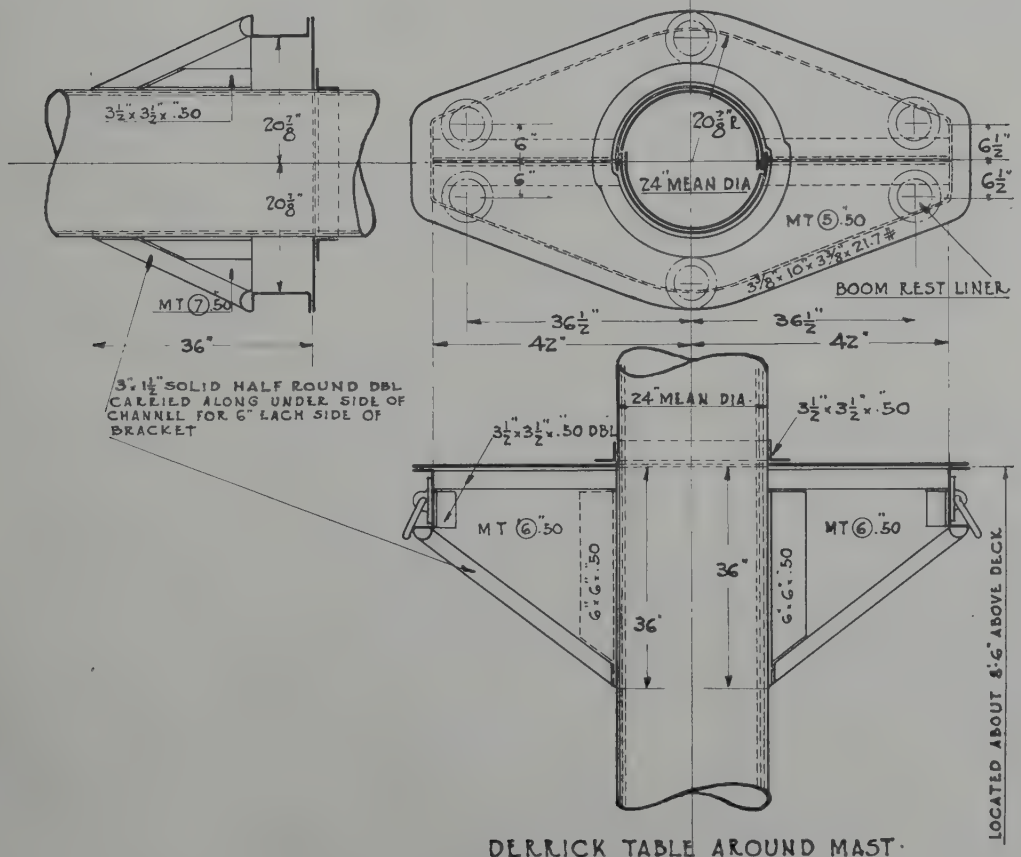
TYPICAL STEEL MAST AND DERRICK POST PLATING PLAN



CROWS NEST

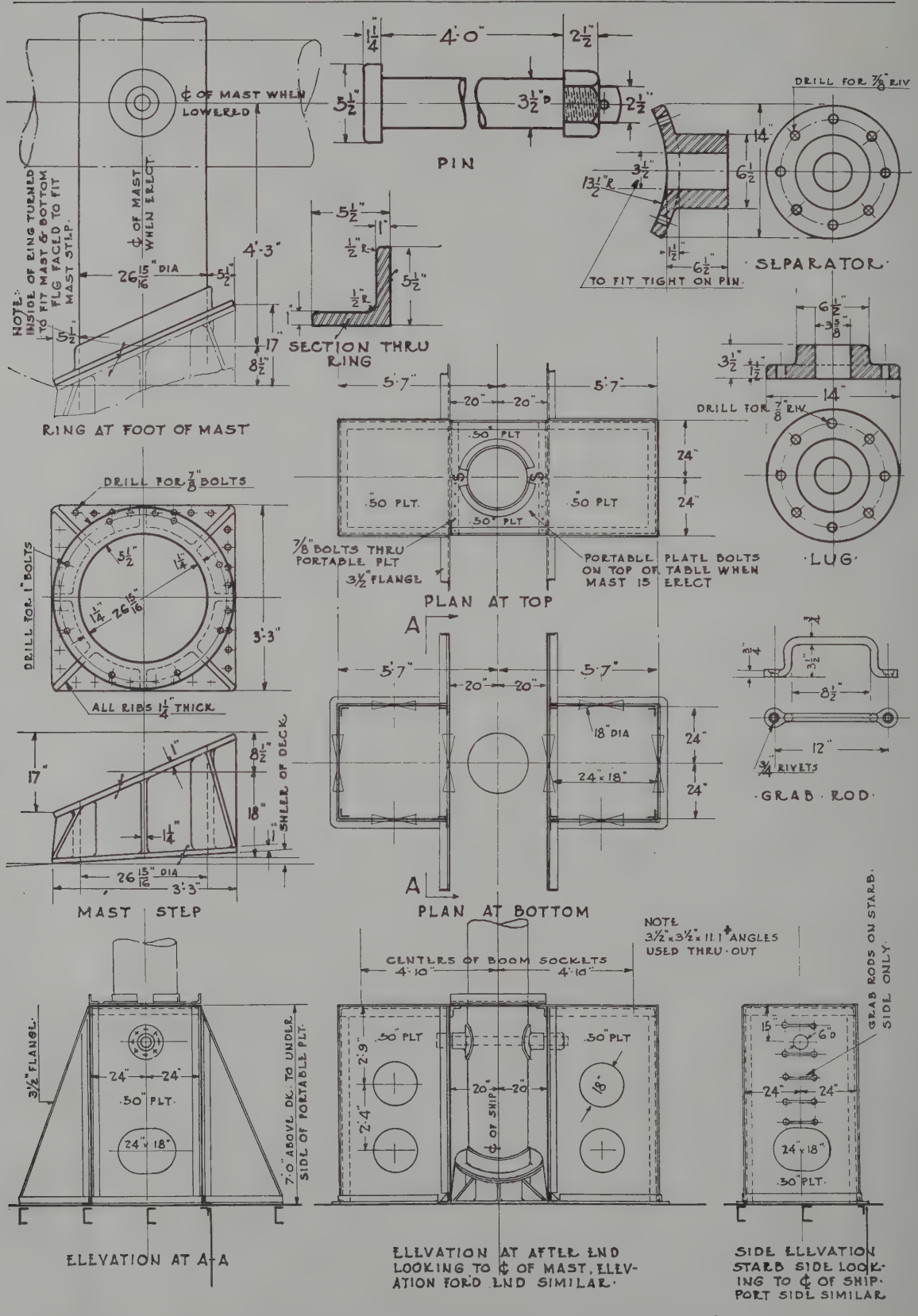


UPPER TABLE OR OUTRIGGER



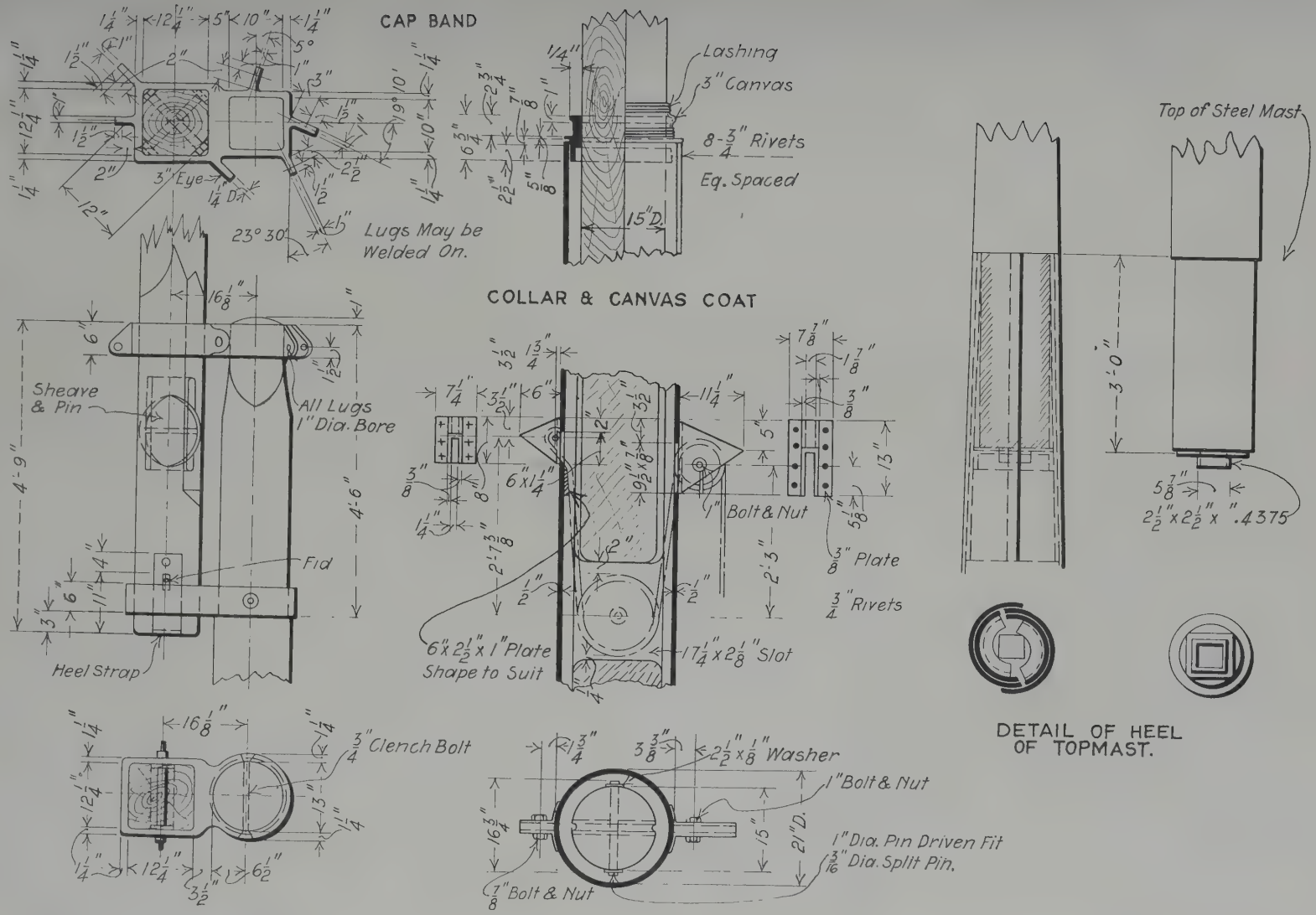
DERRICK TABLE AROUND MAST

MAST TABLES AND CROW'S NEST



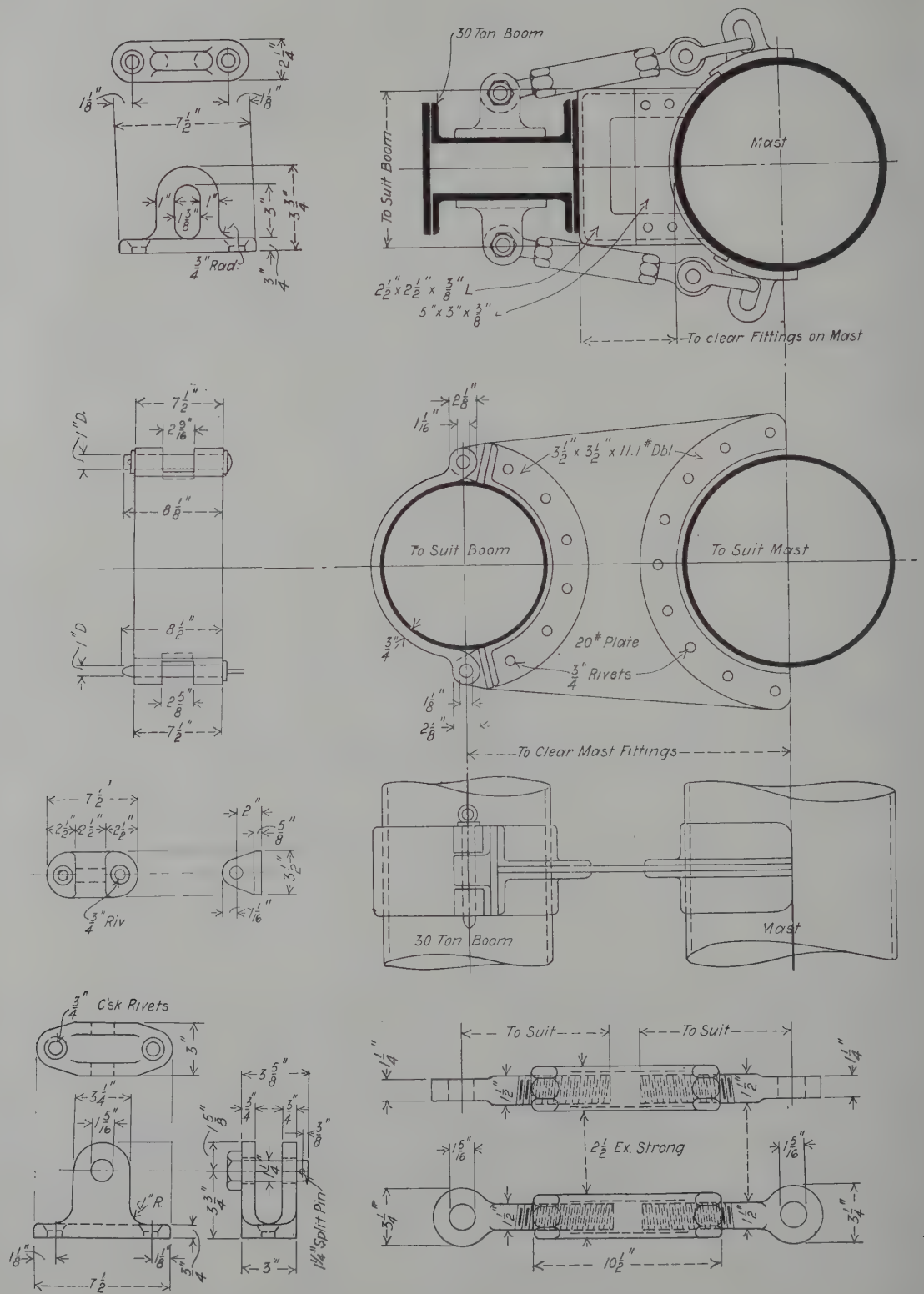
DETAIL OF BOOM TABLE FOR HINGED MAST

ARRANGEMENT AND DETAILS OF HINGED MAST



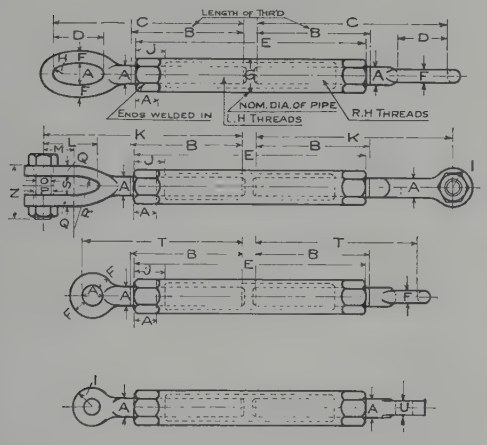
TELESCOPIC TOPMAST LOWERING GEAR

HOUSING, TELESCOPIC AND FIXED TYPES OF TOPMAST



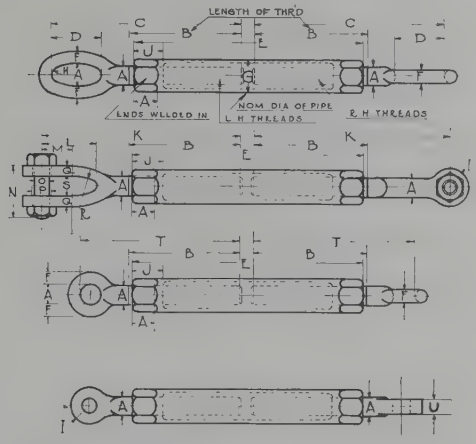
ARRANGEMENT OF FITTINGS FOR VERTICAL STOWAGE
OF STEEL BOOMS AGAINST A MAST

Fig. 1—Pipe or Sleeve Turnbuckles for Cast Steel Wire Ropes



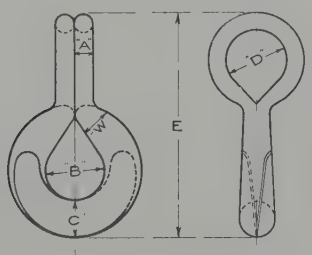
DIMENSION LETTER	CIRCUMFERENCE OF ROPES					
	1¾"	2"	2¼"-2½"	2¾"-3"	3¼"-3½"	3¾"-4"
A	1	1⅛	1⅜	1⅝	1⅞	2
B	7½	7¾	8⅛	8½	8⅞	9
C	11½	12	13¼	14¾	15¾	16¾
D	2½	2⅞	3⅜	4	4⅝	5
E	15	15½	16¼	17	17¾	18
F	⅝	¾	⅞	1	1¼	1⅜
G	1½"/STANDARD	2"/STANDARD	2" EX./STRONG	2½ EX./STRONG	3" EX./STRONG	3" EX./STRONG
H	7/16	½	⅝	¾	13/16	⅞
I	1	1⅛	1⅜	1½	1⅝	1¾
J	1½	1¾	2⅛	2½	2⅞	3
K	12	13	14	15	17	18
L	3¼	3¾	4	4⅝	5½	6¼
M	1½	1¾	2	2⅜	2⅝	3
N	4⅛	4⅜	4⅞	5½	6¼	6⅞
O	⅜	1	1⅛	1⅜	1⅝	1⅞
P	15/16	1 1/16	1 3/16	1 7/16	1 11/16	1 15/16
Q	⅝	⅝	¾	⅞	1	1⅛
R	3¼	3 3/16	4	4⅛	5½	6¼
S	1 3/16	1 3/16	1 7/16	1 11/16	1 15/16	2 3/16
T	10	10¾	11¾	12⅞	13	13⅜
U	5/8	¾	⅞	1	1¼	1⅜

Fig. 2—Pipe or Sleeve Turnbuckles for Plow Steel Wire Rope



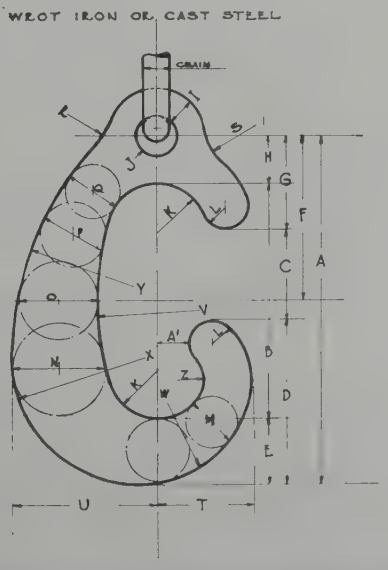
DIMENSION LETTER	CIRCUMFERENCE OF ROPE				
	2¼"-3"	3¼"-3½"	3¾"-4"	4¼"-4½"	4¾"-5"
A	1¾	2	2¼	2½	2¾
B	8⅝	9	9⅜	9⅞	10⅛
C	15⅜	16¾	18½	20	21½
D	4⅝	5	6	6⅜	7¼
E	17¼	18	18¾	19½	20¼
F	1¼	1⅜	1⅜	1⅞	2⅛
G	3" EX./STRONG	3" EX./STRONG	3½" EX./STRONG	4" EX./STRONG	4½" EX./STRONG
H	13/16	⅞	1	1⅛	1¼
I	1⅞	2 1/16	2½	2¾	3
J	2⅜	3	3⅜	3¾	4⅛
K	16	17	18½	19½	20¾
L	5	5½	6¼	6¾	7⅛
M	2⅜	2⅝	3	3¼	3½
N	4⅞	5½	6⅛	6⅞	7¾
O	1⅝	1⅞	2¼	2½	2¾
P	1 13/16	1 15/16	2 3/16	2 7/16	2 13/16
Q	1	1⅞	1¼	1⅞	1¾
R	5	5½	6¼	6¾	7¼
S	1 11/16	1 15/16	2 3/16	2 7/16	2 13/16
T	13	13¾	14¾	15¾	17
U	1 5/16	1 5/16	2 1/16	2 5/16	2 7/16

Fig. 3—Sister Hooks for Steel Wire and Manila Rope



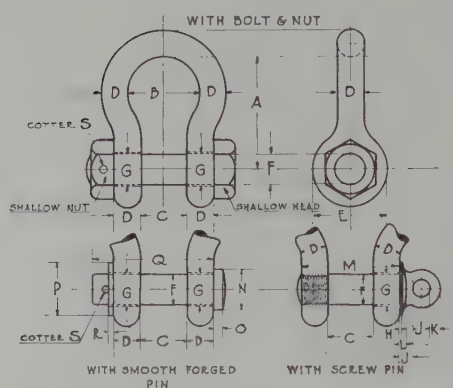
CIRCUM SUITABLE WIRE ROPE	CIRCUM SUITABLE MANILA ROPE	DIAM. OF CLASP "C"	DIAM. OF WIRE "W"	DIAM. OF EYE WIRE "A"	DIAM. OF HOOK "B"	INSIDE DIA OF EYE WIRE ROPE "D"	INSIDE DIA OF EYE MANILA "D"	LENGTH OVERALL WIRE ROPE "E"	LENGTH OVERALL MANILA E
5/8"	1 1/8"	5/16"	1/4"	3/16"	11/16"	9/16"	11/16"	2 3/16"	2 5/16"
3/4"	1 1/4"	3/8"	5/16"	3/16"	7/8"	11/16"	15/16"	2 13/16"	3 1/8"
7/8"	1 1/2"	7/16"	3/8"	3/16"	1"	3/4"	1 1/16"	3 1/8"	3 1/2"
1"	1 3/4"	1/2"	3/8"	1/4"	1 1/8"	7/8"	1 5/16"	1/32"	4 1/16"
1 1/8"	2"	5/8"	1/2"	5/16"	1 5/16"	1"	1 3/8"	4 1/16"	4 5/16"
1 1/4"	2 1/2"	3/4"	1/2"	5/16"	1 3/8"	1 1/16"	1 7/16"	4 3/8"	4 3/4"
1 1/2"		13/16"	9/16"	3/8"	1 7/16"	1 1/8"	1 1/2"	4 7/16"	5 1/2"
1 3/4"	2 3/4"	7/8"	5/8"	3/8"	1 7/16"	1 1/8"	1 1/2"	4 3/4"	5 1/2"
2"	3"	1"	3/4"	7/16"	1 5/8"	1 1/4"	1 5/8"	5 1/2"	6"
2 1/4"	3 1/4"	1 1/8"	13/16"	1/2"	1 13/16"	1 3/8"	2"	6 3/8"	6 3/8"
2 1/2"	3 1/2"	1 1/4"	7/8"	9/16"	2"	1 3/4"	2"	7 3/16"	7 1/2"
2 3/4"	4"	1 3/8"	1"	11/16"	2 1/4"	1 7/8"	2 1/8"	8 1/2"	8 1/2"
3"	4 1/2"	1 1/2"	1 1/8"	13/16"	3"	2"	2 1/4"	9"	9"

Fig. 4—Cargo Hooks Wro't Iron or Cast Steel



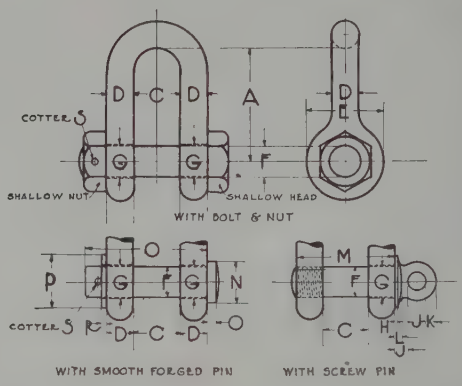
CAPACITY OF HOOK	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A'	
1½	9⅝	6⅝	2¾	4½	1½	4⅝	2⅝	1⅝	1⅛	1⅜	⅜	1⅛	⅜	1⅛	2⅝	1⅛	1⅛	⅜	1⅛	2⅝	4	1⅝	⅜	3⅜	1⅜	⅝	1	¾
2	10¾	6⅞	2¾	5	2¼	4⅝	2⅝	1⅝	1⅛	1⅜	⅜	1⅛	⅜	1⅛	2⅝	1⅛	1⅛	⅜	1⅛	2⅝	4	1⅝	⅜	3⅜	1⅜	⅝	1	¾
3	11	7	3	5½	2⅜	5⅛	2⅝	1⅝	1	1¼	½	1⅜	½	1⅜	3	1⅜	1⅜	½	1⅜	3	5	1⅞	½	4⅛	1⅝	⅞	1	⅞
4	11⅝	7⅝	3½	5½	2½	5⅝	2⅝	1⅝	1	1⅜	½	1⅜	½	1⅜	3	1⅜	1⅜	½	1⅜	3	5	1⅞	½	4⅛	1⅝	⅞	1	⅞
5	12⅛	8	3½	6⅛	2⅝	6	2⅝	1⅝	1⅛	1⅝	⅝	1⅝	⅝	1⅝	3½	2⅛	2⅛	⅝	2	3½	5½	2⅛	⅝	4½	1⅞	1	1⅛	1⅛

Fig. 5—Anchor Shackles



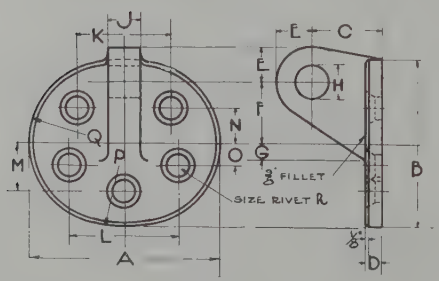
SIZE D	A	B	C	E	F	G	H	J	K	L	M	N	O	P	Q	R	S	APPROX WGT	APPROX STRGTH IN LBS
3/16	1	3/16	3/8	1/16	1/4	5/16	1/16	1/4	3/16	1/8	3/4	1/2	3/32	5/64	5/64	1/16	.06	3000
1/4	1 1/4	3/16	1/2	23/32	5/16	3/8	1/16	5/16	5/32	1	3/16	1/2	1/16	3/64	3/64	1/16	.325	5000
5/16	1 7/16	7/8	9/16	15/16	5/8	7/16	1/16	3/8	3/16	3/16	1 3/16	5/8	1/8	29/64	3 3/32	3 3/32	.21	8000
3/8	1 13/16	1 1/16	5/16	1 1/8	7/16	1/2	1/16	7/16	1/4	7/32	1 7/16	7/16	1/8	43/64	13/32	3/32	1/32	.3225	10000
7/16	2	1 1/8	5/16	1 5/16	1/2	9/16	1/16	7/16	1/4	7/32	1 9/16	7/16	1/8	1	25/64	3/32	1/32	.47	15000
1/2	2 3/16	1 1/4	3/4	1 1/2	1/2	5/8	1/16	7/16	1/4	7/32	1 3/4	7/8	5/16	1 7/64	29/64	1/32	1/32	.75	18000
9/16	2 7/16	1 5/16	7/8	1 5/8	5/8	11/16	1/16	1/2	1/4	7/32	2	1	1/4	1 33/64	2 7/64	1 1/8	5/16	1.1	24000
5/8	2 3/4	1 7/16	1 1/16	1 7/8	3/4	13/16	1/16	1/2	1/4	1/4	2 5/16	1 1/8	1/4	1 37/64	2 27/64	1 5/32	3/16	1.52	33000
3/4	3 1/16	2 1/4	1 3/32	2 1/32	1	15/16	1/16	1/2	1/4	1/4	2 15/32	1 5/8	1/4	1 17/32	2 27/64	1 5/32	3/16	2.34	43000
7/8	3 3/8	2 1/4	1 3/8	2 5/32	1	1 1/16	1/32	5/8	5/16	5/16	3 1/8	1 1/2	3/8	1 13/16	3 1/16	1 9/32	1/8	3.55	55000
1	4 5/16	2 5/8	1 3/8	2 5/8	1 1/8	1 1/8	1/32	3/4	3/8	3/8	3 5/8	1 5/8	3/8	2 1/16	3 7/16	1 3/8	1/8	5.08	74000
1 1/8	5	3	1 7/8	3 1/4	1 1/4	1 5/16	1/16	1	1/2	7/16	3 5/8	1 13/16	7/16	2 5/16	3 13/16	1 1/2	1/4	7.35	90000
1 1/4	5 7/16	3 1/4	2	3 3/8	1 3/8	1 1/2	1/8	1 1/8	7/16	7/16	4 1/2	1 7/8	3/8	2 5/8	4 5/16	1 5/8	1/4	9.89	92000
1 3/8	6	3 1/2	2 1/16	3 5/32	1 1/2	1 5/8	1/8	1	7/16	1/2	4 7/8	2	1/2	2 15/16	4 13/16	1 3/4	1/4	13.38	94000
1 1/2	6 5/8	3 3/4	2 1/4	4 5/16	1 5/8	1 7/8	1/8	1 1/16	7/16	17/32	5 1/4	2 1/8	3/8	3 5/16	5 5/16	1 7/8	5/16	15.63	103000
1 5/8	7 1/8	4 1/8	2 1/2	4 5/8	1 3/4	1 15/16	1/8	1 1/8	1/2	9/16	5 3/4	2 1/4	3/8	3 5/8	6 1/16	2 1/16	3/8	19	135000
1 3/4	8	4 1/2	2 3/4	5 1/8	2	2 1/16	3/16	1 1/4	1/2	5/8	6 1/4	2 3/8	7/16	3 15/16	6 7/16	2 3/16	3/16	24	172000
2	9 1/8	5 1/4	3 1/4	5 3/4	2 1/4	2 5/16	3/16	1 7/16	1/2	23/32	7 1/4	3	1/2	4 15/16	8 3/16	2 1/4	3/8	38	235000

Fig. 6—Chain Shackles



SIZE D	A	C	E	F	G	H	J	K	L	M	N	O	P	Q	R	S	APPROX WGT	APPROX STRGTH IN LBS
3/16	7/8	1/8	3/16	1/4	5/16	1/16	1/4	3/16	1/8	3/4	1/2	3/32	3/16	15/64	3/64	1/16	.06	3000
1/4	31/32	1/2	23/32	5/16	3/8	1/16	5/16	1/4	5/32	1	3/16	1/2	1/16	1 5/64	3/64	1/16	.125	5000
5/16	1 1/16	9/16	15/16	3/8	7/16	1/16	3/8	5/16	3/16	1 1/16	5/8	1/8	1/4	1 29/64	3/64	1/16	.203	8000
3/8	1 7/16	1/16	1 1/8	1/16	1/2	1/16	7/16	1/4	3/32	1 7/16	7/16	1/8	5/16	1 37/64	3/64	1/16	.312	10000
7/16	1 7/8	1/16	5/16	1/2	2/16	1/16	7/16	1/2	3/32	1 7/16	3/4	3/16	1	1 45/64	3/32	1/8	.53	15000
1/2	1 29/32	3/4	1 1/8	9/16	5/8	1/16	7/16	1/4	3/32	1 7/8	7/8	3/16	1 1/16	1 61/64	3/32	1/16	.69	18000
9/16	2 1/8	7/8	1 1/8	5/8	9/16	1/16	7/16	1/4	7/32	2	1	1/4	1 13/64	2 1/16	1/8	3/16	1.04	24000
5/8	2 3/8	1 1/16	1 1/8	3/4	13/16	3/16	1/2	1/4	1/4	2 3/16	1 1/8	1/4	1 29/64	2 5/32	5/32	3/16	1.43	33000
3/4	2 3/8	1 3/32	2 7/32	7/8	15/16	3/32	1/2	1/4	1/4	2 13/32	1 1/4	5/16	1 23/64	2 5/16	11/64	3/16	2.19	43000
7/8	3 3/8	1 1/8	2 7/32	1	1 1/16	3/32	5/8	5/16	5/16	3/8	1 1/2	3/8	1 29/64	2 1/2	11/64	3/16	3.31	55000
1	3 1/16	1 5/8	2 5/32	1 1/8	1 3/16	1/8	5/8	5/16	5/16	3/8	1 5/8	3/8	1 15/32	2 11/16	3/16	1/4	4.75	74000
1 1/8	4 5/16	1 7/8	3 1/4	1 1/4	1 5/16	1/8	3/4	3/8	3/8	3 5/8	1 13/16	7/16	1 17/32	2 15/16	1/4	1/4	6.47	90000
1 1/4	4 7/16	2	3 3/8	1 3/8	1 7/16	1/8	7/8	7/16	7/16	4 1/2	1 7/8	3/8	2 1/16	3 1/16	5/16	1/4	8.62	92000
1 3/8	5 7/16	2 1/8	3 5/16	1 1/2	1 5/8	1/8	1	7/16	1/2	4 7/8	2	1/2	2 5/16	3 3/16	1/4	1/4	10.94	94000
1 1/2	5 7/16	2 1/4	4 1/16	1 5/8	1 7/16	1/4	1 1/16	7/16	17/32	5 1/4	2 1/8	3/8	2 5/16	3 5/16	1/4	5/16	14.7	103000
1 5/8	6 1/8	2 1/4	4 7/16	1 3/4	1 5/8	1/8	1 1/16	1/2	9/16	5 3/4	2 1/4	3/8	2 5/16	3 7/16	5/16	5/16	16.2	153000
1 3/4	6 7/16	2 3/4	5 1/16	2	2 1/16	3/16	1 1/4	1/2	5/8	6 1/4	2 3/4	7/16	3 3/8	3 7/16	3/16	5/16	18	172000
2	7 1/8	3 1/4	5 1/4	2 1/4	2 5/16	3/16	1 7/16	1/2	23/32	7 1/4	3	1/2	4 7/16	8 3/16	1/4	3/8	36	235000

Fig. 7—Pad Eyes or Chain Plates



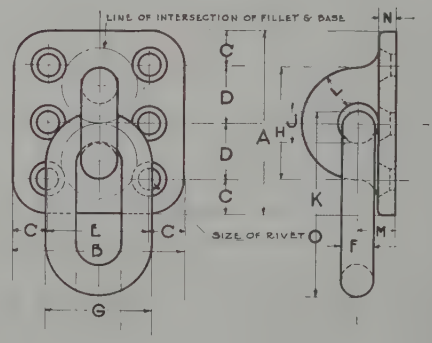
FOR PLOW STEEL RIGGING

DIM. LETTER	CIRCUMFERENCE OF ROPE 2 3/4-3	3 1/2-3 3/4	3 3/4-4	4 1/4-4 3/4	4 1/2-5
A	8 1/8	8 1/8	10	10 3/4	11 3/8
B	7	7 5/8	8 3/16	8 7/8	9 3/8
C	3 3/8	3 1/2	4	4 3/8	4 5/8
D	3/4	7/8	1	1	1 1/8
E	1 1/8	2 1/16	2 1/2	2 3/4	3
F	2 1/8	2 1/8	3 1/16	3 1/8	3 3/16
G	1 5/8	1	1 1/8	1 1/4	1 3/8
H	1 1/16	1 1/16	2 3/16	2 3/16	2 1/16
J	1 3/8	1 3/8	2 1/8	2 1/8	2 3/16
K	4	4 1/8	4 3/16	5 3/8	5 1/2
L	4 7/16	4 5/16	5 3/16	5 13/16	6 1/16
M	2 1/16	2 3/16	2 7/16	2 5/8	2 3/4
N	1 3/8	1 1/2	1 3/4	1 7/8	1 7/8
O	1 1/16	1 1/8	1 5/16	1 3/8	1 1/2
P	5 1/2	6	6 3/4	7	7 1/2
Q	3 3/8	3 7/16	4 1/8	4 1/8	4 3/16
R	7/8	1	1 1/8	1 1/8	1 1/4

FOR CAST STEEL RIGGING

DIM. LETTER	C IRCUMFERENCE OF ROPE 1 3/4	2	2 1/4-2 1/2	2 3/4-3	3 1/4-3 1/2	3 3/4-4
A	5 1/2	5 7/8	6 5/8	7	8 1/8	8 7/8
B	4 7/16	5 1/16	5 3/4	6 1/16	7	7 7/8
C	2	2 1/8	2 1/2	2 7/8	3 1/8	3 1/2
D	1/2	1/2	5/8	3/8	3/4	7/8
E	1	1 1/16	1 1/4	1 1/2	1 7/8	2 1/16
F	1 1/4	2	2 1/8	2 3/8	2 3/4	2 7/8
G	1/2	5/8	3/4	3/4	7/8	7/8
H	1 1/4	1 1/4	1 3/16	1 1/4	1 3/16	1 5/16
J	1 1/8	1 1/16	1 3/8	1 5/8	1 7/8	2 1/8
K	2 1/16	2 1/8	3 1/4	3 3/16	4 1/2	4 1/8
L	3 1/8	3 1/2	3 5/16	4	4 1/16	4 1/16
M	1 3/8	1 1/2	1 5/8	1 3/4	2 1/16	2 1/16
N	1	1	1 1/8	1 1/4	1 1/8	1 1/2
O	5/8	3/4	7/16	7/8	1 1/16	1 1/8
P	3 1/4	4	4 1/2	4 1/4	5 1/2	6
Q	2 1/8	2 1/2	2 11/16	2 15/16	3 1/8	3 1/16
R	5/8	3/8	3/4	3/4	7/8	1

Fig. 8—Pad Eyes and Links



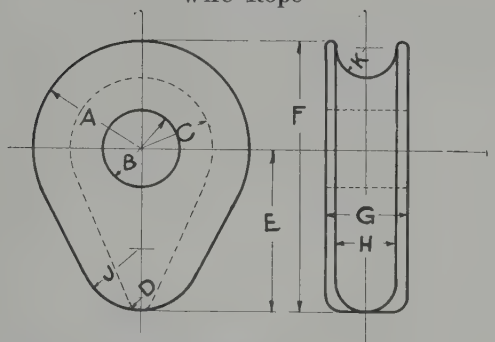
FOR PLOW STEEL ROPES

DIM LETTER	CIRCUMFERENCE OF ROPES 2 3/4-3	3 1/4-3 1/2	3 3/4-4	4 1/4-4 1/2	4 3/4-5
A	7 1/4	8 1/4	9 1/4	9 1/4	10 3/8
B	7 3/16	8 1/8	9 1/8	9 3/8	10 5/8
C	1 7/16	1 5/8	1 13/16	1 13/16	2 1/16
D	2 3/16	2 1/2	2 13/16	2 13/16	3 1/8
E	4 3/16	4 7/8	5 1/2	5 1/4	6 1/2
F	1 5/16	1 1/2	1 3/4	2	2 1/4
G	4 3/8	.5	.5 1/8	6 7/16	7 1/2
H	4 1/16	.5	.5 1/8	6 1/2	7 1/4
J	1 9/16	1 3/4	2	2 1/4	2 1/2
K	7 1/4	8 3/8	10 1/2	11 3/4	13
L	1 3/4	1 5/8	1 7/8	2 1/8	2 3/8
M	1 7/32	1 3/4	2	2 1/8	2 3/8
N	3/4	7/8	1	1	1 1/8
O	7/8	1	1 1/8	1 1/8	1 1/4

FOR CAST STEEL ROPES

DIM LETTER	CIRCUMFERENCE OF ROPES 1 3/4	2	2 1/4-2 1/2	2 3/4-3	3 1/4-3 1/2	3 3/4-4
A	5 1/8	5 1/8	6 1/4	6 1/4	7 1/4	8 1/4
B	4 3/4	4 7/8	6 1/8	6 1/4	7 1/4	8
C	1	1	1 1/4	1 1/4	1 7/16	1 5/8
D	1 3/16	1 3/16	1 7/8	1 7/8	2 3/16	2 1/2
E	2 3/4	2 7/8	3 3/8	3 3/4	4 1/2	4 3/4
F	1 1/16	1 5/16	1	1 1/8	1 1/4	1 3/8
G	2 1/4	2 1/16	3 1/4	3 3/4	4 1/8	4 3/16
H	2 7/16	2 13/16	3 1/2	3 3/8	4 1/4	4 3/8
J	1 5/16	1 1/16	1 1/4	1 3/8	1 1/2	1 3/8
K	4 3/8	5	6	6 3/4	7 1/2	8 3/8
L	3 1/4	3 1/4	1 7/8	1 1/4	1 3/8	1 1/2
M	1 31/32	1 1/32	1 1/4	1 5/16	1 1/2	1 1/16
N	1/2	1/2	5/8	5/8	3/4	7/8
O	5/8	5/8	3/4	3/4	7/8	1

Fig. 9—Cast Iron Thimbles for Wire Rope



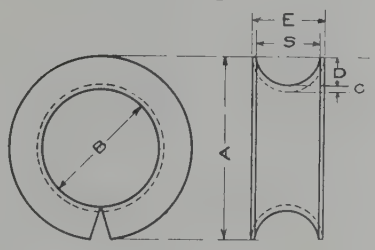
FOR PLOW STEEL WIRE ROPE

SIZE OF ROPE	A	B	C	D	E	F	G	H	J	K
2¾"-3"	2⅛	1 1/16	1½	¼	3½	5⅝	1⅜	1¼	1 1/16	⅝
3¼"-3½"	2⅝	1 1/16	1⅛	¼	3⅞	6 3/16	1⅞	1⅜	1⅛	1/16
3¾"-4"	2¾	2⅛	1 3/16	5/16	4½	7¼	2⅛	1⅝	1 3/16	1/16
4¼"-4½"	3	2 3/16	2⅛	5/16	4⅞	7⅞	2¼	1¾	1¼	⅞
4¾"-5"	3 3/16	2 5/16	2¼	⅜	5¼	8 1/16	2¾	1⅞	1⅞	15/16

FOR CAST STEEL WIRE ROPE

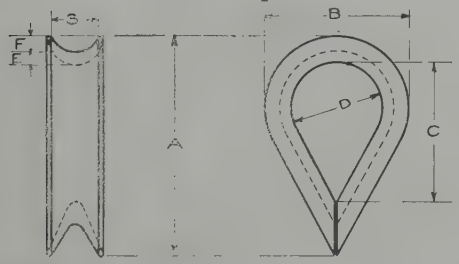
SIZE OF ROPE	A	B	C	D	E	F	G	H	J	K
1¾"	1 5/16	1 3/16	⅞	⅛	2	3 5/16	1⅛	¾	¾	⅜
2"	1½	1 1/16	1 1/16	3/16	2⅜	3⅜	1¼	⅞	⅞	7/16
2¼"-2½"	1 7/16	1 3/16	1 3/16	3/16	2¾	4 7/16	1⅜	1	1	½
2¾"-3"	2⅛	1 7/16	1½	¼	3½	5⅝	1⅝	1¼	1 1/16	⅝
3¼"-3½"	2 5/16	1 5/16	1⅝	¼	3⅞	6 3/16	1⅞	1⅜	1⅜	1/16
3¾"-4"	2¾	1 7/16	1 3/16	5/16	4½	7¼	2⅛	1⅝	1 3/16	1/16

Fig. 10—Wro't Steel Thimbles for Manila Rope



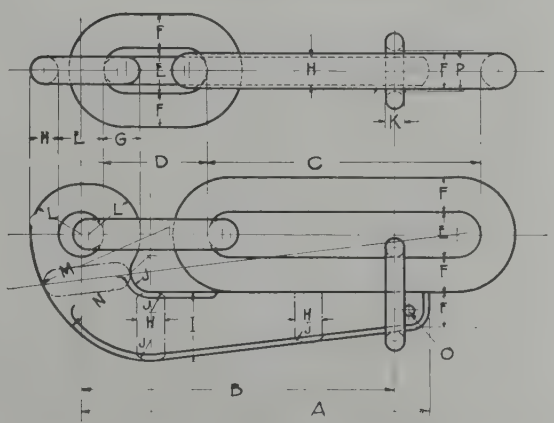
CIRCUMFRNCE OF SUITABLE ROPE	WIDTH OF SCORE	OUTSIDE DIA.	INSIDE DIA.	THICKNESS OR CROWN	DEPTH OF SCORE	WIDTH OVERALL
	S	A	B	C	D	E
1"	5/16"	3/4"	3/8"	1/16"	1/8"	11/32"
1 1/8"	3/8"	7/8"	7/16	3/32	1/8"	13/32
1 1/4"	7/16	1"	17/32	7/64	1/8"	1/2"
1 1/2"	1/2"	1 1/8"	5/8"	3/32	5/32"	9/16
1 3/4"	19/32"	1 3/16	11/16	1/8"	1/8"	5/8
2"	11/16"	1 1/2"	27/32	9/64	3/16	23/32"
2 1/8 & 2 3/4"	7/8"	1 3/4"	1 1/16"	5/32"	3/16	15/16
3"	15/16"	2"	1 1/8"	3/16"	1/4"	1"
3 1/4"	1 1/16"	2 1/4"	1 5/16"	3/16"	9/32	1 1/8"
3 1/2"	1 1/8"	2 3/8"	1 7/16	1/8"	11/32"	1 5/16"
4"	1 1/4"	2 3/4"	1 9/16"	7/32"	3/8"	1 3/8"
4 1/4"	1 3/8	3	1 3/4"	7/32"	13/32	1 1/2"
4 1/2 & 4 3/4"	1 9/16	3 1/2"	2 1/8"	7/32"	15/32	1 3/4"

Fig. 11—Wro't Steel Thimbles for Wire Rope



CIRCUMFERENCE OF ROPE			WIDTH OF SCORE	OVERALL		INSIDE		THICKNESS OR CROWN	DEPTH OF SCORE
BARE ROPE	SERVED ROPE	CANVASS ROPE	S	LENGTH A	WIDTH B	LENGTH C	WIDTH D	E	F
5/8			3/16"	1 1/16"	3/4"	11/16"	3/8"	1/16"	1/16"
3/4			1/4"	1 1/16"	1 1/16"	1 1/8"	2 1/32"	1/8"	1/8"
1	5/8		5/16	2 1/8	1 3/8"	1 3/8	2 5/32"	1/8"	1/8"
1 1/8	3/4		3/8	2 5/16	1 7/16	1 1/2	1 3/16	3/32	3/16
1 1/4	1	5/8	7/16	2 3/8	1 5/8	1 9/16	1 5/16	1/8	7/32
1 1/2	1 1/8	3/4	1/2	2 5/8	1 3/4	1 7/8	1 5/16	5/32	3/16
2	1 1/2	1 1/8	5/8	3 3/8	2 1/16	2 1/8	1 3/32	5/32	7/32
2 1/4	2	1 1/2	3/4	3 3/4	2 3/8	2 3/8	1 3/32	3/16	1/4
2 3/4	2 1/4	2	7/8	4 1/2	2 1/16	2 1/16	1 2/16	3/16	5/16
3	2 3/4	2 1/4	1"	4 1/8	3"	2 1/8	1 8/16"	7/32	11/32
3 1/2	3	2 1/2	1 1/8"	5 1/8	3 1/8"	3 5/16	1 8/16"	7/32	5/16
4	3 1/2		1 1/4"	5 3/4	3 1/16	3 1/2	2 1/16	1/4	3/8
4 1/4	4	3	1 3/8	6 1/16	3 1/16	3 3/4	2 3/8	9/32	1 3/32
4 3/4	4 1/2	3 1/2	1 1/2	6 3/8	4 1/8	4 1/8	2 1/2	9/32	1 7/32
5 1/2	4 3/4	4 1/4	1 3/4	7 1/4	4 5/8	4 1/4	2 5/8	5/16	5/16

Fig. 12—Pelican Hooks



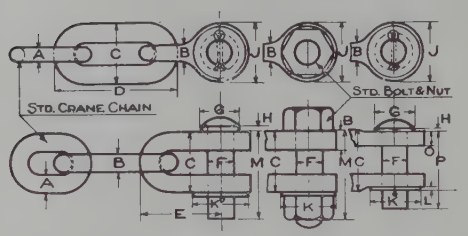
FOR CAST STEEL ROPE

SIZE OF ROPE	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1¾"	7½	6 3/4	6"	2 1/4	1"	3/4"	1 5/16	5/8"	1 1/2	3/16	3/8"	1 1/8	3"	2 1/4	1/4"	7/8"
2"	8 3/4	7 7/8	6 7/8	2 5/8	1 1/8	7/8	1 4/16	7/16	1 3/4	1/2	7/16	1 1/4	3 1/2	2 1/16	1/4	1"
2 1/4"-2 1/2"	10"	9"	7 7/8	3"	1 5/16	1"	1 5/8	1 3/16	2"	9/16	1/2	1 3/8	4"	3 1/16	1/4	1 1/8
2 3/4"-3"	11 1/4	10"	9"	3 3/8	1 1/2	1 1/8	1 3/4	1 5/16	2 1/4	5/8	1/2	1 11/16	4 1/2	3 1/2	3/8	1 1/4
3 1/4"-3 1/2"	12 3/8	12 1/4	11"	4 1/8"	7/8	1 3/8	1 1/2	1 1/16	2 3/4	3/16	5/8	2 1/16	5 1/2	4 3/16	3/8	1 1/2
3 3/4"-4"	14 1/4	14 3/8	12 7/8	4 7/8	2 1/8	1 5/8	1 3/4	1 7/8	3 1/4	1 5/16	3/4	2 1/16	6 1/2	5 1/4	1/2"	1 3/4

FOR PLOW STEEL ROPE

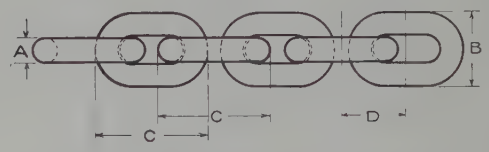
SIZE OF ROPE	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
2¾"-3"	11¼	10"	9"	3 3/8	1 1/2	1 1/8	1 3/4	1 5/16	2 1/4	3/16	1/2	1 1/16	4 1/2	3 1/2	3/8	1 1/4
3 1/4"-3 1/2"	13 3/8	12 1/4	11"	4 1/8	1 7/8"	1 3/8"	1 1/2	1 1/16	2 3/4	3/16	5/8	2 1/16	5 1/2	4 3/16	3/8	1 1/2
3 3/4"-4"	16 1/4	14 3/8	12 7/8	4 7/8	2 1/8	1 5/8	1 3/4	1 7/8	3 1/4	1 5/16	3/4	2 1/16	6 1/2	5 1/4	1/2	1 3/4
4 1/4"-4 1/2"	18 3/4	16 3/4	14 7/8	5 5/8	2 1/4	1 7/8	2"	1 15/16	3 3/4	1 1/16	7/8	2 3/16	7 1/2	6 3/16	1/2	2"
4 3/4"-5"	18 7/8	16 3/4	14 7/8	5 5/8	2 1/2	1 7/8	2"	1 15/16	3 3/4	1 1/16	7/8	2 3/16	7 1/2	6 3/16	1/2	2"

Fig. 13—Standard End Link and Narrow Shackle



A	B	C	D	E	F	G	H	J	K	L	M	N	O	P
½"	9/16	1⅛"	3½"	2½"	¾"	1⅛"	3/16	1½"	1⅜"	3/16	2¾"	2⅜"		
9/16	⅝	2 1/16	3⅜"	2¾"	¾"	1⅛"	3/16	1½"	1⅜"	3/16	2⅜"	2⅜"		
⅝	11/16	2¼"	4⅜"	3"	1"	1⅜"	¼"	2"	1⅜"	3/16	3⅜"	3"		
11/16	¾	2½"	4⅜"	3¼"	1"	1⅜"	¼	2"	1⅜"	3/16	3⅜"	3¼"		
¾"	13/16	2 11/16	5"	3½"	1⅛"	1⅜"	¼"	3½"	2⅜"	3/16	4"	3½"		
13/16	⅞	2⅜"	5¼"	3½"	1⅛"	1⅜"	5/16	2¼"	2⅜"	3/16	4⅜"	3½"		
⅞	1"	3¼"	5¼"	4⅜"	1¼"	1⅜"	5/16	2½"	2⅜"	¼	4⅜"	4⅜"	⅝	3⅜"
15/16	1 1/16	3⅜"	6"	4⅜"	1¼"	1⅜"	5/16	2½"	2⅜"	¼"	5"	4½"	⅝	3⅜"
1"	1⅛"	3⅜"	6⅜"	4⅜"	1½"	2 1/16	⅜"	3"	2⅜"	¼"	5⅜"	4⅜"	⅝	3⅜"
1 1/16	1 1/16	3⅜"	6⅜"	4⅜"	1½"	2 1/16	⅜"	3"	2⅜"	¼	5⅜"	5"	⅝	4"
1⅛"	1¼"	4⅜"	7½"	5⅜"	1¾"	2⅜"	7/16	3½"	3¼"	5/16	6"	5½"	¾"	4½"
1 3/16	1 3/16	4⅜"	7⅜"	5⅜"	1¾"	2⅜"	7/16	3½"	3¼"	5/16	6¼"	5¼"	¾"	4⅜"
1¼"	1⅜"	4 3/16	8⅛"	5¾"	1⅞"	2 1/16	7/16	3¾"	3½"	5/16	6⅜"	6"	¾	4⅜"
1 5/16	1 7/16	4¾"	8⅜"	5⅜"	1⅞"	2 1/16	½"	3⅜"	3½"	3/16	6¾"	6¼"	¾	4⅜"
1⅜"	1½"	5"	8¾"	6¼"	2"	2 1/16	½"	4"	3½"	5/16	7⅛"	6½"	⅞	5¼"
1 7/16	1 5/16	5 5/16	9"	6½"	2"	2 1/16	½"	4"	3½"	5/16	7⅜"	6¾"	⅞	5⅜"
1½"	1⅜"	5⅜"	9⅜"	6⅜"	2¼"	3 1/16	9/16	4½"	4"	⅜"	7¾"	7"	⅞	5¾"
1 9/16	1 1/16	5⅜"	9⅜"	7⅛"	2¼"	3 1/16	9/16	4½"	4"	⅜"	8"	7¼"	⅞	5⅜"
1⅝"	1¾"	5 3/16	10½"	7⅜"	2½"	3 1/16	⅝"	5"	4½"	⅜"	8½"	7½"	1"	6⅜"
1 11/16	1 3/16	6"	10⅜"	7⅜"	2½"	3 1/16	⅜	5"	4½"	⅜"	8⅝"	7⅝"	1"	6¼"
1¾"	1⅞"	6¼"	11⅛"	8"	2¾"	3 1/16	11/16	5½"	5"	7/16	9⅛"	8"	1"	6⅜"
1 13/16	1 5/16	6 3/16	11⅜"	8¼"	2¾"	3 1/16	11/16	5½"	5"	7/16	9⅜"	8¼"	1	6½"
1⅞"	2"	6⅜"	11¾"	8½"	2¾"	3 1/16	11/16	5½"	5"	7/16	9⅜"	8½"	1⅛"	6⅜"
1 15/16	2 1/16	6⅜"	12"	8⅝"	2¾"	3 1/16	11/16	5½"	5"	7/16	9⅝"	8⅝"	1⅛"	6⅜"

Fig. 14—Standard Crane Chain



A	B	C	D	Lbs. per Foot	Load in Pounds	
					Ultimate	Working
¼"	7/8"	1 5/16"	25/32"	.875	3360	670
5/16"	1 1/16"	1½"	29/32"	1·	5040	1000
⅜"	1¼"	1¾"	31/32"	1·7	7280	1460
7/16"	1⅜"	2 1/16"	1 5/32"	2·	10080	2020
½"	1 11/16"	2⅜"	1 11/32"	2 5	13440	2680
9/16"	1⅞"	2⅝"	1 15/32"	3·2	16800	3360
⅝"	2 1/16"	3"	1 23/32"	4·125	20720	4140
11/16"	2¼"	3¼"	1 27/32"	5·	25200	5040
¾"	2½"	3½"	1 31/32"	5·875	30240	6050
13/16"	2 11/16"	3¾"	2 3/32"	6·7	35280	7000
⅞"	2⅞"	4"	2 7/32"	8·	40880	8180
15/16"	3 1/16"	4⅜"	2 15/32"	9·	47040	9410
1"	3¼"	4⅝"	2 13/32"	10·7	53760	10750
1 1/16"	3 3/16"	4⅞"	2 23/32"	11·2	60480	12100
1⅛"	3¾"	5⅜"	2 27/32"	12·5	68320	13660
1 3/16"	3⅞"	5 5/16"	3 3/32"	13·7	76160	15230
1¼"	4⅛"	5¾"	3 7/32"	16·.	84000	17000
1 5/16"	4⅜"	6⅛"	3 15/32"	16·5	91840	18400
1⅜"	4 3/16"	6⅜"	3 5/8"	18·4	101360	20300
1 7/16"	4¾"	6 1/16"	3 23/32"	19·7	109760	21900
1½"	5"	7"	3 31/32"	21·7	120960	24200

Fig. 15—Method of Obtaining Curvature of Mast

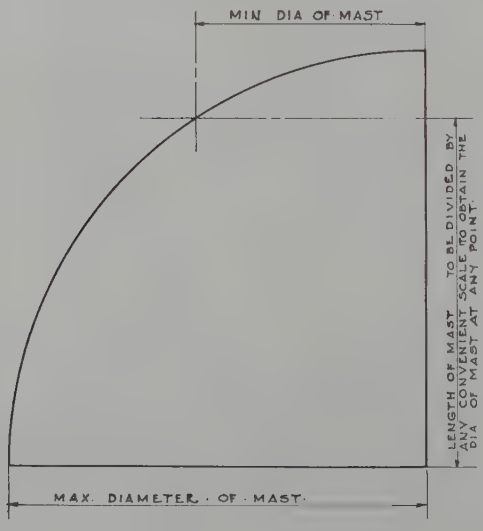
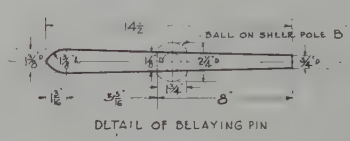
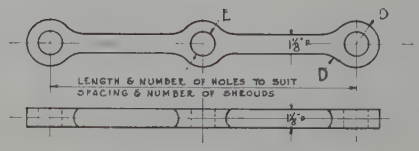

MIN DIA OF MAST
LENGTH OF MAST TO BE DIVIDED BY ANY CONVENIENT SCALE TO OBTAIN THE DIA OF MAST AT ANY POINT
MAX. DIAMETER OF MAST

DIAGRAM TO BE MADE ON FULL SIZE SCALE

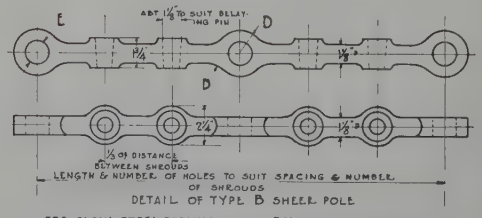
Fig. 16—Belaying Pin and Sheer Poles



DETAIL OF BELAYING PIN



DETAIL OF TYPE A SHEER POLE



DETAIL OF TYPE B SHEER POLE

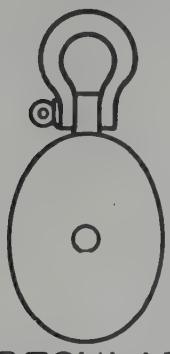
FOR PLOW STEEL RIGGING

DIM LETTER	CIRCUMFERENCE OF ROPES				
	2¼-3	3¼-3½	3⅝-4	4¼-4½	4⅝-5
D	1⅜	1⅞	2¼	2½	2¾
E	1⅝	1¾	2⅝	2⅞	2⅞

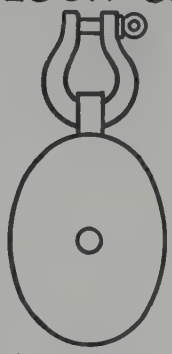
FOR CAST STEEL RIGGING

DIM LETTER	CIRCUMFERENCE OF ROPES					
	1¾	2	2¼-2½	2⅝-3	3¼-3½	3¾-4
D	⅞	1	1⅛	1⅜	1⅝	1⅞
E	1⅛	1⅛	1⅜	1⅛	1⅞	1⅝

TYPES OF BLOCK CONNECTIONS



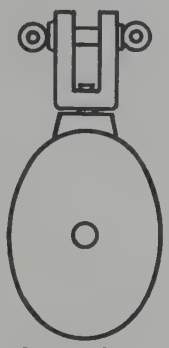
REGULAR SHACKLE



UPSET SHACKLE

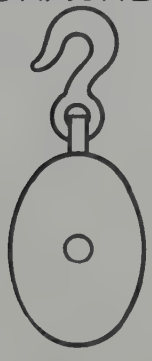
REVERSE SHACKLE

REVERSE UPSET SHACKLE



SWIVEL JAW

SWIVEL EYE
MADE ROUND OR OVAL

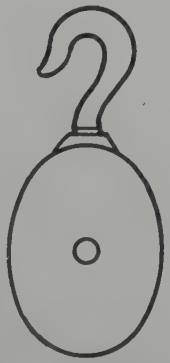


LOOSE FRONT HOOK

LOOSE SWIVEL HOOK

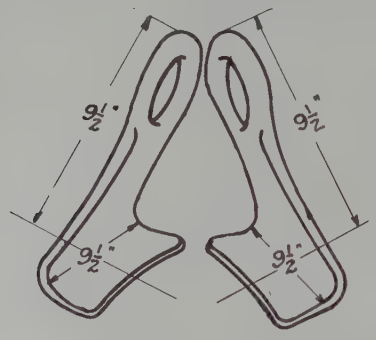
STIFF SWIVEL HOOK

LOOSE SIDE HOOK

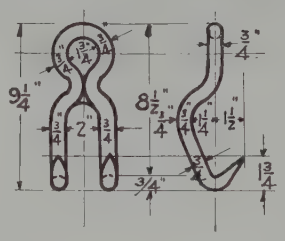


STIFF FRONT HOOK

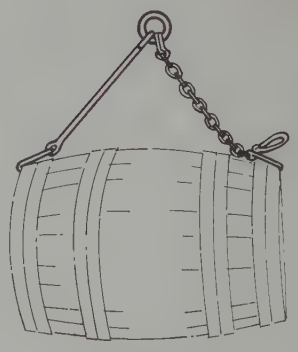
SIDE SISTER HOOK



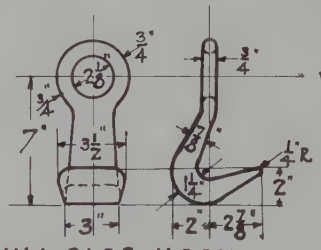
W. I. HOGSHEAD HOOKS



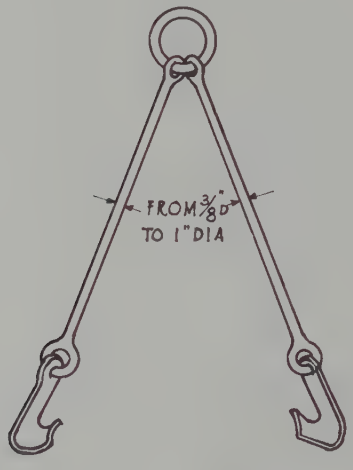
W. I. BALE HOOK



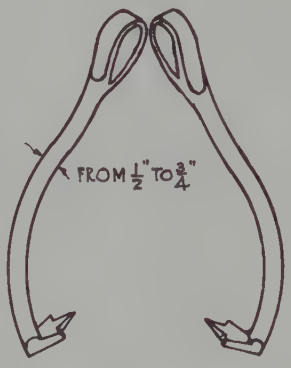
W. I. COMBINATION BARREL HOOKS



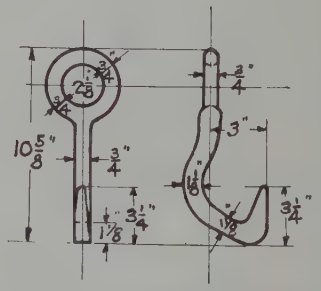
W. I. CASE HOOK



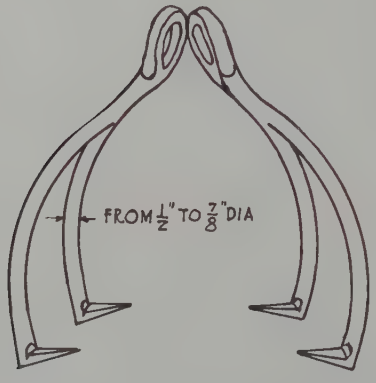
W. I. CAN HOOKS



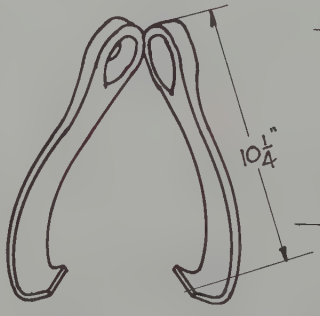
W. I. BOX HOOKS



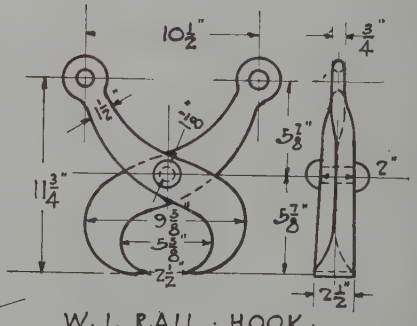
W. I. LUMBER HOOK



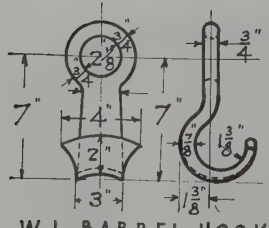
W. I. BALE HOOKS



W. I. LARGE BARREL HOOKS



W. I. RAIL HOOK



W. I. BARREL HOOK

HOOKS FOR HANDLING VARIOUS KINDS OF CARGO

Table of Unit Displacement of Commodities

Compiled by

The Bureau of Standards

Foreword:

With the large demand made upon the transportation and shipping facilities of this country in the recent times, the need for such a classification as is given in the following pages became urgent as a basis for making estimates as to the most efficient utilization of the existing facilities. Requests on the Bureau of Standards to supply these data were made by military agencies and others, and accordingly their compilation was undertaken.

These data were compiled from information furnished by leading shippers who appreciate the fact that there is considerable variation in the densities of commodities and their manner of preparation for shipment. The Bureau has not attempted to check the information in many cases, owing to the great amount of labor involved and the extreme pressure of other necessary work.

As the cubic space rather than the weight is the determining factor in the average cargo, that is not carried in bulk, these tables will be found invaluable for estimating the amount of merchandise a ship will carry and also for planning the most efficient stowage.

Table of Unit Displacement of Commodities

Commodity	Weight per cubic foot	Space per short ton	Space per long ton	How packed for shipment
	Pounds	Cubic feet	Cubic feet	
Abrasit	90	22	24	Wooden casks, 32 inches high, 19 inches diameter.
Abrasive paper:				
Alundum cloth	58	35	39	Rolls, 28 by 9 inches; 50 pounds per 480 sheets; 60 pounds per 50-yard roll.
Alundum paper	72	28	31	Rolls, 25 by 7 inches; 45 pounds per 480 sheets; 35 pounds per 50-yard roll.
Carborundum paper	65	31	35	Rolls, bundles, boxes.
Corundum paper	65	31	35	Do.
Emery cloth	35	57	64	Rolls, 19 by 9 inches; 25 pounds per 50-yard roll; 32 pounds per 480 sheets.
Emery paper	45	44	50	Rolls, 25 by 7 inches; 25 pounds per 50-yard roll; 20 pounds per 480 sheets.
Flint paper	65	31	35	Rolls, bundles, boxes.
Sandpaper	65	31	35	Do.
Absorbent cotton	8–9	216–250	242–280	Bales.
Accroides gum				Bags and cases, 100 to 200 pounds.
Acetanilid	23	87	97	Sugar barrels; containers, 25–50 pounds.
Acetic acid, commercial (70 per cent acid).	67	30	33	12-gallon carboys.
Pure	56	36	40	Do.
Acid phosphate. See Phosphate acid.				
Adding machines. See Computing machines.				
Adhesive paste. See Paste.				
Adzes				1 dozen to a case, 40 to 50 pounds.
Air humidifiers, baker's	56	35	40	Crates, 17 by 64 by 21 inches.
Alcohol	58	35	39	Barrels.
Algarobilla. See Tanning extract.			28–32	50-gallon barrels.
			35	Kegs, barrels.
Alizarine colors	71–79	25–28	25	Cans, boxes, sacks, 120 pounds.
Alizarine dyes	65	31		
Allspice	18	111		
Almonds, shelled, unsalted, and unsweetened.	35	57	64	
Unshelled	17	116	130	
Aloes, gum				Cases; kegs; barrels, 150–500 pounds.
Alumina ore. See Bauxite.				
Aluminum:				
Acetate of	70	31	34	Barrels, kegs.
Bisulphite				Hardwood barrels, 550–570 pounds.
Bronze powder	35	57	64	Cans in boxes.

Table of Unit Displacement of Commodities—Continued

Commodity	Weight per cubic foot	Space per short ton	Space per long ton	How packed for shipment
Aluminum—Continued.	Pounds	Cubic feet	Cubic feet	
Carbide	70	29	32	Casks, 42 inches long, 24 inches, diameter.
Chloride	81	25	28	Carboys.
Coiled	32	62	70	
Dross	66	30	34	
Foil	70	29	32	
Ingots				Each, weight 25 pounds or over.
Interleaved	60	33	37	
Mats or matting	167	12	14	Each, 9–13 inches wide.
Phosphate. See Wavellite ore.				
Plain	70	29	32	
Sulphate				Barrels, 424 pounds; bags, 202 pounds.
Wire. See Wire.				
Alundum cloth and paper. See Abrasive paper.				
Alundum refuse	120	17	19	
Amber				Cases, 150–250 pounds.
Ammonia, anhydrous	60	33	37	Iron cylinders.
Phosphate	60	33	37	Barrels, kegs.
Ammoniacal liquor	67	30	33	Tank cars.
Ammonium, bromide	77	26	29	
Nitrate	39	51	57	Boxes, 20 by 13¾ by 11½ inches.
Aniline:				
Dyes	79	29	32	Tins, cans, kegs, barrels.
Oil	64	32	35	Iron drums, 1100–1600 dpouns.
Salts	45	45	50	Wooden casks.
Animal charcoal. See Boneblack.				
Animi				Cases, 150–250 pounds.
Annato seed				Bags, 190 pounds net.
Anodes. See Nickel anodes.				
Antifreezing compound	41	49	55	Cans.
Antimony:				
Metal	232	8.6	9.7	Boxes, 16¾ by 10½ by 11 inches.
Oxide	40–65	30–50	35–56	Barrels; kegs; casks.
Regulus:				
Chinese	160	12	14	Cases of slabs of 40 pounds each, cases, weight 250 pounds.
English				Cases of cakes 10 by 10 by 2 inches; cases, weight 700 pounds.
Hungarian and other European.				Casks, 300–1200 pounds.
Anvil tools. See Machine shop equipment.				
Apricot kernels	42	48	53	Sacks.
Aqua ammonia. See Ammonia.				
Arabic gum. See also Gum arabic				Bags; cases; barrels 350 pounds.
Arch supports and arch-support insoles.	16	125	140	1 dozen in carton; 1 gross in box 23.5 by 18½ by 8 inches.

Blanks in the following pages indicate that data are not available. Corrections and additional data addressed to Bureau of Standards will be appreciated.

Table of Unit Displacement of Commodities—Continued

Commodity	Weight per cubic foot	Space per short ton	Space per long ton	How packed for shipment
Areca nuts. See Betel nuts.				
Army kitchen equipment:	Pounds	Cubic feet	Cubic feet	
Army kitchens				50 by 50 inches, weight 2,120 pounds; weight of kitchen and supplies, 2,920 pounds.
Army range No. 1	26	76	85	Crates.
Army range No. 2	32	63	70	Do.
McClary's field kitchen, used by Canadian troops.	7	285	320	
Pintsch portable gas cooker				Trunk furnished by Commissary Department, inside dimensions 25⅛ by 17½ by 17½ inches.
Arrowroot				Flour barrels.
Artgum	60	33	37	Strong rectangular boxes.
Artificial leather. See Leather.				
Asafetida gum	41	49	55	Cases, 50–450 pounds.
Asbestos	35	57	64	Rolls.
Building, felt paper	49	41	46	Rolls, wrapped with burlap on the ends.
Not bituminized	85	24	26	Rolls.
Cloth	37	55	61	Cases.
Crude	50	40	45	Bags, 102 pounds.
Doors	55	36	41	
Fiber	22–33	60–90	67–100	Bags.
Filler blocks for acetylene-gas cylinders.	18	111	125	
Gaskets. See Gaskets.				
Lumber	125–130	15–16	17–18	Boxes; crates, 350 pounds.
Millboard	45–85	24–45	25–50	Cases; crates.
Ordinary pipe or boiler covering.	35	57	64	Crates, 25.5 by 25.5 by 37.5–44.5 inches.
Packing. See Packing.				
Roofing	50–55	36–40	40–45	Crates; rolls wrapped and burlap ends 33 by 14 inches.
Corrugated	22–100	20–91	22–102	Crates.
Refuse	42–56	35–48	40–54	
Sand	56–65	31–36	34–40	
Scrap	24–85	24–83	26–94	Bags, 100–125 pounds; bales, 458 pounds.
Table covers or pads	30–45	44–67	50–75	Heavy pasteboard boxes packed in strong wooden boxes.
Tubes	40–45	44–50	50–56	
Woven and wire fabrics	32	63	70	
Yarn	50	40	45	Spools or cones of 1 pound packed in wooden boxes.
Asphaltum. See Oil; Road oils.				
Assayer's furnaces	16	124	138	
Atomizer or nebulizer	16	124	138	Compressed-air tank; bottles; tubing.
Awnings or covers for wagons:				
Made of canvas or cotton duck.	8	250	280	25 to shipping bundle, 2.5 by 2.5 by 4 feet, wrapped with paper and tied with cord.
Tarpaulin tents	20	100	112	Shipped knocked down with ridings tied in bundles.
Axes, without handles	196	10	11	1 dozen in a case 11 by 15 by 6 inches.
With handles	44	45	51	1 dozen in a box 30 by 7 by 9 inches.
Axle grease	54	37	41	Barrels; kegs; boxes; pails; 28-gage iron cans.
Axles:				
Car axles	129–193	10–16	12–17	Boxes for export, 7 feet by 1 foot 8 inches by 8 inches. Sizes vary from 5 feet to 7 feet 6 inches length, and 3 to 7 inches diameter.
Carriage and wagon	60–75	27–33	30–37	Loose and uncrated, 2.5–4 inches by 3.5–5.5 by 54–68 inches.
Locomotive	450	4.4	5	Shipped loose; average, 10 inches diameter by 72 inches long.
Backbands	15	133	149	Paper-lined bags.
Padded	15	133	149	Bundles, 28 by 18 by 24 inches.
Bag fasteners, wire	60–80	25–33	28–37	
Bag holders	20	100	112	
Bagging	40	50	56	Rolls, 32 by 20 by 20 inches, wrapped with burlap.
Bags, golf club	12	167	186	
Baking pans	23	87	97	
Baking powder	36–40	50–56	56–62	Tin cans, boxed, 12 by 7 by 8 inches or 16 by 10 by 9 inches; flour barrels, sugar barrels, larger barrels.
Balls:				
Fire-clay, heat-radiating	45	44	50	
Steel crusher	480	4	5	4.5–16 inches in diameter.
Steel polishing	300	7	8	Boxes, 15 or 18 inches by 10 by 10 inches.
Balsam-fir tips	18–20	100–112	112–124	Bushel bags.
Bamboo fiber	20	100	112	Bales, 2.5 by 2.5 inches by 4 or 5.5 feet long.
Barbed wire	65	31	34	On wooden reels, 16 inches diameter by 13½ inches high; on steel reels, 18 inches diameter by 13.5 inches high.
Barium:				
Aluminate	46	43	49	Barrels, 300 pounds; kegs, 75 pounds.
Chlorate	80	25	28	Barrels, 23 inches high, 17 inches diameter.
Chloride	80–90	22–25	25–28	Containers holding 3 cubic feet.
Sulphide	40–50	40–50	45–56	Wooden barrels, 400–500 pounds.
Barrel carts	25–35	57–80	64–90	Knocked down.
Barrels, oil. See Oil barrels.				
Baseball bases, bats, and masks. See Sporting goods.				

Table of Unit Displacement of Commodities—Continued

Commodity	Weight per cubic foot	Space per short ton	Space per long ton	How packed for shipment
Baseballs. See Sporting goods.				
Baskets, berry	Pounds 7	Cubic feet 286	Cubic feet 320	
Battens, building	32	63	70	Crates, 6–10 feet long.
Batteries, dynamite	30	67	78	
Battery jars, rubber	11 – 13½	147–182	165–235	
Battery plates or frames, burnt-out.	57	35	40	
Battery wells	4	500	560	3 sizes: 8 feet 8 inches by 4 feet 10 inches, 6 feet 8 inches by 4 feet 10 inches, and 3 feet by 4 feet 10 inches.
Battery zincs. See Zinc.				
Bauxite. See Halloysite.				
Bauxite-ore concentrates	55 – 58	35–36	39–41	Loose or in bags.
Bay rum	36	56	62	Barrels, 24 inches diameter, 34 inches high.
Bean and pea thrashers	6.3–8.4	24–30	27–33	
Beans, castor	37	54	61	Bags, 165 pounds.
Bedsteads, iron	5 – 8	250–400	280–448	Knocked down, 75–80 pounds to the bed.
Bee-comb foundation	16	125	140	
Beef extract, solid	67	30	33	Case of 12 1-ounce tins; case of 2 50-pound tins.
Beer	83	24	27	Hogsheads; barrels; ½, ⅓, ¼, ⅙, ⅛ barrels.
Beeswax	14	143	160	Shipped raw in all shapes and sizes wrapped in gunny sacks; also in boxes 19 by 16.5 by 20 inches and 19 by 8½ by 20 inches.
Beet sugar. See Sugar.				
Benches, folding	48	42	47	Shipped 2 in a bundle, 7 by 24 by 10 inches.
Benzoin				Cases, 75–200 pounds.
Benzoinated lard	42	47	53	In 1, 5, 10, 25, and 50 pound tins, boxed and crated.
Berths, galvanized, for ships, camps, or barracks. See Cots.	15	133	149	2 in a bundle, 70 by 24 by 6 inches.
Berths or bunks, steel	21	95	107	Wired in packages; each package contains 2 springs.
Betel or areca nuts				Sugar barrels, 300–350 pounds.
Bicycles	5 – 9	222–380	249–422	
Blackboard crayon, See Crayon.				
Blanchers for beans and peas	6 – 8½	240–333	264–373	
Blangas	81	25	28	Steel cylinders, 8.5 by 43 inches; contains 20 pounds liquified gas.
Block salt. See Salt.				
Boat knees	63	32	36	Loose; require 0.8 cubic foot.
Boat parts—steel-launch hulls	5 – 12	167–400	186–448	Knocked down.
Boilers, range	92	22	24	
Bolts, railroad track				Kegs, 200 pounds.
Bone black	65 – 75	27–31	30–34	Bags or barrels.
Bone blanks	40 – 43	47–50	52–56	
Bone grease	56	36	40	
Bookbinders, loose-leaf	17	120	135	
Do	45	44	49	
Bookcases:				
Filing cabinet	10	200	224	
Sectional	7.5	267	299	Crates. Crate consisting of 1-9 inch section, 1-11 inch section, and 1-13 inch section, 37½ by 27 by 29.5 inches; crate containing 1 section with glass removed, 34 by 14 by 19 inches.
Bottles, paper:				
Half pint	4.4	455	509	Boxes.
Pint	3.7	540	606	Do.
Quart	3.5	571	630	Do.
Bowkerosa. See Sugar clarifier				
Bows, wagon or carriage. See Wagon bows.				
Box cars, standard				36 feet long, 8 feet 6 inches wide, 8 feet high.
Box straps or strapping, fiber board for fruit boxes, etc.	50	40	45	Bundles, 50 inches long, 5 inches diameter.
Boxes, ball, butter, fig, grease, or spice.	6–7	286–333	320–376	
Boxing gloves. See Sporting goods.				
Brake blocks	20	100	112	
Brake lining	75	27	30	
Brass washers. See Washers.				
Briar-root blocks	25	80	90	Bags, 9 gross each; weight, 180 pounds.
Briar wood, crude	20	100	112	Bags, 10 cubic feet.
Brick:				
Graphite				Boxes, 100 and 450 pounds; kegs, 200 pounds; barrels, 500 pounds.
Insulating	29	69	77	Barrels, boxes, crates, laid loose in straw.
Pouring				Shipped loose; weight, about 60 pounds each.
Brimstone	47	43	48	Cases, 35 by 22 by 16 inches.
Briquets:				
Carbon, cylindrical, 2½ by 2½ inches.	43	47	52	Sacks.
Charcoal	31	65	72	1 dozen in box, weight 95 pounds; 2 dozen in box, weight 175 pounds.
Coal	49–53	38–41	42–46	
Lignite	50	40	45	
Britannia metal	130	15	17	Boxes; barrels.
Bromide mining salts	98	20	23	50-gallon barrels; iron-bound boxes, 13.5 by 15 by 22 inches.
Bronze powder	70–75	27–29	30–32	Boxes; wooden drums.
Broom-corn heads	10–12	167–200	187–224	Fiber-board cartons, 12–18 pounds.

Table of Unit Displacement of Commodities—Continued

Commodity	Weight per cubic foot	Space per short ton	Space per long ton	How packed for shipment
Buggy bodies. See Vehicle bodies.				
Burlap:	Pounds	Cubic feet	Cubic feet	
Bituminized (gunny bagging).	34	59	66	Rolls, 400 square feet.
For compressed bales	44	45	51	Compressed bales, 40 by 40 by 24 inches.
Saturated with asphalt	21–23	87–95	97–107	Rolls, 32 inches long, 10 inches diameter, or 36 inches long, 15 inches diameter.
Butcher's blocks				60 pounds per square foot top surface.
Butter	50	40	45	
Butter color	43–46	43–46	49–52	Cases, six 1-gallon cans; drums, 50–100 gallons.
Butts. See Hinges.				
Cable, insulated copper wire	60	33	37	Reels, varying sizes; weight package, 600 pounds average.
Steel-covered, electric	70	29	32	Reels.
Cabinets, dental	11	182	204	Boxes, 24 by 42 by 72 inches.
Cable terminal boxes	10	200	224	
Cadmium:				
Metallic	275	7	8	Small bundles in boxes.
Sulphide	200	10	11	Barrels, 300–400 pounds.
Do	65	31	34	10 bags, 5 kilos each, in paper-lined wooden box; tin cans crated, 20 by 12 by 36 inches.
Calcimine or kalsomine	110	18	20	Tin cans, 1, 5, 10, 25–48 pounds.
Calcium:				
Acetate. See Lime acetate.				
Carbide	52	38	43	Drum, 22 inches high, 12½ inches diameter.
Nitrate	80	25	28	Casks, 240 pounds.
Calves' stomachs. See Rennets.				
Camp chairs, iron or steel, folding.	21	95	107	
Wooden, folding	20	100	107	
Camphor, coal tar, for household purposes.				Barrels, 500 pounds; boxes, 100 pounds; kegs, 75 pounds.
Gum				Barrels and cases, 100 pounds.
Canned goods. See Appendix No. 1.				
Can stock: Ends, bottoms, and tops for cans.	51	39	44	Nested in fiber or wooden boxes, 18 by 12 by 9 inches.
Candies: Paraffin, wax, or stearic acid.	29–37	54–69	61–77	Cases, 7.5 by 8.5 by 16.5 inches to 14.5 by 12 by 18.75 inches.
Canoes	3.5	572	640	Nested.
Cant hooks	30	66	75	Bundles, ½ dozen, 4.5 feet long.
Canteens, aluminum, Army	11	172	203	Each wrapped in paper, then packed in wooden boxes.
Canvas benches, folding	6	333	373	Bundles of 2; weight, 50 pounds.
Capstan bars	20–25	50–100	90–112	Crates, 50 by 12 by 12 inches to 122 by 15 by 15 inches; 16 bars in a box.
Car axles. See Axles.				
Car heaters, electric	20–26	77–100	86–112	
Car seats and parts	10	200	224	Boxes or crates, knocked down.
Carbon:				
Bisulphide	75	27	30	Tank cars, drums of 60, 112-123 pounds.
Clinkers or gas retort	58	35	39	Boxes; bags; barrels.
Flour	10	200	224	Bags, 175–200 pounds; barrels, 250–300 pounds.
Tetrachloride	90	22	25	5 or 10 gallon cans.
Carbolineum	69	29	33	Drums, 30–50 gallons.
Carborundum paper. See Abrasive paper.				
Carded, hand, cotton or wool	28	71	80	
Carpenter's chisels. See Machine-shop files and rasps.				
Carpet lining	22	91	103	
Carriage axles. See Axles.				
Carriage poles. See Wagon poles.				
Carriage springs. See Wagon springs.				
Cartridge cases	30	67	75	Bundles of 100, used in packing 12½ pounds blasting powder.
Carving knives. See Machine-shop files and rasps.				
Casings, house-heating furnace	8–30	67–250	75–280	
Cassava flour	25	80	90	Bags, average weight 150 pounds.
Cassia. See Cinnamon.				
Cast-iron radiators. See Radiators.				
Casters for furniture	64–120	17–31	19–35	Cases; boxes; barrels.
Castor beans. See Beans.				
Castor pomace. See Pomace.				
Caterpillar tractors:				
55 horsepower	27	74	83	Single package, 14 feet 5 inches by 6 feet 9 inches by 7 feet 8 inches; Holt Mfg. Co.
75 horsepower	17	118	132	Single package, 20 feet 11 inches by 9 feet 2 inches by 9 feet 5 inches; Holt Mfg. Co.
120 horsepower	17	118	132	Single package, 22 feet 1 inch by 9 feet 6 inches by 9 feet 5 inches; Holt Mfg. Co.
Caterpillar trailer	19	105	118	Single package, 12 feet 11 inches by 9 feet 9 inches by 5 feet 9 inches; Holt Mfg. Co.
Cayenne pepper. See pepper.				
Cell pads, for insane	8–12	167–250	188–280	
Cell pitch. See Sulphite liquor.				
Cellulose	8	250	280	

Table of Unit Displacement of Commodities—Continued

Commodity	Weight per cubic foot	Space per short ton	Space per long ton	How packed for shipment
Cement:	Pounds	Cubic feet	Cubic feet	
Furnace	42–130	15–48	17–53	Barrels; half barrels; kegs; cans.
Hydraulic. See Puzzolan cement.				
Keene	50	40	45	100-pound jute bags.
Linoleum	54	37	41	Cakes, 36 by 20 by 3.5 inches; bags of 2 cakes; cans.
Magnesia	20	100	112	Bags, 3.5 cubic feet.
Metallic	50–100	20–40	22–45	Barrels; kegs; steel cans.
Paving	75	27	30	30-gallon barrels.
Pipe fitting	45	44	50	Kegs; cases.
Do	50	40	45	Tin cans, crated.
Do	70	29	32	350-pound barrels; 100-pound sacks.
Do	77	26	29	Tin cans; kegs; barrels
Portland	62	32	36	Barrels; bags.
Puzzolan	80	25	28	
Roofing (dry and liquid)	75	27	30	Barrels; half barrels; kegs; tin cans.
Rubber	32–56	36–63	40–70	Barrels; cans packed in wooden boxes.
Cement in cans	36	56	62	
Cement blocks	80	25	28	Sizes from 4 by 6 by 12 inches to 8 by 8 by 24 inches.
Chains. See Sprocket chains.				
Chairs:				
Dental	23	87	97	Knocked down usually.
Folding	13	154	172	Bundles, 38½ by 16½ by 10½ inches.
Frames of iron or steel	35	57	64	Knocked down.
Invalid or rolling	12	167	187	Knocked down flat.
School, with desk attached	6.4	331	371	
Stenographer or typewriter	10	200	224	Packages, 17 by 17 by 18 inches.
Surgical operating	86	23	26	Crated and partially knocked down, 26 by 57 by 33 inches.
Charcoal	16	125	140	Bags, 50–80 pounds; barrels, 100 pounds.
Charcoal, animal. See Bone black.				
Charging boxes, open-hearth furnaces.	25–50	40–57	45–64	Average size, 8 by 2 by 2½ feet.
Cheesecloth or gauze	9–11	182–222	204–249	Boxes; bales.
Cheese color	50–55	36–40	41–45	Drums, 50–100 gallons.
Chest of red gum wood	12	167	187	Completely knocked down.
Chicle gum				Bags, 150–200 pounds.
Chicle paste	90	22	25	Barrels, 54-gallon; one-half barrels; tubs, 110 pounds.
Chrome:				
Liquor	75	27	30	Tank cars; steel drums, 50–100 gallon.
Paste	45	44	50	Barrels, 532 pounds.
Yellow				Sugar barrels, 500–600 pounds.
Chucca	46	43	49	Cases, 19 by 17 by 15 inches.
Chueca gum				Cases, 150–200 pounds.
Chufas	35	57	61	
Churns, metal	11	182	204	
Chutes, coal-delivery	10–30	66–200	75–224	
Cigar boxes, empty	7.6	263	295	
Cinnamon or cassia	10–36	56–200	62–224	Whole or ground in tin, glass, or paper packages, packed in wooden or fiber boxes.
Clam juice	40	50	56	Packages, 15 by 11 by 10 inches.
Clams, malted	28	71	80	Barrels; drums, 170 pounds; bottles, packed in wooden boxes.
Clamshells	30–40	50–66	56–75	Bulk.
Clay, China or German				Casks, 1,200 pounds.
Cleaners, street car track	20	100	112	190 pounds each.
Clinker hooks, iron or steel	25	80	90	
Clips. See Paper fasteners.				
Cloth, asbestos. See Asbestos cloth.				
Clothesline	23	87	97	Barrels; boxes.
Wire	23	87	97	Reels; coils in boxes; bundles; barrels.
Clothing bags, folding wardrobe	10–15	133–200	149–224	Wooden cases.
Kraft or sulphite paper				Bundle of 250; weight, 38 pounds.
Cloves and clove stems	20	100	112	Ground, in boxes; unground, in bags and bales.
Coal hods	3–7	286–666	320–747	1 single, 12 by 12 by 12 inches; nested in packages, 16 by 12 by 24 inches.
Coal hoppers	5–9	222–400	249–448	
Coal-saving compounds	85	24	26	Barrels, 45-gallon; sacks, 100 pounds.
Coal separators, spiral	30–40	50–66	56–75	Knocked down, crated, 38–60 inches diameter, 11–16 feet long, 700–1500 pounds.
Coal-tar camphor. See Camphor.				
Cobalt, linoleate				Barrels, 400 pounds.
Metallic	80	25	28	Barrels; kegs; boxes; small quantity in bars and ingots.
Cocos	26	77	86	In bulk; barrels; cases and crates of tins (crate of 100 pounds cocos in tins, 18 by 21 by 20 inches).
Butter	25	80	90	Cases, 24 by 18 by 18 inches; bales, 45 by 19 by 11.5 inches.
Cocoanut. See also Copra.				
Cocoa nuts				Bags, 100 nuts; weight, 150 pounds.
Crushed or grated	42	48	53	In cans, boxed, 17¾ by 17¾ by 9 inches.
Desiccated	34	59	66	Barrels, 29 inches high, 22 inches diameter; boxes, 157 pounds; packages, 17¾ by 12¾ by 9¾ inches
Oil cake	27	74	83	Bags.
Olein. See Oleine.				
Stearin. See Stearine.				

Table of Unit Displacement of Commodities—Continued

Commodity	Weight per cubic foot	Space per short ton	Space per long ton	How packed for shipment
	Pounds	Cubic feet	Cubic feet	
Coffee beans, roasted	15–31	65–133	72–149	Bags, 25–100 pounds; cases, 10–100 pounds; tin cans crated; drums; barrels.
Coffins, glass	50	40	45	Boxes.
Sheet-iron, cloth-covered	10	200	224	Average weight, 280 pounds, when packed.
Coir yarn	9–33	61–222	68–249	Bales, 18 by 24 by 42 inches and 3 by 2 by 2 feet; bullots in rope form, 12 pounds each.
Cólanut				Barrels, 310–315 pounds.
Collar blocks	48	42	47	Each, 24 by 6 by 4 inches.
Collar pads. See Sweat pads.				
Collodion	49	41	46	48-gallon barrels.
Compensators, electrical	40	50	56	
Computing machines, adding machines.	22–27	74–91	83–102	Wooden boxes, 11 by 11½ by 16½ inches to 23 by 23 by 16 inches.
Adding and listing machines	22	91	102	Packages, 100–200 pounds.
Conch shells				Barrels, 170 pounds.
Concrete distributing chutes	2.5	800	896	10 by 9 inches by 10 feet.
Concrete forms and molds	35	57	64	Knocked down, usually.
Concrete hardener. See Powdered iron.				
Concrete surface hardener	100	20	22	
Conduit fittings, complete	69	29	32	
Iron or steel parts	70	29	32	
Conduits, fiber	7	286	320	
Iron or steel	50	40	45	
Cones, stove or furnace	27	74	83	4½ inches high, 5½ inches diameter.
Congo gum				Cases, 150–250 pounds.
Congoleum	30	66	75	Cases, varying size; pieces wrapped around a fiber-board tube.
Contact block, electrical	160	12	14	
Containers for flour and meal				Carload lots: Barrels, 8.66 per cent; cotton sacks, 77¾ per cent; paper sacks, 13.59 per cent. Less than carload lots: Barels, none; cotton sacks, 99½ per cent; paper sacks, 0.5 per cent.
Controllers, electric	26	77	86	
Copal gum				Cases and bags, 150–250 pounds.
Copper:				
Bullion (98 per cent copper)	535	3.7	4	Slabs of 325–375 pounds.
Concentrates (15 per cent grade)	128	16	18	Sacks, 108 pounds.
Concentrates (50 per cent grade)	157	13	14	Sacks, 133 pounds.
Matte (30–50 per cent copper)	350	6	6.4	Sacks.
Nitrate	90	22	25	Carboys.
Ore	150	13	15	Density varies according to assay.
Oxide	120	17	19	Barrels and in bulk.
Sulphate	60	33	37	Barrels.
Tacks. See Tacks.				
Washers. See Washers.				
Copperas, sulphate of iron	92	22	24	Carboys and barrels.
Copra	22	91	102	Bags, 150 pounds.
Coquina shell				Barrels. 250 pounds.
Corncribs, wood and iron combined.	9	222	249	
Wooden	11	182	204	
Corn oil	30	66	75	4 dozen 5½-ounce bottles in fiber-board compartment containers.
Corn-oil cake	58	34	39	Sacks, 224 pounds.
Ground	60	33	37	Bags, 100 pounds.
Corn sirup, inlved	74	27	30	Barrels; half barrels; kegs; tin cans, boxed, 15⅝ by 11⅞ by 10⅝ inches to 22⅝ by 17½ by 6½ inches.
Unmixed	76	26	29	Barrels; half barrels; kegs; steel drums.
Corn sirup products:				
Jams	59	34	38	Glasses, boxed; wooden or tin pails or kits.
Jellies	50	40	45	
Mass	93	21	24	Barrels, 34½ inches high, 25½ inches diameter.
Preserves	59	34	38	Glasses, boxed: wooden or tin pails or kits.
Cornstalk fiber				Bales, 110 pounds; about size of small hay bales.
Cornstarch. See Starch.				
Sugar. See Sugar.				
Corset stays or steels	100	20	22	
Corundum paper. See Abrasive paper.				
Cots:				
Canvas	6–8	250–333	280–373	Bundle 3 cots, 39 by 29 by 12½ inches; bundle 4 cots, 75 by 29 by 8 inches.
Jail				2 by 6 feet to 2 feet 6 inches by 6 feet 6 inches; weight 60–80 pounds.
Steel, folding	9	222	249	Bundle 1 cot, 74 by 39 by 3 inches.
Woven-wire	6	333	373	Bundle 2 cots, 72 by 30 by 3.5 inches.
Cotter pins: [a]				
⅜ by 1 inch	55	36	41	1 box, containing 79 000, 19 by 10½ by 27 inches.
⅞ by 1½ inches	80	25	28	1 box, containing 20 000, 19 by 10½ by 27 inches.
½ by 4½ inches	59	34	38	1 keg, containing 1000 (¼ by 4½ inches).
⅝ by 5½ inches	59	34	38	1 keg containing 500 (⅝ by inches), 17 by 17 by 26 inches.
Cotton cloth, asphaltum coated				Burlapped bales; rolls in boxes, 403 pounds.
Cotton mop yarn. See Mop yarn.				

[a] Jute bags, boxes, and kegs. Trading unit, 100 pounds.

Table of Unit Displacement of Commodities—Continued

Commodity	Weight per cubic foot	Space per short ton	Space per long ton	How packed for shipment
	Pounds	Cubic feet	Cubic feet	
Cotton seed, green	30	66	75	
Well dried	27	74	83	
Cotton seed:				
Cake	60	33	37	Slabs, 14 by 30 by 0.75 inches; bags.
Hull ashes	40	50	56	
Hull fiber, bleached	20–23	87–100	97–112	Bales, 14 by 18 by 24 inches.
Meal	38	57	59	Bags, 100 pounds.
Softeners				Barrels; kegs; cases, 10–65 gallons.
Unbleached	34	59	66	Bales, 16 by 16 by 20 inches.
Cracker pans	65	31	34	Wired flat in boxes.
Crates, cracker can				Bundles of 10, folded flat, 34 by 1½ inches.
Poultry crates or coops	5	400	448	
Crayon:				
Blackboard	63–75	27–32	30–36	20–25 gross, average case 9 by 12 by 28 inches.
Lumber	27	74	83	Package, 13 by 13 by 12.5 inches.
Wax	28–30	66–71	75–80	Cases, 1–20 cubic feet.
Crepe paper	7.3	274	307	Crates, 40 by 25 by 21½ inches.
Cresol. See Cresylic acid.				
Cresylic acid	58	34	49	
Crucibles:				
Clay				Casks of 700; weight, 500 pounds.
Muffles				Casks of 20; weight, 600 pounds.
Scorifiers				Barrels of 1000; weight, 300 pounds.
Crusher balls				5-inch diameter ball; weight, 185 pounds.
Crutches	9–15	133–222	149–249	Wrapped in heavy fiber paper; tied in bundles of 1 dozen pairs; bundles 54 by 12 by 12 inches. 25 pairs and over wrapped and then crated, crates 54 by 22 by 18 inches.
Cupboards	3–10	200–666	224–747	Knocked down flat, except drawers.
Cupro-nickel:				
Blanks	167	12	13	Unfinished shapes.
Plate or sheet	149	13	15	
Rod	180	11	12	
Scrap	38	53	59	Bales; machine-pressed bund...
Currycombs	19–30	66–105	75–118	Boxes, 1 dozen; cases of 6–24 dozen; 24-dozen case requires 9 cubic feet.
Cuspidors, dental	8	250	280	
Cutch (catechu)	47–56	36–43	40–48	Hardwood box, wrapped in burlap.
Extract				Bales, 112 pounds.
Cut-outs, electrical appliance	80	25	28	
Cyanimid	40–50	40–50	45–56	Bags, 150–170 pounds.
Cylinders, automobile, motorcycle.	55	36	41	
Damar gum				Cases, 150–250 pounds.
Dasheen	48	42	47	Sold by the bushel.
Date-nut butter	40	50	56	Cases. 33 pounds.
Dates	26	76	86	In small boxes and cartons in cases, 30–140 pounds.
Degras, moellon. See Oil, Sod oil.				
Degras or wool grease	38	53	59	Barrels, 450 pounds.
Dental cabinets. See Cabinets.				
Dental chairs. See Chairs.				
Dental plaster	57–62	32–35	36–39	Barrels, 280–300 pounds; jute sacks, 100 pounds; paper sacks, 80 pounds; cans, 2–10–20 pounds.
Desiccated eggs. See Eggs.				
Desks, birch, mahogany, oak	42	48	53	
Office, flat-top	8.7	230	257	Crated, 30 cubic feet.
Roll-top	8	250	280	Crated with top removed from base, 45 cubic feet.
Dextrin				Sugar barrels, weight 300 pounds; bags, 220–280 pounds.
Dichlorbenzol	77	26	29	Iron drums, 50–110 gallons.
Dictaphone shaving machine (motor separate).	11	182	203	Package, 31 by 18 by 13 inches.
Dish-washing machines	6–12	167–333	187–373	
Ditch digger	40	50	56	24 by 24 inches by 14 feet
Divi-divipods	16–17	118–125	132–140	
Door hasps. See Hasps.				
Doormats, oilcloth or imitation	84	24	27	Crate of 100; 5⅛ by 19½ by 17½ inches.
Door springs. See Springs.				
Doors, asbestos. See Asbestos doors.				
Dough kneaders or mixers	10	200	224	
Dragon's blood				Cases, 100 pounds.
Draintile heads	50	40	45	Weight, 270 pounds.
Dry-battery shells	12–24	83–167	93–187	
Dry cells. Spent or worn-out	45	44	50	
Duck:				
Awning strips, width 31 inches				7½ ounces per linear yard; bales, 20 pieces, 50 yards to piece.
Narrow, width 6–20 inches				Rolls, 100 yards; bales, 4–5 rolls.
Number, width 26–144 inches				Rolls, 100 yards.
Sail, width 22 inches				7–19 ounces per linear yard; bales, 2 pieces, 100 yards to piece.
U. S. Army, width 28.5 inches				7–15 ounces per linear yard; bales, 400 pounds.
Dump-wagon bodies. See Wagons.				
Dump wagons. See Wagons.				
Dye, liquid pulp	70	29	32	Wooden barrels, 325–350 pounds.
Dyestuffs. See Alizarine; Annaline; Cutch (catechu); Gambier; Indigo paste; Liquid pulp dye; Sulphur black.				

Table of Unit Displacement of Commodities—Continued

Commodity	Weight per cubic foot	Space per short ton	Space per long ton[a]	How packed for shipment
	Pounds	Cubic feet	Cubic feet	
Dynamite				In pound sticks or cartridges. For packing directions see Interstate Commerce Regulations for the Transportation of Explosives, section 1555–1559.
Eggs:[c]				
Albumen	45	44	50	Soldered, tin-lined, heavy wooden, iron-strapped cases.
Desiccated	32– 47	43– 63	48– 70	Sugar barrels; 50-pound tin-lined square boxes; tin cans boxed.
Frozen, for bakers' use	50– 75	27– 40	30– 45	1-2-4, 15-pound cans, wrapped in heavy paper and boxed.
Yolks				Barrels, 24 by 34 inches; cases, 34.5 by 18 by 19 inches.
Electric Appliances. See Manufacturer's yearbooks, e. g., Western Electric Year Book, 1918.				
Electric cable. See Cable; Telephone cable.				
Electrolytic cells	23	87	97	
Elevator, plungers	42– 50	40– 48	45– 53	
Elevators, grain, portable	11	182	204	
Elfini				Cases, 150–200 pounds.
Elliptical springs. See Wagon springs.				
Emery paper. See Abrasive paper.				
Emery wheels. See Machine-shop equipment.				
Engine and gear parts, automobile	6– 40	50– 333	56– 374	Sizes, 15 by 13 by 7 inches to 54 by 62 by 12 inches.
Epsom salts				Barrels, 300 pounds net; kegs, 130 pounds net; wooden drums, 100 pounds net; bags, 300 pounds net.
Ethyl acetate	60	33	37	Iron drums, 50–100 gallon.
Fanning-mill seed cleaners	2– 7	289–1000	320–1120	
Farm wagons. See Wagons.				
Fasteners, wire-tag	20– 40	50– 100	56– 112	1000 in carton; weight, 2½ pounds; 100 cartons in a case; barrels; kegs.
Featherbone or quill fiber	20	100	112	Buddies, 1–2 pounds packed in boxes, 28 by 28 by 28 inches.
Feeders and grinders	6	333	373	
Felt, hair, for glass polishing	30– 35	57– 66	64– 75	
Fenules	36	56	62	
Fence stretchers	17– 25	80– 118	90– 132	
Fennel seed	20	100	112	
Fertilizers:				
Black	9	222	249	Barrels; burlap or canvas bags.
Double manure	80	25	28	
Kainit	85	24	26	
Manure	85	24	26	
Sylvinit	85	24	26	
Fiber. See Asbestos fiber; Bamboo fiber; Cornstalk fiber; Featherbone or quill fiber; Grass fiber; Manila fiber; Palm-leaf mattress fiber.				
Field coil. See also Armature coils.	90	22	25	
Figs	26	77	86	Mats or hampers; skeleton crates of small boxes, 350–550 pounds; bags, 28–60 pounds; baskets, jars, cartons, 35–100 pounds.
Film. See Moving-picture films.				
Filter paper				Tin-lined boxes, 4 by 3 by 3 feet; 5 cases, weight, 1056 pounds.
Fine tools. See Machine-shop equipment.				
Fire-alarm boxes	50	40	45	
Fireplaces, sheet iron or steel, nested	7	286	320	
Not nested	3	[illegible]	747	
Fish balls	40– 50	40– 50	45– 56	Cans; 150 cans to a case. Boxes, 25 by 19 or 14 inches; tin cans, boxed, 12 by 24 by 24 inches.
Fish glue. See Isinglass.				
Fish meal	40	50	56	
Fish roe, herring	20	100	112	Cases, 15 by 11½ by 9½ inches.
Flax straw	8	250	280	Bales, 20 by 21 by 46 inches.
Flint. See Silex silicia.				
Flint paper. See Abrasive paper.				
Flintstone or silex linings	170	12	13	
Flint stone pebbles	160	12	14	
Floats for gloss melting tanks	125	16	18	10–15 feet long.
Floor arches, stucco or paper	18	111	125	
Flour containers. See Containers for flour.				
Flour:				
Foundry				Bags, 140–150 pounds.
Potato	41	49	55	
Wheat	47	43	48	Bags.
Do	37	54	60	Barrels.
Wood. See Wood flour.				
Fly nets for horses, cotton yarn	12	170	187	
Fly swatters	24	83	93	12 in box; 12 boxes in carton, 32 by 9 by 7.3 inches.
Folding benches. See Benches.				

[a] Standard egg crate holds 30 dozen. Sides, tops, bottoms of ⅛ inch veneer from whitewood or cottonwood; ends and centers ⅞ inch; length of sides 25 by 12.5 inches; tops and bottoms 26 by 12¼ inches; ends and centers 11⅝ by 12⅝ inches; 4 cleats used, 11⅜ by 1⅛ inches; thickness ⅛ inch.

Table of Unit Displacement of Commodities—Continued

Commodity	Weight per cubic foot	Space per short ton	Space per long ton	How packed for shipment
	Pounds	Cubic feet	Cubic feet	
Folding chairs. See Chairs.				
Fonugreek seed meal	45	44	50	Bags; barrels, 200 pounds.
Food-preserving compounds	8– 50	40– 250	45– 280	Cans, boxed; bulk in boxes or crates; barrels.
Fossil flour	24	83	93	Bags, 100 pounds.
Foundry flour. See Flour.				
Frankincense. See Olibanum gum.				
Fresh fruits. See Appendix No. 3.				
Frozen eggs. See Eggs.				
Fruit-jar rings	20– 30	66–100	75–112	Fiber-board boxes, 14 by 20 by 12 inches, 14 by 14 by 20 inches, 21 by 13 by 10 inches, 14 by 18 by 10 inches, and 19 by 25 by 10 inches; 50 gross in box, 36 by 20 by 15 inches.
Fruit pectin	47	43	48	5-gallon square tins; 2 tins in wooden case, 22.5 by 11 by 15.5 inches.
Fur, hatters'	30	66	75	2–5 pound bags; cases, 60–80 bags; package, 33 by 40.5 by 51.5 inches; bales, 100–300 pounds.
Furnace casings or jackets, iron or steel, asbestos lined.	25– 85	24– 80	26– 90	Knocked down.
Furnace cement	42–130	15– 48	17– 53	Barrels; half barrels; kegs; cans.
Furnaces:				
Assayers' clay	16	125	140	Weight, 260 pounds gross.
Charcoal				Average weight, 20 pounds; 10 inches high, 12 inches wide.
Metal, melting, on wheels	12– 30	66–167	75–187	
Plumbers' or tinners'	13	154	172	
Soldering	18	111	124	Corrugated strawboard case, 13 by 13 by 17 inches; wooden crate, 9 by 12 by 26 inches.
Fuse wire	150	13	15	On spools packed in tin containers packed in boxes.
Fustic, extract of				Barrels, 550 pounds.
"G" gum	35– 40	50– 57	56– 64	Barrels, 200 pounds net; kegs, 100 pounds net.
Galvanizing solution	9	222	249	
Gambier				Pressed in bales, 230 pounds; small cubes, 1 inch, packed in boxes, 2–300 pounds.
Gamboge				Cases, 100 pounds.
Garbage cans	6– 8	250–333	280–373	16-gallon, 15 inches diameter, 26 inches high; 24-gallon, 18 inches diameter, 26 inches high; 32-gallon, 21 inches diameter, 32 inches high.
Garment hangers	38	53	59	
Gas burners, incandescent	10– 15	133–200	149–224	
Gas drips, hydrocarbon	52	38	43	
Gas globes	4– 7	286–500	320–560	
Gas mantles and parts:				
Fabric	12	167	187	Paper boxes packed in wooden cases, 24 by 24 by 24 inches; 6000 or 7000 packed in a case.
Gas or lamp mantles	9	222	249	Double-faced corrugated boxes, 21 by 21 by 18 inches; case, 1000 inverted mantles, 34 by 25½ by 22 inches; case, 1000 upright mantles, 38 by 25½ by 19 inches.
Rings	18	110	124	Cardboard boxes packed in wooden cases, 19 by 20½ by 20½ inches.
Wires	32– 45	44– 63	50– 70	Tied in bundles, shipped in barrels 22 inches diameter, 28 inches high.
Gas-purifying compounds	33– 35	57– 61	64– 68	Iron drums; wooden boxes, 3 by 3 by 3 feet; casks, 30 inches diameter, 42 inches high; sugar barrels.
Gas-purifying compounds for acetylene gas.	45– 50	40– 44	45– 50	
Gaskets:				
For manhole and handhole plates on boilers.	75	27	30	Pasteboard boxes packed in crates or cases.
For steam-engine packing	60	33	37	Boxes; cases; fiber packages.
For steam-fitting work	29	69	77	Cases.
Gasoline-pressure tanks	8– 10	200–250	224–280	
Gatto gum (Ghatti)	28	71	80	Bags, 112 pounds.
Gauze. See Cheesecloth.				
Gelatin:				
Broken pieces	10	200	224	Package, 3½ by 5 by 10 inches.
Flake or sheet	17– 25	80–117	90–132	Casks, 265–315 pounds; kegs, 61 pounds.
Ground	34– 38	53– 59	59– 67	Barrels, 276–335 pounds.
Do	26	77	86	Kegs, 91 pounds.
Do	24	83	93	Boxes, 35 pounds.
Sheets	33– 42	48– 61	53– 97	
Shredded	15	133	149	Casks, 185–215 pounds; barrels, 100–150 pounds; keys, 36 pounds.
German-silver ingots	215	9 3	10	
Ginger, ground	20	100	112	Boxes; drums.
Glass, powdered	75	27	30	Bags, 250–500 pounds.
Glass-faced brick. See Brick.				
Glass-factory bootlegs	70	29	32	180 pounds each.
Glass-flattening stones	154	13	15	Dimensions, 48 by 69 by 5 inches to 84 by 100 by 5 inches.
Glass goblets. See Goblets.				
Glassware, fish globes	9– 14	143–222	160–249	
Towel rods	25	[illegible]	90	
Glazier lead. See Lead.				
Gloves and mittens	15	133	149	1 dozen bundles or paper cartons packed in wooden boxes, fiber containers, or cases, average 36 by 40 by 40 inches.

Table of Unit Displacement of Commodities—Continued

Commodity	Weight per cubic foot	Space per short ton	Space per long ton	How packed for shipment
Glue:	Pounds	Cubic feet	Cubic feet	
Dry	27	74	83	Bags; barrels.
Flake form	33–50	40–60	45–68	Bags, 150 pounds; barrels, 350–500 pounds.
Powdered	38	53	59	Bags, 100 pounds.
Fish glue	78	25	29	Barrels; kegs; cans; bottles.
Liquid or jelly	50–55	36–40	41–45	Jelly glue in cakes semisolid, 8 inches square, 3 feet long.
Gluten feed	40	50	56	
Gluten meal	39	51	57	
Glycerin	60	33	37	Cans packed in boxes, 50 pounds.
Goblets				Barrels, 100–135 pounds.
Grain baggers	9	222	249	
Grain elevators	11	182	204	
Granulated lead. See Lead.				
Graphite brick. See Brick.				
Graphite or plumbago stoppers	68	29	33	Tight hardwood, 55-gallon barrels.
Graphotype	57	35	39	Boxes, 21 by 23 by 25 inches; crates, 25.5 by 36 by 50 inches.
Grass fiber	20	100	112	Parcels, 5 pounds each, then compressed.
Grating, air-duct	15–25	80–133	90–149	
Griddle holders, asbestos	16	125	140	Cases; crates; boxes.
Griddles, asbestos	17	118	132	Cases.
Griddles, soapstone	53–80	25–38	28–42	1 dozen griddles 8 by 16 inches, case 20.5 by 12 by 10.5 inches; 1 dozen griddles 9 by 18 inches, case 20.5 by 11 by 14.5 inches; 1 dozen griddles 14 by 14 inches, case 14.5 by 14.5 by 14.5 inches.
Grinding wheels, carborundum	140	14	16	Stout boxes; barrels; kegs, packed with sawdust.
Corundum or emery	150	13	15	Do.
Grits	37	54	61	Sacks; bags.
Brewers'	40	50	56	Burlap bags, 100 pounds.
Refined	52	38	43	Bags, 100–140 pounds.
Grommets	51	39	44	Boxes; barrels.
Guayule resin grease (Malagum).	60	33	37	Oil barrels.
Guiac gum				Barrels and cases, 100–450 pounds.
Gum arabic	32–35	57–63	64–70	Bales, 35 by 25 by 14 inches and larger.
Gun-barrel tubes	66–85	24–30	26–34	100–120 in box, 13½ by 14½ by 40 inches.
Gun barrels:				
Autoguns	25	80	90	10 in case, 36.5 by 15 by 16 inches.
Autorifles No. 1	35	57	64	10 in case, 25.5 by 16.5 by 13.5 inches.
High-power rifles	36	56	62	10 in case, 30 by 15½ by 10½ inches.
Pump guns	30	67	75	10 in case, 34 by 16 by 12.5 inches.
Single-shot rifle No. 4	33	60	68	10 in case, 25.5 by 15 by 10 inches.
Single-shot rifle No. 6	40	50	56	10 in case, 23 by 13 by 8 inches.
Gun butt plates, imitation rubber.	10–15	133–200	149–224	
Gun wads, felt	14–19	105–143	118–160	
Gutta-percha	75	27	30	Bottles; jugs; cases.
Gypsum. See also Silesian white.	85	24	26	
Hair, cattle	5–7	286–400	320–448	Wooden boxes, 48.5 by 27.5 by 30 inches; some in strawboard boxes.
Haircloth:				
Camel's-hair press	45	44	50	Rolls, 15 inches wide, 4–4½ feet diameter, wrapped in burlap.
Crinoline	22	91	102	Cases, 46 by 29 by 27 inches.
For coat fronts	20	100	112	Bales, 24 by 12 by 6 inches.
Haircloth clippings	17–26	77–118	86–132	Bags; compressed bales, 500–700 pounds.
Hair, human, waste	40–50	40–50	45–56	Bales, 45 by 24 by 18 inches.
Halloysite	100	20	22	
Hame sticks	32	63	70	Sacks, 16 pounds.
Hammers:				
Blacksmiths' hand	47	43	48	½ dozen in box; 6 dozen in case, 33.5 by 20.5 by 13 inches.
Carpenters' claw	50	40	45	Case, 23 by 16 by 11 inches.
Cast-iron shingling	50	40	45	Do.
Riveting	50	40	45	Do.
Setting	50	40	45	Do.
Hammocks, couch	9	222	249	Each folded flat, baled in burlap 6 by 30 by 72 inches.
Handles:				
Bamboo	12	167	187	42 inches long.
Brown, with metal brown holder.	6.5	308	345	Crate, 44.5 by 24 by 4.5 inches.
Sadiron	39	51	57	
Wire handles and bails	90	22	25	
Wooden broom	25–30	67–80	75–90	
Hand planes. See Machine-shop files and rasps.				
Hand trucks, four-wheeled	29	69	77	Body, knocked down, in package, 120 by 40 by 20 inches. Wheels in separate crate.
Two-wheeled				Body, knocked down, package 6 by 72 by 36 inches or 8 by 19 by 35 inches. Wheels in separate package, 36 inches diameter.
Handsaws. See Machine-shop files and rasps.				
Hard salts. See Sylvinit				
Harisalz	85	24	26	Bags, 200 pounds.
Rasps and hooks combined	60–70	29–33	32–37	3 dozen in paper cartons, packed in cases, 21 by 13.5 by 12.5 inches
Hat bodies:				
Buckram	11	182	204	Bags.
Felt	21	95	107	Do.
Straw	6–8	250–333	280–373	Burlapped bales, 10–12 in box.
Hats and caps	10–13	154–200	172–224	Crates; barrels

Table of Unit Displacement of Commodities—Continued

Commodity	Weight per cubic foot	Space per short ton	Space per long ton	How packed for shipment
	Pounds	Cubic feet	Cubic feet	
Hatchets	31–40	50–65	50–72	2 dozen in case, weight 90 pounds; 4 dozen in case, weight 140 pounds; 6 dozen in case, weight 180–200 pounds.
Hatters' fur. See Fur.				
Headlights:				
Acetylene, sheet steel body	10	200	224	
Electric, for locomotives, sheet-iron body.	7	286	320	
For street cars, cast-iron body.	20–29	69–100	77–112	
For street cars, sheet-iron body.	16–25	80–125	90–140	
Incandescent, cast-iron body.	25	80	90	
Oil, sheet steel	10	200	224	
Heaters:				
Feed water with metering attachments.	40–50	40–50	45–56	
Locomotive superheaters	30	67	75	Knocked down, weight 750–1250 pounds.
Water, gasoline or oil	15	133	149	2 parts, 1 crate, 23⅝ by 20 by 11⅝ inches; 1 box, 28½ by 16½ by 13⅛ inches.
Hemp yarn. See Yarn.				
Hinges:				
Brass automobile	110–190	10–20	12–20	Package, 1.07–1.6 cubic feet.
Common brass butts	50–730	3–40	3–45	Package, 0.6–2.38 cubic feet; barrels.
Composition continuous	264–300	7–8	7–8.5	Package, 0.23–0.26 cubic feet.
For hanging doors, screens, etc.	154	13	15	Paper cartons, packed in box, 21½ by 13½ by 9 inches.
Hockey sticks. See Sporting goods.				
Hoists, chain	47	43	48	Box, 17 by 27 by 36 inches.
Hay press	48	42	47	
Homogenizers, for dairy plants	38	53	59	3 feet 6 inches by 5 feet 5 inches by 3 feet.
Honey, comb	55	36	41	Case of 24 frames, 4½ by 4½ by 1⅞ inches.
Strained				Two 5-gallon cans to the case; weight, 140 pounds.
Hoods or canopies for stoves	4	500	560	
Hooks and eyes, dressmaking	19	105	118	
Hopper gates	45	44	50	
Horntips	73	27	31	Bags, 225 pounds.
Horse blankets, shoddy	26	77	86	
Horse collars	9–10	200–222	224–249	Bales of 1 dozen, oval shape, average size, 20 by 24 by 48 inches.
Hose couplings, brass	26	77	86	Package, 14 by 14 by 10 inches.
Hot-water bottles, metal	14	143	160	
Hot-water radiators. (See Radiators.				
House-moving trucks	31	65	72	Knocked down; complete outfit; weight, 500–1700 pounds.
Hydraulic cement. See Cement, Puzzolan.				
Hydrochloric acid				Carboys, 18° B., 125 pounds net; 208 pounds gross; 20° B., 128 pounds net, 211 pounds gross; 22° B., 131 pounds net, 214 pounds gross.
Hydrofluosilic acid	84	24	27	Barrels; tank cars.
Hydrol	76	26	29	Barrels, 33½ inches high, 25½ inches diameter.
Ice-cream can linings	28	71	80	
Incinerators, garbage:				
For consuming matter by coal fire.	34	59	66	Crated, 4 feet high, 2 feet diameter.
McCall's, adopted by U. S. Army.	22	87	97	
Square, large size	8	250	255	Crated, 30 inches square, 5 feet high.
Small size	17	117	132	Crated, 18 inches square, 4 feet high.
Indigo pastes, synthetic				Barrels, 500 pounds.
Injectors	40	50	56	Boxes.
Inkstands, earthenware	43	47	52	
Insecticides:				
Fly and germ killer	35–60	33–57	37–64	5-gallon cans, jacketed; 1 dozen gallon tins, boxed, 22 by 17 by 12 inches.
Lead arsenate	47	43	48	Barrels; wooden pails, crated; glass or stoneware in fiber cases.
Lead arsenate, paste	135	15	17	
Lime and sulphur combination.	35–46	43–57	49–64	Barrels; fiber or veneer drums; cans; glass and stoneware containers.
Sheep dip	41	49	55	5-gallon cans heavily crated, 12 by 9 by 14 inches.
Insulating compounds	30–100	20–67	22–75	Casks; barrels.
Insulating material, hemp fiber	12	167	187	
Insulators, joint	75	27	30	Boxes.
Invalids' bed rests	15	133	149	½ dozen in crate, 9 by 28.5 by 30 inches.
Invalids' or wheeled chairs, folded.	5–8	250–400	280–448	Folded.
Knocked down	12	164	186	Knocked down flat.
Iron acetate	81	25	28	Barrels, 43–48 gallons.
Iron chloride, dry	62	32	36	Barrels; jars; bottles.
Liquid	55–88	23–36	25–41	Carboys; demijohns; bottles.
Iron-cleaning compound	53	38	42	
Iron nitrate. See Copperas, nitrate of iron.				

Table of Unit Displacement of Commodities—Continued

Commodity	Weight per cubic foot	Space per short ton	Space per long ton	How packed for shipment
	Pounds	Cubic feet	Cubic feet	
Iron, powdered, concrete hardener.	164–200	10– 12	11– 14	Bags, 50–100 pounds; kegs; barrels; casks.
Ironite	164	12	14	Bags, 100 pounds.
Ironing boards	21	95	107	1 dozen in 2 packages; also flat in bundles of 2, 15 by 6.5 by 58.5 inches.
Ironing table	25	80	90	Knocked down.
Ironite. See Iron, powdered.				
Isinglass	24	83	93	Case, 19 by 19 by 39 inches; half case, 19 by 19 by 26 inches.
Jail cots. See Cots.				
Juniper berries, dried				Sacks, 125 pounds.
Jute bags and waste	15	133	149	Bags or bales, machine pressed.
Kainit	85	24	26	Bags, 200 pounds.
Kapok fiber	2– 13	154–1000	172–1120	Compressed bags, 5 feet 6 inches by 3 feet by 2 feet 6 inches. Compressed bales, single, 2 by 2 by 2 feet; double, 2 by 2.5 by 4 feet; triple, 2 by 3 by 4 feet.
Karaya gum	31	65	72	Sugar barrels; boxes, 20 by 14 by 12 inches and 15 by 11 by 9 inches.
Keene cement	50	40	45	Jute bags, 100 pounds.
Keg, standard, nail				16 by 12 by 11 inches; tare, 8 pounds.
Kino gum				Cases, 100–200 pounds.
Kola nuts				Barrels, similar to sugar barrels, 300–315 pounds.
Kowrie gum				Bags and cases, 150–300 pounds.
Lac gums. See Shellac.				
Lac refuse				Bags, 164 pounds net.
Lactic acid	30	67	75	Barrels, 52 gallons.
Lamp guards, nested	25– 30	67– 80	75– 90	Nested
Not nested	7– 10	200– 286	224– 320	
Lamp mantles. See Gas mantles.				
Lamp sockets, for electric lamps	34	59	66	
Lamps	18	111	124	
Lamps, automobile. See Automobile.				
Lanolin	45	44	50	Packed in tins, 140 pounds per case.
Lanum	45	44	50	Do.
Lap links or rings	150–250	8– 13	9– 15	Barrels; boxes.
Lard, benzoinated. See Benzoinated lard.				
Lard oil. See Oil; Tallow.				
Lasts or last stands	60– 80	25– 33	28– 37	
Lathing	34	59	66	
Lathing, cellular	15	133	149	
Tarred paper, wire interwoven.	20	100	112	
Laundry blue, dry powder or crystals.	50	40	45	
Laundry starch. See Starch.				
Lead:				
Bars	228	9	10	Boxes, 15 by 7½ by 6½ inches; kegs, 21.5 inch staves by 12 inches diameter.
Dust	40	50	56	
Glaziers				On reels, various sizes, boxed.
Granulated	400	5	5.6	Bags, 25–50–100 pounds.
Ingot				Wired in bundles, 100 pounds.
Sheet				Rolls, slatted; boxes.
Wool	93–111	18– 22	20– 24	Bags, 12 by 12 by 6 inches; reels, 12.5 inches diameter, 15 inches high.
Lead arsenate. See Insecticide.				
Lead bars. See Lead.				
Lead concentrates	275	7	8	
Lead-covered telephone cable. See Telephone cable.				
Lead linoleate				Barrels, 400 pounds.
Lead pipe	47	43	48	Barrels, 300 pounds.
Do	35– 65	31– 57	34– 64	Box, 6 by 6 by 95 inches to 18 by 36 by 36 inches.
Do	66– 92	22– 30	24– 34	Crates, 6 by 28 by 28 inches to 7 by 18 by 120 inches.
Do				Casks, 39 by 144 inches, weight 1875 pounds, to 40 by 42 inches, weight 1100–1200 pounds.
Do				Reels, 29 by 30 inches, weight 1200 pounds, to 21 by 31 inches, weight 585 pounds.
Do				Coils in straw, 7 by 32 inches, weight 200 pounds, to 40 by 40 inches, weight 240 pounds.
Do	65	31	34	Wire covered.
Lead sulphate	118	17	19	Wooden barrels; steel kegs; pails; drums.
Lead wire	63–170	12– 42	13– 47	On reels, 11 by 10 inches to 20 by 24 inches.
Do	143	14	16	Barrels, 36 by 24 inches.
Do	84–224	9– 24	10– 27	On spools, crated, 9 by 9 by 9 inches to 16 by 16 by 18 inches.
Lead wool. See Lead.				
Leads, printers'. See Printers' leads.				
Leather:				
Artificial	30	67	75	Cases, 55 by 16 by 15 inches; bales not over 60 inches long.
Board	36	56	62	Slat bundles, 50 pounds each.
Stam	75	27	30	Barrels, 50-gallon.
Softener	67	30	33	5-gallon tin cans with a wooden jacket.
Lenses, lighthouse	14	143	160	Boxes, 45–60–70–85 cubic feet.
Levels, railroad track	18	111	124	Boxed.
Library paste. See Paste.				

Table of Unit Displacement of Commodities—Continued

Commodity	Weight per cubic foot	Space per short ton	Space per long ton	How packed for shipment
	Pounds	Cubic feet	Cubic feet	
Licorice root, spent	47	43	48	Used for fuel purposes.
Lightning arrester, electric	20	100	112	5-gallon carboy, 13 by 15 by 31 inches; 10-gallon carboy, 19 by 21 by 35 inches; 15-gallon carboy, 20 by 21.5 by 40 inches.
Lignin liquor (called also Sulphite pitch, Glutrin, Spruce extract, and Lignosite).	77	26	29	
Lime	32	63	70	Barrels, holding 5 bushels.
Acetate (acetate of calcium)				Sacks, 140 pounds.
Nitrate. See Calcium nitrate.				
Nitrogen	60	33	37	Tank cars; drums; barrels; packages 100–1000 pounds.
Limestone, ground	85–115	17– 24	19– 26	Barrels, 417 pounds; burlap bags, 100–200 pounds; paper bags, 100 pounds.
Lincrusta	28	72	80	Bundles, 10 inches diameter, 21 inches long, wrapped in heavy paper, ends reinforced.
Lining, crinkled paper or fiber	27	74	83	Wood and fiber-board cases, 7 sizes, 7 by 11 by 40 inches to 22 by 40 by 21.5 inches.
Shoddy	18– 20	100–111	112–124	Exclusively in machine-pressed bales, 42 by 32 by 28 inches.
Linoleum cement	54– 70	29– 37	32– 41	Cakes, 36 by 20 by 3.5 inches; bags, 2 cakes; 5-gallon cans, crated, 14½ by 10½ by 10½ inches.
Linseed cake	60	33	37	Bags, 300 pounds.
Linseed-oil soap. See Soap.				
Litharge	200	10	11	Barrels, 500–800 pounds.
Litters. See also Stretchers	11	182	208	Litters detached and crated or boxed, 24 by 27 by 75 inches; carriage frame, crated, 28 by 28 by 65 inches.
Loading coil. See Telephone transformer.				
Locks. See Machine-shop equipment.				
Locomotive axles. See Axles.				
Logwood extract	15	133	149	Cotton bags, paper lined; boxes of solid extract, 20–150 pounds; barrels of liquid extract, 510 pounds.
Machine guns	27	74	83	
Machine-shop equipment:				
Anvil tools	240	8	9	
Carpenters' chisels	80	25	28	
Carving knives	16– 20	100–125	112–140	
Emery wheels	90	22	25	
Files and rasps	100	20	22	Wooden cases, 16 by 24 by 12 inches.
Fine tools	30– 50	40– 67	45– 75	
Hand planes	55	36	41	
Handsaws	25	80	90	
Hatchets	35	57	64	
Locks	80–100	20– 25	22– 28	
Pocket knives	90	22	25	
Rasps	30	67	75	
Rules	75	27	30	
Try squares	55	36	41	
Magnesia cement	20	100	112	Bags, 3.5 cubic feet.
Magnesium:				
Chloride	26	77	86	Bottles, 5-pound, 1-pound, and smaller; jars, 25–37.5 pounds
Ingots	8– 10	200–250	224–280	Boxes, 100 pounds.
Powder	6	338	373	Cans, 10 pounds.
Malted clams. See Clams.				
Malted milk. See Milk, malted.				
Manganese:				
Chloride	60– 62	32– 33	36– 37	Barrels, average 70 pounds.
Linoleate				Barrels, 400 pounds.
Oxide, black	120	17	19	Sacks, bags, 200 pounds; imported in 1000-pound barrels.
Resinate	12	160	178	Barrels, 180 pounds.
Mangers, feed boxes, or troughs, cast iron.	70	29	32	
Sheet iron	7	286	320	
Mangrove bark. See Tanning extract.				
Manila fiber	30	67	75	
Manila gum				Bags, 150–200 pounds.
Mantles. See Gas mantles.				
Manure salts. See Sylvinit.				
Maple sugar. See Sugar.				
Marbles, steel	107	19	21	
Marine lights, for life buoys	25– 30	67– 80	75– 90	
Mariola gum				Barrels; kegs; burlap bags; boxes.
Mastic				Cases, 100–200 pounds.
Match blocks	22	91	102	Cases, 31 by 25.5 by 22 inches.
Mattocks	36– 50	40– 56	45– 62	1 dozen in box, 32 by 13 by 10 inches; 2 dozen in box, 3.2 cubic feet.
Mattress, wire, woven or linked				Barrels, 300–500 pounds.
Mazam	16	125	140	Bags, 100 pounds.
Meal:				
Corncob	18	111	124	
Gluten. See Gluten meal.				
Peanut. See Peanut meal.				
Meal containers. See Containers for flour and meal.				
Meal cutters	23	87	97	Require 10.6 cubic feet each.
Mercury				Steel flasks, 90 pounds.
Metal-purifying compounds	115	17	19	Loose; kegs, 100 pounds; barrels, 700 pounds.

Table of Unit Displacement of Commodities—Continued

Commodity	Weight per cubic foot	Space per short ton	Space per long ton	How packed for shipment
Metal shingles. See Shingles.				
Metallic cement	Pounds 100	Cubic feet 20	Cubic feet 22	Heavy tin cans, sealed and boxed in heavy wire-bound cases; weight full case, 400 pounds.
Do	50- 80	25- 40	28- 45	Wooden barrels; kegs; steel cans.
Meter tanks:				
14-gage	10	200	224	
16-gage	14	143	160	
20-gage	36	56	62	
Cast	48- 64	31- 42	35- 47	
Methyl acetate	59	34	38	Iron drums, 50-100 gallons.
Milk, malted	30- 55	36- 67	41- 75	Steel drums, 29.5 inches high, 21 inches diameter; glass containers packed in excelsior in sugar barrels.
Powdered	47	43	48	Oiled paper-lined barrels, 200 pounds; tin-lined wooden boxes, 59 pounds; cases of 24 1-pound cans, 12 5-pound cans, and 6 10-pound cans.
Milking machines	10- 15	133-200	149-224	
Millboard, asbestos. See Asbestos millboard.				
Milling machinery:				
Bolting and scalping reels	7- 15	133-286	149-320	
Bolting and scalping sieves	50	40	45	Knocked down.
Do	5- 20	100-400	112-448	Set up.
Bran duster, upright	4- 19	105-500	118-560	
Bran dusters, horizontal	14- 28	71-143	80-160	
Corn degerminators	35- 85	24- 57	25- 64	
Corn shellers and cleaners, combined.	5- 12	167-400	187-448	
Feed-brake governors	20- 30	67-100	75-112	
Flour aging or bleaching machine agitators.	14- 17	118-143	132-160	
Flour, feed, or meal feeders and mixers.	4- 15	286-500	320-560	
Flour and meal packers	8- 29	69-250	77-280	
Germ separators	7.5	267	299	
Heaters, steamers, and temperers.	15- 40	50-133	56-149	
Meal coolers	4.5	444	498	
Meal driers	20- 30	67-100	75-112	
Oat and rice clippers	6- 8	250-333	280-373	
Rice hullers	15- 25	80-133	90-149	
Rice hullers and polishers combined.	15- 25	80-133	90-149	
Rice polishers	15- 20	100-133	112-149	Knocked down.
Do	9	222	249	Set up.
Mimeograph ink	55	36	41	Tin cans, 4½ by 3½ by 2½ inches.
Mittens. See Gloves.				
Moellon degras. See Oil; Sod oil.				
Mohair in grease	8- 10	200-250	224-280	Bales and sacks, 180 pounds.
Molasses	53- 88	23- 38	25- 42	Tin cans, boxed; barrels; half barrels; kegs; tank cars.
Molasses carbon residue				Bags, 200 pounds.
Monazite sand	125	16	18	Canvas sacks, 100 pounds.
Monel-metal ingots	558	3.6	4	Vary from 100-1600 pounds.
Monel-metal wire	554	3.6	4	Barrels; coils.
Monochlorbenzol	35	57	64	Iron drums, 50-110 gallons.
Mop yarn, cotton	14- 20	100-143	112-160	In skeins and on tubes pressed in bales, wrapped in paper, and covered with burlap, 48 by 30 by 24 inches; skeins, 34 by 38 by 28 inches; tubes, 29 by 24 by 14 inches.
Mordant	30	67	75	
Mosaics				10 pounds per square foot.
Mother-of-pearl shell. See Pearl shells and also Sea shells.				
Motorcycle:				
Cylinders. See Cylinders.				
Mud guards	36- 43	47- 56	52- 62	Crates, 36 by 38½ by 8½ inches to 38 by 33 by 9½ inches.
Package carriers	9	222	249	Crates, 52 by 65 by 51 inches.
Motorcycle side cars	5.6- 7.3	274-357	307-400	Crates, 44 by 36 by 31 inches to 62 by 32 by 31 inches.
Motorcycles	6- 17	118-333	132-373	Dimension crates, 83 by 36 by 12 inches to 100 by 43 by 25 inches.
Moving picture:				
Booths	36- 40	50- 55	56- 62	Knocked down.
Films	17- 24	83-118	93-132	Average wooden case, 20 by 10 by 20 inches.
Reels	25- 87	23- 80	26- 90	
Mussel shells	100	20	22	
Mustard bran	33	61	68	2-4 bushel bags.
Mustard cake	60	33	37	3-bushel bags; burlap bags, 200 pounds.
Myrobalan. See Tanning extract.				
Myrrh gum				Cases, 100-200 pounds.
Nail keg, standard				Dimensions: 16 by 12 by 11 inches; tare weight, 8 pounds.
Nail pullers	75	27	30	
Nails, tree	59	34	38	
Zinc shoe	128-143	14- 16	16- 18	Boxes, 15 by 12 by 8 inches.
Naphtha and toluol and xylol	67- 70	29- 30	32- 33	
Nickel:				
Anodes	200	10	11	Barrels; boxes, different sizes.
Crude	384	5.2	5.8	Slabs, 6 by 15 by 2 inches.
Shot	283-313	6.4- 7.1	7.2- 7.9	Kegs, 100-1000 pounds.
Nitrate-soda-sulphur mixture	50	40	45	

Table of Unit Displacement of Commodities—Continued

Commodity	Weight per cubic foot	Space per short ton	Space per long ton	How packed for shipment
	Pounds	Cubic feet	Cubic feet	
Nitric acid				36° B., 226 pounds; 38° B., 228 pounds; 40° B., 230 pounds; 42° B., 232 pounds; 44° B., 234 pounds.
Nitro and cellulose	30	67	75	Zinc-lined wooden containers, 30 by 16 by 40 inches.
Nitroxylene, liquid	66	30	34	Iron drums, 32 inches diameter, 41 inches long.
Nut meats, sweetened and salted pecans.	23	87	98	Corrugated cartons; boxes; barrels.
Nutgalls	28- 62	32- 72	36- 80	Packages, 4-9 cubic feet.
Oars, boat, long	22	91	102	6 cubic feet.
Short	25	80	90	12 cubic feet.
Oil:				
Albasol	75	27	30	50-gallon barrels.
Amber	50	40	46	In tanks or tank cars.
Anise seed	62	32	36	Do.
Battery	56	36	40	Barrels; glasses, boxed.
Camphor	57	35	39	In tanks or tank cars.
Castor	61	33	37	2-5 gallon cans, 10 by 20 by 15 inches; 4-5 gallon cans, 21 by 21 by 16 inches.
Coal-tar	62	32	36	Metal cans in boxes; barrels.
Coconut	58	35	39	In tanks or tank cars.
Cod-liver	56	36	40	2-5 gallon can cases; 30-gallon tin-lined barrels.
Cooking	56	36	40	
Corn, refined	30- 68	29- 67	33- 75	5-10 gallon containers; fiber-board containers of 48-5.5 ounce bottles.
Solidified	60	33	37	Barrels, 33½ inches high, 25½ inches diameter.
Cotton-seed, liquid	58	35	39	In tanks or tank cars; barrels.
Solidified	55	36	41	Bags; barrels.
Creosote	64	31	35	Flat-top cans, ½, 1, 2, 3, 4, 5, 6, 8, or 10 gallon.
Fish	56	36	40	
Harness	56	36	40	52-gallon barrels.
Japan	57- 69	29- 35	32- 39	52-gallon barrels; cans; tank cars.
Lavender	53	36	41	In tanks or tank cars.
Lemon	49	41	46	
Linseed	59	34	38	Barrels; tanks; tank cars.
Miscellaneous refined:				
Burning	50	40	45	Cases 2-5 gallon cans, in nailed or wire-bound yellow or white pine boxes and in gum boxes.
Gasoline and naphtha	46	44	49	
Lubricating	55	36	41	
Mustard seed	55	36	41	Barrels, 3.5 feet high, 3 feet diameter, and larger 60-gallon barrels.
Mystic. See Rosin.				
Neat's-foot	55	36	41	
Oleo	55	36	41	
Olive	57	35	39	Tanks; tank cars.
Paint. See Oil, regal paint.				
Palm	57	35	39	Tanks; tank cars; hogsheads, 40 inches diameter and 45 inches diameter.
Peanut	56	36	40	Quart, half-gallon, gallon, and 5-gallon tins; small, medium, and large bottles.
Pine	54	38	42	50-gallon barrels; tank cars.
Pine tar	62	32	36	Do.
Rapeseed	40-57	35- 50	39- 56	Barrels, 35 inches long, 26 inches diameter. For sanctuary purposes, in 5-gallon tin cans, boxed, and cases of 2 dozen 24-ounce cans.
Red	55	36	41	Tank cars; barrels, 450 pounds; half barrels.
Refined. See Miscellaous refined.				
Regal paint	61	33	37	50-gallon barrels.
Resin	60	33	37	Tanks; tank cars
Road	54	38	41	
Sesame	32-46	44- 63	49- 70	Glass bottles, cased.
Sod. See Moellon degras.				
Soya bean	55	36	41	
Spirtine or spiritine	69	29	32	Barrels.
Tallow	55	36	41	Tierces, 462 pounds; barrels, 440 pounds.
Turpentine	60	33	37	Tanks; tank cars.
Valerian	55	36	41	Do.
Wood tar. See Creosote.				
Wool and wax paraffin	49- 55	36- 41	41- 46	
Oil barrels:				
13-gage metal barrels				Weight over 100 pounds each.
16-18 gage metal barrels				Weight over 78 pounds each.
Wooden barrels				Weight over 72 pounds each.
Oil cake, peanut	45- 56	36- 44	40- 50	Bags.
Oilstones. See Whetstones.				
Oil strainers	79	25	29	
Oil-wagon tanks. See Wagons.				
Oiled clothing				Long coats or slickers, 1 dozen to a case, 11 by 17 by 31 inches; jackets and pants, 24-50 garments, 11 by 17 by 31 inches; hats, 25 dozen to a case, 11 by 17 by 31 inches; 20 horse covers or 50 jackets or pants, case, 15 by 30 by 30 inches.
Oilers, ice, cast iron	40	50	56	
Sheet iron	8	250	280	

Table of Unit Displacement of Commodities—Continued

Commodity	Weight per cubic foot	Space per short ton	Space per long ton	How packed for shipment
	Pounds	Cubic feet	Cubic feet	
Olein	60	33	37	Cans, in 100-pound cases; barrels, 26 inches diameter, 33 inches high; drums, 24 inches diameter, 33.5 inches high.
Oleomargarine	32- 45	44- 61	50- 70	Bulk, in tubs, 14 by 16 by 16 inches; in tierces, 25 by 25 by 34 inches; in cartons, in boxes, 15 by 11 by 8.5 inches; in bricks, in boxes, 16 by 14 by 6 inches; in rolls, in boxes, 16 by 14 by 8.5 inches; in cans, as boxes, 12 by 21 by 22 inches. in
Olibanum gum				Bags and cases, 100-200 pounds.
Onions	32- 36	56- 63	62- 70	Bushel baskets; crates; bags.
Onyx, unfinished	167-180	11- 12	12- 13	In rough blocks of ½ ton to 10 tons, received from the quarry.
Operating chairs. See Chairs.				
Ore milling and smelting machinery:				
Accumulators	35	56	64	Set up; exported knocked down.
Agitators	30- 40	50- 67	56- 75	
Amalgam safes	20	100	112	
Amalgamating barrels	39	50	57	86 cubic feet per barrel.
Bin gates	55	36	41	
Cages	8	250	280	Set up; knocked down for export.
Chlorination barrels	75	26	30	
Classifiers	50	40	45	
Clean-up barrels	39	50	57	86 cubic feet per barrel.
Concentrating tables	22	90	102	Knocked down.
Concentrator table or vanning machine frames, iron, steel, or wood.	12- 40	50-164	56-186	
Converters (copper matte into blister copper).	31	63	72	
Grizzlies	60	33	37	
Landing dogs	120	17	19	Knocked dow
Mine hoists, complete (drums, gears, cables, etc.).	60-100	20- 33	22- 37	
Ore driers	45	44	50	
Ore roasting or smelting furnaces.	30- 35	56- 67	64- 75	Knocked dow
Ore samplers	25- 50	40- 80	45- 90	
Ore separators	37-100	20- 54	22- 60	
Ore sizers	10	200	224	
Ore skips (heavy buckets)	30	67	75	
Pans, agitator, amalgamating, clean up, or settler.	23- 50	40- 87	45- 97	
Pots, ladle, settling, or slag	35	57	64	
Vanning machine	35	57	64	
Vanning machine, rollers, iron or steel.	31	65	72	
Zinc lathes	16	125	140	
Osteopathic tables, adjustable	17	118	132	Ship crated, 25 by 29 by 65 inches.
Outlet boxes, electric junction	53	38	42	
Ovens:				
Drum	12	167	187	2½ cubic feet space each.
Electric	12	167	187	
Retl	7-50	40-286	45-320	Knocked down.
Stationary	6-18	111-333	124-357	Set up.
Do	10-50	40-200	45-224	Knocked down.
Oyster shells. See Sea shells.				
Oysters	90	22	24	1, 3, and 5 gallon tins and galvanized cans.
Packing:				
Asbestos, in rope or wick form.	50	40	45	
Manila rope, paper, glue, and glycerine.	67	30	33	
Wood-pulp fiber	45-65	31- 44	34- 50	
Pads, sweat or collar. See Sweat pads.				
Pails, fiber, nested	7- 9	222-286	249-320	Nested.
Palm:				
Flour	48	42	47	Bags, 1-300 pounds.
Kernels				Bags, 200 pounds.
Leaf mattress fiber	3.5	557	640	Bales.
Leaves				Bales, 375 pounds; cases, 750 pounds.
Paloja gum				Sugar barrels, 150 pounds.
Paper cups:				
Fiber board or pulpboard	10-28	71-200	80-224	Folded.
Paper	6-11	182-333	204-373	
Parchmented	6-10	200-333	224-373	Nested.
Paper doilies and napkins	8-20	100-250	112-280	Bales.
Do	6-10	200-333	224-373	Boxes.
Paper fasteners, metal	36	56	62	Boxes, 2¾ by 1¾ by 10¾ inches and 30 by 24 by 46 inches.
Paper-makers' felts	9	222	249	Bales of 1, 2, or 3 felts with 2 wrappers of paper and 1 of burlap, 36 by 27 by 18 inches.
Paper toweling. See Toweling.				
Paper twine	29	69	77	On reels in packages, 19 by 19 by 14 inches.
Parasol	60	33	37	Barrels, 355 pounds.
Paste:				
Adhesive	40	50	56	Metal cans; pails; barrels; boxes, 200-250 pounds.
Flour	43	47	52	Barrels, 29½ by 20 inches; kegs, 24 by 15 inches; cases, 19½ by 10½ by 10½ inches.
Library	40-50	40- 50	45- 56	Glass bottles, metal or tin cans, packed in boxes.

Table of Unit Displacement of Commodities—Continued

Commodity	Weight per cubic foot	Space per short ton	Space per long ton	How packed for shipment
	Pounds	Cubic feet	Cubic feet	
Paving blocks:				
Asphalt	150	13	15	
Furnace slag	170	12	13	
Iron slag (scoria)	170	12	13	Uniform standard-size blocks, 8 by 3.5 by 4 inches.
Paving cement	75	27	30	Barrels, 30-gallon.
Paving expansion joints	67	30	33	Boxes; bundles; crates.
Paving paper				Cylindrical bundles, 30 inches long, 8 inches diameter.
Peanut:				
Chaff from kernel	20	100	112	Pressed in bags.
Diggers	15	133	149	Total weight, 575 pounds.
Hearts or germ	20	100	112	
Kernels	40	50	56	Bags, 125 pounds; barrels, 225 pounds.
Meal	45- 56	36- 44	40- 50	Bags, 100-150 pounds.
Pearl shells, Australian	38	53	59	Cases, 16 by 18 by 42 inches.
Mother-of-pearl				Barrels, casks, cases, and sacks, 100-300 pounds.
Peavies	31	65	72	Crates; bundles.
Pectin	47	43	48	Metal cans; boxes.
Pencils	18- 54	37-111	42- 124	
Pencil slats	13	154	172	Wooden cases, 30 by 36 by 25 inches.
Pepper	28	71	80	Ground in boxes or barrels; whole in bags, 130 pounds.
Cayenne	18	111	124	Ground in boxes or barrels; whole in bags, 130 pounds.
Percolators	10	200	224	
Phosphate, acid	33	61	68	Bags, 167 pounds; bulk.
Rock	33	61	68	
Phosphor tin	458-500	3- 4.4	3.7- 4.9	Boxes; casks; barrels.
Phosphoric acid	70- 80	25- 29	28- 32	Casks, 540-560 pounds.
Photonegatives	150	13	15	
Photoprinting cabinets, electric	12	167	187	
Pig-toe nails	23- 25	80- 87	90- 97	Bags, 100-200 pounds.
Pike poles	20	100	112	Bundles, 3 or 6, usually 6; package of 6 is 4 by 6 inches by 14 feet.
Piles, sheet-steel. See Sheet pile castings.				
Pillows, shoddy	6- 10	200-333	224- 373	18 by 26 inches, compressed to ½ thickness.
Pine tar. See Tar.				
Pins:				
Channel	200	10	11	
Common	40	50	56	3½ cubic feet per case.
Safety. See Safety pins.				
Pintsch gas drips. See Gas drips.				
Pipe, cast-iron, porcelain-lined	40	50	56	Barrels, 300 pounds.
Pipe-fitting cement	45-140	14- 44	16- 50	Barrels, 350 pounds; sacks, 100 pounds; packages, 4½ by 2½ by 1 inches; cases, 10 by 6 by 15.5 inches; 1, 5, 10, and 25 pound tin cans; kegs.
Pipe shell, wooden: [a]				
Lined—				
Bore, 3 inches	21	95	107	
Bore, 3.5 inches	19	105	118	
Bore, 4 inches	19	105	118	
Bore, 4.5 inches	17	118	132	
Bore, 5 inches	16	125	140	
Bore, 5.5 inches	16	125	140	
Bore, 6 inches	16	125	140	
Bore, 7 inches	17	118	132	
Bore, 8.5 inches	15	133	149	
Bore, 9.5 inches	15	133	149	
Bore, 11 inches	13	154	172	
Bore, 12 inches	12	167	187	
Bore, 13 inches	11	182	204	
Bore, 15 inches	12	167	187	
Bore, 16.5 inches	9	222	249	
Bore, 17.5 inches	10	200	224	
Bore, 18.5 inches	11	182	204	
Bore, 21 inches	11	182	204	
Bore, 22.75 inches	11	182	204	
Bore, 25 inches	8	250	280	
Bore, 27 inches	8	250	280	
Unlined—				
Bore, 3 inches	19	105	118	
Bore, 3.5 inches	18	111	124	
Bore, 4 inches	16	125	140	
Bore, 4.5 inches	19	105	118	
Bore, 5 inches	17	118	132	
Bore, 6 inches	15	133	149	
Bore, 7 inches	15	133	149	
Bore, 8.5 inches	15	133	149	
Bore, 9.5 inches	12	167	187	
Bore, 11 inches	11	182	204	
Bore, 12 inches	9	222	249	
Bore, 13 inches	9	222	249	
Bore, 15 inches	8	250	280	
Bore, 17.5 inches	6	333	375	
Pipe tin				On reels of about 250 pounds; packed in small cases of 50 pounds.
Do	33	61	68	Coils, 6 by 24 inches.
Do	22	91	102	Coils, 7 by 26 by 26 inches.
Do	53	38	42	Coils, 6 by 36 by 36 inches.
Do	17	118	132	Casks, 39 by 46 inches.
Do	44	46	51	Boxes, 4 by 22 by 22 inches.
Do	30	67	75	Barrels, 31 by 19 inches diameter.
Do	38	53	59	Reels, 24 by 24 inches.
Do	40	50	56	Reels, 24 by 24 by 18 inches.
Pitch, coal tar	68- 74	27-29	30-33	Barrels, 500-570 pounds.
Ground				Heavy jute bags, paper lined.
Plastering fiber, made from old rope.	13	154	172	

[a] That can be loaded in a car 36 by 8.5 by 8 feet.

Table of Unit Displacement of Commodities—Continued

Commodity	Weight per cubic foot	Space per short ton	Space per long ton	How packed for shipmen.
Platinized asbestos. See Asbestos platinized.				
	Pounds	Cubic feet	Cubic feet	
Plugs	60	33	37	
Plum pudding	25–40	50– 80	56 –90	6-ounce and 1, 2, and 3 pound tin cans, boxed.
Pocketknives. See Machine-shop equipment.				
Polishing powder	27	75	83	Fiber-board packages, 17 by 11 by 11 inches.
Polo balls				Barrels, 120 pounds.
Polo sticks. See Sporting goods.				
Pomace	.36	56	62	Bags, 100–200 pounds.
Pontianac gum resin	28–44	46– 72	51– 80	Bags, 125 pounds; barrels, sometimes open-topped.
Porcelain-lined cast-iron pipe. See Pipe, cast iron.				
Portable cooker. See Army range.				
Posts, lawn tennis				2 in a bundle, 5 by 6 inches by 6 feet.
Potash, balls	47	43	48	Boxes, 22 by 15 by 8 inches; 48 balls, packed in sawdust in box 21 by 16½ by 9½ inches.
Crude	65	31	34	Barrels, 600–800 pounds.
Potassium:				
Bichromate				Casks, 650 pounds.
Bromide	72	28	31	
Bromide crystals	89	22	25	
Chlorate	65	31	34	Wooden kegs with paper lining, 122 pounds; boxes, 8½ by 10½ by 16½ inches.
Chloride	60	33	37	Bags, 200 pounds.
Citrate	33	60	68	Boxes, 17½ by 16½ by 11½ inches; smaller boxes; bottles; cans.
Hartshz	85	24	26	
Hydrozite				5 and 10 pound tin cans; sheet-iron cans, 25, 50, and 112 pounds; drums, 560 pounds.
Metallic				1 ounce to 1 pound bottles, packed in tin cans, containing whiting; cans are packed in excelsior, saturated with calcium chloride, in wooden boxes.
Sulphate	80	25	28	Bags, 200 pounds.
Potato:				
Chips	11	182	204	Cases, 12 cans, 18½ by 12½ by 16½ inches and 17½ by 13 by 13½ inches; cases, 36–4 ounce packages, 16 by 16½ by 12½ inches.
Flour. See Flour.				
Mashers, wire	35	57	64	1½ dozen in package occupies 1 cubic foot.
Parer	22	91	102	Crates, 53 by 21 by 29 inches.
Pouring brick. See Brick.				
Powder cans, empty	20	100	112	
Powdered milk. See Milk, powdered.				
Power trucks for transporting materials in and about warehouses, etc.	9– 70	29–222	32–249	Sizes from 18 by 37 by 51 inches to 150 by 45 by 126 inches, crated.
Printers' furniture, miscellaneous.	6– 13	154–333	172–373	
Quercitron bark extract				Barrels, 562 pounds.
Quicksilver. See Mercury.				
Quill fiber. See Featherbone fiber.				
Radiators, cast-iron	67	30	33	
Pressed-steel	25	80	90	
Radio cliute	100	20	22	
Raffia fiber	24	83	93	Compressed bales, 18 by 24 by 36 inches.
Rag pulp	25– 47	43– 80	48– 90	Barrels, 225 pounds, topped with paper and burlap securely tied; bundles, 100 pounds.
Rail bonds	125–130	15– 16	17– 18	
Ramie grass	51	39	44	Bales, 12½–16 cubic feet.
Ramie noils or tops	8	250	280	Cases, 3 by 2 by 5 feet; bags and compressed bales, 6 by 2 by 3 feet.
Rapeseed oil	58	35	39	
Rasps. See Machine-shop equipment.				
Rectifier bulbs	6	333	373	Slatted box.
Rennet extract	45	44	50	Barrels, 45-gallon; 5, 6, 10, and 12 gallon kegs.
Rennets	20– 45	44–100	50–112	Cases and barrels.
Repair kits. See Tire-repair kits.				
Replacers, car and locomotive	50– 60	33– 40	37– 45	Each about 200 pounds.
Resin. See Guayule resin grease; Pontianac gum resin.				
Retarder, plaster or stucco	50	40	45	
Rheostats	25	80	90	
Rice:				
Bran				Bags, 100–150 pounds.
Broken, or rice screening				Bags, 100–240 pounds.
Chaff				Bags, 50 pounds.
Cleaned				Bags, 100–240 pounds.
Flour				Jute sacks, 280 pounds.
Do	23	87	97	12 cartons in containers, 11 by 11 by 13 inches; 24 cartons in containers, 12.5 by 9.5 by 14 inches.
Hulls				Bags, 125–150 pounds.
Meal				Bags, 100–200 pounds.
Polish				Do.
Rough				Bags, 180 pounds.
Rims, steel, emergency. See Autowheel parts.				
Rivets, brass, bronze, copper	75	27	30	1-pound package in cases, 10 by 12 by 20 inches.

Table of Unit Displacement of Commodities—Continued

Commodity	Weight per cubic foot	Space per short ton	Space per long ton	How packed for shipment
Rock candy sugar. See Sugar.				
Rock salt. See Salt.				
Rolling chairs. See Chairs.	Pounds	Cubic feet	Cubic feet	
Roof trimmings, or gutterings	35	57	64	
Roofing:				
Composition and prepared	50	40	45	Rolls, 36 inches long.
Iron or steel, asbestos, and asphalt.	22	91	102	
Slate. See Slate roofing.				
Roofing cement, dry or liquid	70–75	27– 29	30– 32	Barrels; kegs; tin kegs; package, 350 pounds.
Rosin	63–67	30– 32	33– 36	Wooden barrels, 36–38 inches high, 24–26 inches diameter.
Rowboats, not nested	1– 1.5			
Steel	2– 4	500–1000	560–1120	
Rubber:				
Cement	32–56	36– 63	40– 70	Barrels, 50 gallons; cans, packed in wooden boxes.
Crude	38	53	59	All sizes of packages.
Glass	20	100	112	Rolls between corrugated paper, 38 inches wide, 60 inches long; wooden cases, 14 by 17 by 17 inches.
Scrap	15	133	149	Bales.
Tire-applying outfit	38	53	59	
Tire filling	43–60	33– 47	37– 52	Boxes; tubes; tin cans; jacketed tin cans; bags.
Tubing	10–35	57– 200	64– 224	Cardboard containers boxed.
Rubber boots and shoes: [a]				
"Arctics"—				
Bulk—				
Child's	24	83	93	Cases, 16.5 by 9.4 by 6.5 inches.
Men's	19	105	118	Cases, 23.5 by 13.8 by 10 inches.
Women's	17	118	132	Cases, 21.5 by 12.4 by 8 inches.
Cartons—				
Child's	12	167	187	Cases, 20.8 by 12.1 by 11.5 inches.
Men's	12	167	187	Cases, 26.5 by 13.9 by 13 inches.
Women's	12	167	187	Cases, 22.8 by 13.1 by 12.5 inches.
Boots—Men's	20	100	112	Cases, 32 by 14.5 by 18.5 inches to 26.5 by 13.5 by 15.5 inches.
"Eversticks"—				
Men's	11	182	204	Cases, 31.8 by 19 by 13.5 inches.
Women's	9	222	249	Cases, 31.5 by 15.4 by 12.5 inches.
Shoes—				
Bulk—				
Child's	16	125	140	Cases, 18.5 by 11.4 by 18.5 inches.
Men's	15	133	149	Cases, 27 by 14.9 by 12 inches.
Women's	15	133	149	Cases, 24.5 by 12.9 by 10 inches.
Cartons—				
Child's	14	143	160	Cases, 26.5 by 13.4 by 9 inches.
Men's	11	182	204	Cases, 31.8 by 18.9 by 13.5 inches.
Women's	11	182	204	Cases, 31.5 by 15.4 by 12.5 inches.
Rubbing stones				Brick shaped, each 16 ounces; 100 stones per box, weight 135 pounds.
Rules. See Machine-shop equipment				
Safety pins	20	100	112	Packages, 3.7d cubic feet.
Salt:				
Block	78	26	29	Blocks, 0.64 cubic foot.
Celery	27– 34	59– 74	66– 83	
Lump rocksalt for live stock	114	18	20	Bulk.
Salt bricks, medicated	74	27	30	Cases, 30 bricks.
Plain	70	29	32	Do.
Sand asbestos. See Asbestos.				
Sand whetstones. See Whetstones.				
Sandarac gum				Barrels and cases, 150–300 pounds.
Sandpaper. See Abrasive paper.				
Sash, steel bar	25– 40	50– 80	56– 90	
Saws, barrel or bilge	26	77	86	
Scrap asbestos. See Asbestos.				
Scrapple				Cases, 10 by 16 by 12 inches to 14 by 19 by 8.5 inches.
Screens, coal, gravel, sand	9– 12	167–222	187–249	
Shaking	11– 14	143–182	160–204	
Screws	100	20	22	Paper boxes packed in wooden cases; in bulk in wooden cases.
Sea grass	13– 30	67–154	75–172	Bales, 13 by 26 by 36 inches to 18 by 48 by 60 inches; sugar barrels.
Sea shells, oyster and mother-of-pearl.	70–100	20– 29	22– 32	Cases, 16 by 16 by 36 inches; sugar barrels; potato bags.
Rough or natural scallop	30	67	75	Barrels; casks; boxes, 3 feet square.
Sensitized paper ashes	74	27	30	Iron drums, 47 by 29 by 29 inches.
Septic tanks	.40	14	16	
Shades, porch	13	154	.72	
Sheep pelts	40	50	56	
Sheepskins				In bundles, 6–12 skins, laid flat.
Sheet iron, aluminum coated	360	5.6	6.2	Crated; bundles, 160 pounds.
Sheet lead. See Lead.				
Shellac gum				Bags and cases, 150 pounds.
Shells. See Clamshells; Oyster shells; Pearl shells; Sea shells.				
Shelves, oven, rack, or refrigerator.	40– 50	40– 50	45– 56	
Sherardizing zinc	200	10	11	Secondhand whisky barrels, 1300–1375 pounds.
Shingles, metal	49– 58	35– 41	39– 46	Boxes, 20 by 15 by 10 inches; each box contains a square, or 100 square feet, of shingles, as laid on the roof.
Shock absorbers, automobile	41–116	17– 49	19– 52	Boxed.

[a] "Arctics" and boots are packed 12 pairs to a case; "Eversticks" and shoes are packed 24 pairs to a case.

Table of Unit Displacement of Commodities—Continued

Commodity	Weight per cubic foot	Space per short ton	Space per long ton	How packed for shipment
	Pounds	Cubic feet	Cubic feet	
Shoddy cloth				Bales, 200–500 pounds; goods 72 inches wide, folded double, making pieces 36 inches wide.
Shoe:				
Dressing, liquid	27–38	53–74	59–83	1 dozen bottles, in corrugated partitioned box; 6 dozen in a wooden box.
Findings, crimped in heel shape.	250	8	9	Boxes.
Lasts, made of aluminum	21	95	107	Bags.
Scraper and bench combined.	14	143	160	
Shoes:				
Child's, 36 pairs	13	154	172	Cases, 10 by 17 by 38 inches.
Ladies', 36 pairs	14	143	160	Cases, 13 by 17.5 by 46 inches.
Men's, 12 pairs	13	154	172	Cases, 14 by 13 by 26.5 inches and 28.2 by 13 by 13.2 inches.
Men's, 24 pairs	14	143	160	Cases, 14 by 20 by 37.5 inches and 32.5 by 19.6 by 13.2 inches.
Men's, 36 pairs	16	125	140	Cases, 36.5 by 26.1 by 13.2 inches.
Misses', 36 pairs	13	154	172	Cases, 11 by 17.5 by 40.5 inches.
Shot chilled, cast iron	200–270	7.4–10	8.3–11.4	Double bags, 100 pounds.
Sieves	4	500	560	Not nested.
Silex	170	12	13	Cases, 2.5 cubic feet.
Silica, or flint	86	23	26	Casks; bags; barrels, 24 by 30 inches.
Silica, or silicon oxide	40–75	27–50	30–56	Bags, 250 pounds; barrels, 250–350 pounds.
Silicon carbide	100	20	22	Barrels, 550 pounds; kegs, 200 pounds.
Silk waste	10	200	224	Compressed bales, 4 feet square.
Silver wire. See Wire.				
Sizing	65	31	34	
Slate:				
Marbleized mantels, game boards, wainscoting, etc.	100	20	22	Securely crated, in packages of various dimensions.
Pencils	59–81	25–34	28–38	Cases, 10 000 pencils in cases 10 by 12 by 32 inches.
Roofing				Crates, 200 pounds each; weighs 600 pounds to the 100 square feet.
Used for pavement, etc	170	12	13	
Sleeve protectors, straw cuffs	12	170	187	Case, 500 pairs.
Sloe berries				Sacks, 160 pounds.
Sluge acid	112	18	20	Tank cars.
Smoke-flue cleaning compounds.	46	44	49	Barrels; boxes.
Smokestack collars, made of 16–20 gage sheet iron.	16	125	140	Usually shipped in halves, 3–8 feet diameter, 12 inches high; nested.
Soap:				
Castile	54	37	41	1 gross small cakes to case 7 by 13 by 19 inches.
Common, or laundry	50	40	45	Wooden boxes.
Flake or chips	31–35	57–65	64–72	Barrels and cases.
Linseed oil	65	31	34	Barrels; kits; cans.
Liquid	55–60	33–36	37–41	Barrels; drums; tins, boxed.
Soap or washing powder	40	50	56	Cartons packed in wooden boxes; in barrels, in bulk.
Washing or scouring compound.	64	31	35	Barrels, 325 pounds
Soap griddles. See Griddles, soapstone.				
Sockets, lamp. See Lamp sockets.				
Sodium:				
Aluminum sulphate				Sugar barrels.
Antimoniate	109	18	20	Kegs; barrels; casks, 32.5 inches high and 23.5 inches diameter.
Bicarbonate				Cases, 60 pounds; kegs, 112 pounds; bags, 200–400 pounds; sometimes carload shipments in bulk.
Bromide	96	21	23	
Chlorate				Kegs, 120–125 pounds.
Fluoride				Sugar barrels.
Hyposulphite	52	38	43	Barrels, 400 pounds; kegs, 111 pounds; cases, 115 pounds; drums, 108 pounds; bags, 100–200–300 pounds; boxes, 21.5 by 16.5 by 11 inches; 31 per cent shipped in barrels, 56 per cent in bags, and 20 per cent in wooden drums.
Metallic	43	46	52	Steel drums, 20 inches diameter, 22–34 inches high.
Nitrate				Bags, 200 pounds.
Nitrite	60–68	29–33	33–37	Barrels, 300–500 pounds; casks, 377 pounds.
Peroxide				Drums, 380 pounds net.
Silicate	86	23	26	
Silico fluoride	69	29	32	Bags, 220 pounds.
Trisodium phosphate	55	36	41	
Soil-insulating compounds	35	57	64	
Solder	582	3.4	3.9	In loose slabs, over 30 pounds each.
Soldering furnaces. See furnaces.				
Soot-removing compounds	46	43	49	Corrugated cases, 14 by 15 by 11 inches.
Sorghum				Same density and shipping characteristics as corn sirup.
Sound-deadening or joist chair	30–65	31–67	34–75	Plate from chair or socket with a groove containing a felt pad.
Sounding machines, navigation	31	65	72	
Spark plugs	50	40	45	Packages, 36 by 17 by 14 inches.
Spikes, railroad track				Kegs, 200 pounds, all spikes, base, $\frac{7}{8}$ by 4½ inches and heavier.
Sponge clippings, or waste	10–40	50–200	45–224	Bales, 250–500 pounds; density varies according to dampness and pressure.

Table of Unit Displacement of Commodities—Continued

Commodity	Weight per cubic foot	Space per short ton	Space per long ton	How packed for shipment
	Pounds	Cubic feet	Cubic feet	
Sponge waste	12–15	133–167	149–187	Bales, 400–600 pounds.
Sporting goods:				
Baseball, cheap varieties	28	71	80	Box, 72 dozen, 24 by 27½ by 37½ inches.
Bases	18	111	124	Wrapped in paper, packed in boxes, 13.5 by 13.5 by 14.5 inches.
Bats, hardwood	25	80	90	Crates, 17½ by 7½ by 33½ inches.
Willow	32	63	70	Crates, 14 by 5 by 38½ inches.
Masks	6.5	308	345	Pasteboard boxes, 12, 6, 3, or 1 to a box.
Professional	26	77	86	Box, 60 dozen, 20 by 32 by 40 inches.
Boxing gloves				Pasteboard cartons containing 4 gloves, 4 dozen in a case; weight, 185 pounds.
Hockey sticks	23	87	97	Cases, 19 by 19½ by 79 inches.
Polo sticks	30	67	75	Cases, 9½ by 15 by 49 inches.
Spring wagon bodies. See Vehicle bodies.				
Springs:				
Carriage or wagon				15–200 pounds each.
Door	60–70	28–33	32–37	Barrels; boxes, 10 by 20 by 14 inches and 13 by 18 by 8 inches.
Elliptical carriage springs				3–4 feet long, 20–150 pounds each.
Furniture	15	133	149	Compressed bundles, 15 by 18 by 10 inches.
Sprocket chains	100–150	13–20	15–22	Cases, 31 by 9 by 7.5 inches; boxes and bundles.
Spruce gum				Flour barrels; bags; boxes.
Stalls, stanchions	6	333	373	Knocked down; crates, 4 feet 6 inches by 2 feet 6 inches by 4 feet 2 inches.
Starch	52	38	43	Barrels, 29⅝ inches high, 23½ inches in diameter; bags, 100–140–280 pounds.
Corn	52	38	43	Barrels, 220–260 pounds; bags, 225–240 pounds; boxes, 15–78 pounds; containers, 21–48 pounds; crates, 101 pounds.
Laundry	42	48	53	Same as cornstarch.
Starters for automobiles	35	57	64	
Steam radiators. See Radiators.				
Steam-shovel dipper handles	150–190	11–13	12–15	12–55 feet long.
Stearic acid	52	38	43	Sugar barrels; density varies.
Stearine, coconut	62	32	36	Cases, 8 cakes each, 16 by 16 by 12½ inches; packages, 16 by 17 by 20 inches.
Steel:				
Cleaning compound	53	38	42	
Crushed	200	10	11	Bags, 100 pounds.
Launch hulls. See Boat parts.				
Sheet, pile castings	7	286	320	
Steering-wheel rims	13	154	172	Crates, 25–30 rims; average, 42 inches long, 18 inches diameter.
Stenographers' or typewriters' chairs. See Chairs.				
Stepladders	28	71	80	
Stereotype bases	100	20	22	
Sterilizers:				
Dressing—				
Large size	20	100	112	Crate containing apparatus, 51 by 55 by 37 inches.
Do	6	333	373	Crate containing stand, 40 by 31 by 30 inches.
Medium size	20	100	112	Crate containing apparatus, 44 by 40 by 28 inches.
Do	6	333	373	Crate containing stand, 33 by 31 by 25 inches.
Small size	23	87	98	Crate containing apparatus, 37 by 30 by 20 inches.
Do	10	200	224	Crate containing stand, 14 by 34 by 22 inches.
Instrument—				
Large size	21	95	107	Box, 24 by 12 by 36 inches.
Small size	35	57	64	Box, 26 by 16 by 36 inches.
Utensil	11	189	204	Crate, 43 by 32 by 29 inches.
Water-				
Large size	14	143	160	2 cases, 42 by 22 by 22 inches; 1 case, 33 by 19 by 16 inches, containing tanks and fittings.
Do	12	167	187	2 crates, 44 by 25 by 25 inches, containing stands.
Small size	17	118	132	2 cases, 38 by 19 by 19 inches; 1 case, 33 by 19 by 16 inches, containing tanks and fittings.
Do	12	167	187	2 crates, 44 by 22 by 22 inches, containing stands.
Stick lac gums. See Shellac.				
Stones, made of clay, used in annealing ovens in glass factories.	125–130	15–16	17–18	
Stone crusher and elevator combined.	15–25	80–133	90–149	
Stopper heads or sleeves	90	22	25	Device used in foundries for handling hot metal.
Stoppers, lavatories, etc	35–40	50–57	56–64	
Storm aprons, vehicles	24	83	93	Boxes, 16½ by 15½ by 55 inches.
Stove mats, asbestos	26	77	86	Cases; crates; boxes.
Stoves, electric:				
Disk heaters	35	57	64	
Electric stoves	5–35	57–400	64–448	
Hot plates	19	105	118	
Radiators	13–18	111–154	124–172	

Table of Unit Displacement of Commodities—Continued

Commodity	Weight per cubic foot	Space per short ton	Space per long ton	How packed for shipment
Slovepipe:	Pounds	Cubic feet	Cubic feet	
Drums or radiators	6	333	373	Packages, 12 by 12 by 36 inches.
Thimbles				Barrels, 180 pounds.
Straightedges, metal	59	34	38	
Straw braid	10–20	100–200	112–224	Bales; boxes; packages, 480–1,000 pieces.
Straw cuffs	12	167	187	Case containing 500 pairs.
Stretchers (see also Litters):				
Folding collapsible frame and canvas top, for ambulance and Army use.	41	49	55	Folded and wrapped in bundles, 10 by 10 by 72 inches.
Other than wheeled, collapsible.				4½ pounds each.
Wheeled	8–11	189–250	204–280	Knocked down.
Strontium:				
Bromide	59	34	38	Tins, 19 by 13½ by 13½ inches.
Carbonate	20–50	40–100	45–112	Casks, 38 inches high, 26 inches diameter; kegs, 100–200 pounds.
Nitrate	73	27	31	Cartons, cork-stopped bottles, jars, paper bags in cases; boxes; kegs.
Sugar:[a]				
Beet	50–60	33–40	37–45	Cotton-lined burlap bags, 100 pounds.
Do	41	48	54	Sugar barrels.
Cane, refined	57	35	39	Barrels; ¾ barrels; ½ barrels; bags, 100 pounds; cases, 120 pounds.
Clarifier	47–80	25–43	28–48	
Corn cakes or chips	51–85	24–39	27–44	Bags, 112 pounds; barrels, 29½ inches high, 23.5 inches diameter.
Corn sugar bread	51	39	44	Do.
Cubes	47	43	48	Bags, 191 pounds; barrels; cases, 23 by 15 by 14 inches.
Flavored with spices	28	71	80	5.5 ounces fiber cans, with metal top, 24 to a box, 10 by 7½ by 9 inches.
Invert	9.3	215	241	53-gallon barrels.
Maple	69	29	33	Bags, 27 by 15 by 6½ inches; tubs, 40–60 pounds.
Rock candy	53	38	42	Sugar barrels; cases, 35 by 20 by 21 inches.
Tanner's corn	85	24	27	Same as corn sugar, but sometimes in 100-pound slabs.
Sulphite liquor, pitch or cell liquor.	80	25	28	In molasses or oil barrels; in tank cars.
Sulphur:[b]				
Black	90	22	25	50-gallon barrels.
Chloride	1.7[c]			Carboys.
Dioxide				Steel cylinders, 321 pounds; small cylinders, 20 pounds.
Sulphuric acid				Carboys, 270 pounds, 60 B.; carboys, 280 pounds, 66° B.
Sumac, extract				Barrels, 550 pounds.
Surgical operating chairs. See Chairs.				
Supplies, throat-swab applicators.	28	71	80	
Tongue-depressing blades	32	62	70	
Sweat or collar pads	12	167	187	In bales in burlap bags, 18 by 21 by 24 inches.
Swinging couch hammocks. See Hammocks.				
Sylvinit, double manure salts	80	25		Bags, 200 pounds.
Hard, or manure, salts	85	24	26	Do.
Table covers or pads, asbestos. See Asbestos.				
Tops, enameled steel	22–25	80–91	90–102	
Tacks:				
Brass-head upholstery	41	49	55	Paper boxes, packed in wood or fiber boxes.
Copper	90	22	25	Boxes; kegs; cartons packed in boxes.
Double-pointed shade or carpet.	20	100	112	Boxes; kegs.
Iron or steel	109	19	21	Cartons packed in boxes; standard nail kegs.
Tallow, vegetable	58	34	39	In mats or wrapped in burlap, bound with rope.
Oil. See Oil, tallow.				
Tank heaters	16–75	27–125	30–140	
Wagons. See Wagons.				
Tankage	40	50	56	
Tanks, copper, water-closet	14	143	160	
Tanning extract:				
Algarobilla				Bags, 160 pounds.
Black oak bark	69	29	32	Wooden, paper-lined boxes, 17 by 11 by 9 inches, and 18 by 15 by 11 inches.
Mangrove	22	91	102	Bags, 10 cubic feet.
Myrobalan beans	22	91	102	Bags, 7½ cubic feet.
Valonea	15	133	149	Bags, 9½ cubic feet.
Tape, insulating	38–42	48–53	53–59	
Tapioca	43	47	52	Bags.
Tar	70	29	32	Barrels, 500–600 pounds; metal cans boxed.
Pine	64	31	35	
Teasels	6	333	373	Cases, 72 by 48 by 56 inches; weight, 10 pounds per thousand.
Telephone:				
Cable, lead-covered, with jacks attached.	20	100	112	Package, 44 by 44 by 23 inches.
Jacks	20	100	112	
Transformers, or loading coils.	60	33	37	Average weight, 111 pounds.

[a] Average sugar barrel contains 5.82 cubic feet, but on account of its shape occupies 8.03 cubic feet in a car.
[b] Imported from Japan in "Chinese mats," grass mats tied with grass rope, refined at seaboard and shipped to interior in 100–110 pound sacks.
[c] Specific gravity.

Table of Unit Displacement of Commodities—Continued

Commodity	Weight per cubic foot	Space per short ton	Space per long ton	How packed for shipment
Tent equipment:	Pounds	Cubic feet	Cubic feet	
Pins, aluminum	55	36	41	Boxes, 11 by 20½ by 8 inches.
Poles, hardwood	20	100	112	Bundles, 6 pieces, 6 by 6 by 96 inches.
Pine	35	57	64	Bundles, 2 pieces, 4 by 4 by 144 inches.
Slides or keys to tighten guy ropes.	15	133	149	700 keys in heavy burlap bags, 15 by 15 by 32 inches.
Stakes, hard maple	36	55	62	Wired together in bundles of 50–200 pins.
Tripods for conical tents	50	40	45	
Tetrachlorethane	89	22	25	10-gallon, 12-guage galvanized-iron drums; 50-gallon drums, 38 inches high, 25½ inches diameter; 100-gallon drums, 41½ inches high, 33½ inches diameter.
Thorium nitrate	9	222	249	Heavy glass bottles, packed in excelsior and packed in wooden boxes, 10 bottles in a case, 49 by 27 by 27 inches.
Thus, white turpentine				Barrels, 500 pounds.
Ties, railroad	109–214	9–18	10–20	Standard sizes, 7 feet by 8 inches by 8 inches and 7 feet by 6 inches by 8 inches.
Tile:				
Clay	82–96	21–24	23–27	9-inch tile, crate, 25 by 11 by 11 inches; 6-inch tile, crate, 23 by 13 by 17 inches.
Flooring—				
Composition	280	7	8	
Rubber tile	139	14	16	
Wainscoting	256	8	9	Barrels; boxes.
Tire:				
Bands	25–40	50–80	56–90	
Chains	82	24	27	Flour barrels; 30 pairs per barrel.
Filler, rubber	60	33	37	
Flanges.				
Reliners	27	74	83	
Repair kits				Varying number of kits, size 8 by 3 by 3 inches, packed in one large wooden box.
Tires:				
Pneumatic	7–12	167–286	187–320	
Solid	33–58	34–60	39–68	
Toasters, asbestos	44–60	33–45	37–51	Cases; crates; boxes.
Tobacco extract	56	36	40	
Toilet powder	28	71	80	Cases, 18½ by 18½ by 32 inches.
Do	32	63	70	Cases, 19½ by 10½ by 31 inches.
Do	30	67	75	Tins and strawboard boxes.
Toluol and xylol	65–70	29–31	32–34	1–2–10 gallon tin cans, jacketed; drums, 42 by 31½ inches and 35½ by 25 inches.
Torpedoes, shipped in 3 sections:[a]				
After body	26	77	86	Over all, but unboxed, 24 by 24 by 88 inches.
Flask	30	67	75	Over all, but unboxed, 24 by 24 by 112 inches.
Head	18	111	124	Over all, but unboxed, 22 by 22 by 38 inches.
Tow yarn. See Yarn.				
Toweling	10–20	100–200	112–224	Cases, 32 by 29 by 27 inches; containers, 31½ by 30½ by 24 inches.
Tractors, caterpillar. See Caterpillar tractors.				
Tragacanth gum				Bags and cases, 150–200 pounds.
Tragasol				Barrels, 450 pounds.
Trailer trucks. See Automobile Appendix.				
Transformer cooling coils, copper	30	67	75	Weight, 200–500 pounds.
Transformers, telephone	55	36	41	
Trichlorethylene	73	27	31	10-gallon, 12-guage, galvanized-iron drums; 50-gallon drums, 39 inches high, 26 inches diameter; 100-gallon drums, 41 inches high, 33½ inches diameter.
Trinitrotoluol	78	26	29	Iron drums, 47 by 40 inches.
Tripods, rock drill	25	80	90	Weight, 80–300 pounds.
Tripoli	73	27	31	Paper-lined sacks.
Lump form	65–70	29–31	32–34	
Trolley hasps	50–90	22–40	25–45	
Troughs, feeding or watering	18	111	124	
Troughs and tanks, combined, iron or steel.	8–12	168–250	187–280	
Truck gears. See Wagon gears.				
Truck wheels, all steel	23–30	67–87	75–98	Shipped loose; average weight, 70 pounds; 4-inch tire.
Trucks. See Hand trucks.				
Try squares. See Machine-shop equipment.				
Tungsten metal in powdered form.	205	10	11	Sheet-iron boxes in wooden cases, 8½ by 7 by 13½ inches and 11½ by 8 by 15 inches.
Tungsten oxide or acid	100	20	22	In 50–100 pound kegs.
Turpentine cup aprons, galvanized iron.	74–160–200	10–12–27	11–14–30	Flat or nested.
Turpentine, white. See Thus.				
Twine, paper	37	54	61	Reels, 19 by 19 by 14 inches.
Ultramarine blue, in balls	33	61	68	Flour barrels.
In packages	39	51	57	Package, 15½ by 15½ by 9 inches; crates, 6 or 12 boxes.
Valonea. See Tanning extract.				

[a] Typical torpedo is 17 feet long, 21⅛ feet diameter; total weight 2,108 pounds. Never shipped containing the explosive.

Table of Unit Displacement of Commodities—Continued

Commodity	Weight per cubic foot	Space per short ton	Space per long ton	How packed for shipment
	Pounds	Cubic feet	Cubic feet	
Valves of brass, etc	100–125	16– 20	18– 22	In packages of many sizes.
Do	80	25	28	In boxes.
Do	76	26	29	In barrels.
Vegetable ivory scrap. See Palm flour.				
Vegetables. See Appendix No. 2.				
Vehicle parts:				
Arm rails	70–100	20– 29	22– 32	
Axle chips	80–150	13– 25	15– 28	
Axle couplings	80–100	20– 25	23– 28	Boxes, 200–500 pounds.
Bodies—				
Buggy	1– 6	333–2000	373–2240	1 set up and crated, 24–30 by 56–64 by 12–16 inches; 5–10 in a crate usually.
Carriage or surrey	4– 6	333– 500	373– 560	Set up and crated, 30–36 by 64–72 by 14–18 inches.
Do	3– 4	500– 667	560– 747	Knocked down and 2 bodies crated, 36–46 by 72–96 by 14 inches.
Convertible wagon beds	14– 16	125– 143	140– 160	Total displacement, 44–48 cubic feet.
Farm wagon				Sides crated together, end gates bundled, 10 feet 6 inches long, 30 inches wide; average weight, 300 pounds.
Laundry, grocery, etc., for use on Ford running gears.	2	1000	1120	Crated, 5 by 5 feet by 8 feet 6 inches.
Spring wagon	5– 7	286– 400	320– 450	Set up and crated, 34 by 80–90 by 7–8 inches.
Bolster plates	150–170	12– 13	13– 15	Bundles and bags, 45–195 pounds; barrels, 400–450 pounds.
Standards	170	12	13	Boxes and bundles, 100–1000 pounds.
Bow sockets used for buggy tops	40– 60	33– 50	37– 56	Boxes, average 36 by 24 by 9 inches.
Brake parts	50– 60	33– 40	37– 45	
Buggy valances	18– 20	100– 111	112– 124	
Carriage dashes	35– 52	38– 57	43– 64	
End straps for singletrees	80	25	28	Barrels, 570 pounds; bags, weight, ¾ pound each.
Evener plates	280–350	6– 7	6– 8	Bags up to 250 pounds; packages 1200 pounds; weight, ½ pound each.
Felly irons	80– 91	22– 25	25– 28	Kegs; barrels; 300 pounds.
Fellies for vehicle wheels	30– 60	33– 67	37– 75	Crates, 10–15 cubic feet.
Fifth wheel				Sugar or cracker barrels, 175–275 pounds.
Gate rods	90–120	17– 22	19– 25	Bundles, 36–50 pounds.
Hammer straps	100–260	8– 20	9– 22	Bags, 200 pounds; barrels, 400–600 pounds.
Neck yoke—				
Centers	130	15	17	
End irons	105	19	21	
Irons	168	12	13	Barrels.
Pole caps	40– 60	33– 50	37– 56	
Poles, vehicle				
Carriage, hickory				1¼ by 2–2 by 3 inches and 12 feet long. Shipped 4–6 in a bundle.
Towing, steel				2 inches diameter, 66 inches long; weight, 25 pounds.
Wagon, oak or ash				2 by 4½–3 by 7 inches and 12–13 feet long. Shipped 2 in a bundle.
Reach or coupling plates	320	6	7	Barrels, 320 pounds; bags, 250 pounds; kegs, 80 pounds; weight, ½ pound each.
Rub irons	120–150	13– 17	15– 19	Barrels, 400–750 pounds; bags, 250 pounds; kegs, 180 pounds; weight, 2 pounds each.
Seat hooks for wagon seats	80–120	17– 25	19– 28	Barrels, 400–480 pounds; bags, 250–380 pounds.
Shifting rails	25– 40	50– 80	56– 90	
Singletree hooks	70–150	13– 29	15– 32	Barrels, 400 pounds; bags, 200–250 pounds.
Spokes	30– 34	59– 67	66– 75	Bundles crated, 10–15 cubic feet; bags, 50–100 pounds.
Storm shields	3.5	552	640	
Tongue plates	322–350	5.5– 6	6.4– 7	Bags, 100–250 pounds; packages, up to 1200 pounds; weight, ½ pound each.
Top joints	60– 75	27– 33	30– 37	
Wagon awnings or covers	8	250	280	2.5 by 2.5 by 4 feet, packages.
Vellumoid, a sheet packing for pumps and engines	67	30	33	Rolls; bundles; crates; boxes; usual package weight, 100 pounds.
Vinegar	40– 63	32– 50	36– 56	½–4 dozen jugs or glass containers, boxed or packed in fiber-board boxes or sugar barrels; barrels; half barrels; casks; tank cars.
Vulcanizing compounds	72	28	31	5-gallon cans.
Wagon and carriage springs				15–200 pounds each.
Wagon and truck gears:				
Bundle whiffletrees and and neck yoke, 1	22	91	102	Dimensions, 78 by 5 by 9 inches
Extra stakes, 4	30	67	75	Dimensions, 22 by 3 by4 inches
Front bolster, 1	7	286	320	Dimensions, 48 by 18 by 13 inches.
Front gear, 1	7	286	320	Dimensions, 68 by 12 by 45 inches.
Front wheels, 2	7	286	320	Dimensions, 41 by 41 by 13 inches.
Hind gear, 1	3	667	747	Dimensions, 68 by 24 by 48 inches.
Hind wheels, 2	6	333	373	Dimensions, 45 by 45 by 13 inches.
Pole, 1	5	400	448	Dimensions, 133 by 6 by 20 inches.
Reach, 1	50	40	45	Dimensions, 111 by 2 by 4 inches.

Table of Unit Displacement of Commodities—Continued

Commodity	Weight per cubic foot	Space per short ton	Space per long ton	How packed for shipment
Wagon:				
Awnings. See Awnings.				
Axles. See Axles.				
Bodies. See Vehicle bodies.				
	Pounds	Cubic feet	Cubic feet	
Carriage, and auto bows	6– 7	286–333	320–373	Knocked down. In bundles of varying dimensions.
Covers. See Awnings.				
Poles. See Vehicle poles.				
Springs, elliptical				3–4 feet long; weight, 20–150 pounds each; 18–60 inches long; weight, 10–90 pounds each.
Springs, seat				Bundles or loose; weight, 11–12 pounds per pair.
Wheels	9– 11	182–222	204–249	1 or 2 in a bundle.
Wheels, auto	11	182	204	Packed flat and crated hub to hub.
Do	28	72	80	Nested together in car.
Wheels, tires 2 inch thick—				

	Width of tire (inches)					
	2	3	3.5	4	5	6
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
20-inch wheel weighs	47	53	56	59	65	71
22-inch wheel weighs	49	56	60	63	70	77
24-inch wheel weighs	51	59	63	67	75	83
26-inch wheel weighs	53	62	67	71	80	89
28-inch wheel weighs	55	65	70	75	85	95
30-inch wheel weighs	59	69	74	79	89	99
32-inch wheel weighs	61	71	76	81	91	101
34-inch wheel weighs	67	78	84	89	100	111
36-inch wheel weighs	70	81	87	92	103	114
38-inch wheel weighs	76	88	94	100	112	124
40-inch wheel weighs	79	92	101	109	118	131
42-inch wheel weighs	81	98	106	113	123	137
44-inch wheel weighs	88	103	110	117	131	145

Commodity	Weight per cubic foot	Space per short ton	Space per long ton	How packed for shipment
Wagons:				
Average wagon consists of—	Pounds	Cubic feet	Cubic feet	
Bolster, 1				Weighs 35 pounds.
Bottom, 1				Weighs 125 pounds.
Box trimmings, 1				Weighs 30 pounds.
Bundle end gates, 1				Weighs 50 pounds.
Bundle sides, 1				Weighs 145 pounds.
Bundle trimmings, 1				Weighs 50 pounds.
Coupling pole, 1				Weighs 19 pounds.
Front gear, 1				Weighs 112 pounds.
Hind gear and brake, 1				Weighs 200 pounds.
Seat, 1				Weighs 34 pounds.
Tongue, 1				Weighs 46 pounds.
Wheels, 4				Weighs 100 pounds each.
Dump	5.4– 8	250–371	280–415	Knocked down. From 44 inches wide, 10 feet long, bed to 5 feet by 4 feet 6 inches by 12 feet.
Do	22	91	102	Accessory parts packed in wagon box, 11 feet 6 inches by 46 by 25.5 inches.
Dump, 1-horse, 2-wheeled	10	200	224	Requires 66 cubic feet.
Farm	6– 16	125–333	140–373	Knocked down, small parts bored; rest in bundles wired together. Requires from 110–125 cubic feet.

	Length in feet	Diameter in inches	Gage steel	Capacity in gallons	Weight in pounds
Tank—					
Oil	6	17.5	16	72	85
Do	6	24.5	16	142	125
Do	8	24.5	16	190	155
Do	8	30	14	290	255
Do	8	34.5	12	380	410
Do	10	34.5	12	500	500

Commodity	Weight per cubic foot	Space per short ton	Space per long ton	How packed for shipment
	Pounds	Cubic feet	Cubic feet	
Street flushers	6	333	373	Require 676 cubic feet.
Street sprinklers	5	400	450	Require 576 cubic feet.
Wall paper	22	91	102	
Wardrobes	7– 12	167–286	187–320	Crated.
Washers, brass and copper, for riveting.	151	13	15	Barrels; boxes.
Steel plate				100–200 pounds in wooden kegs bound with steel hoops.
Washing compound or powder. See Soap.				
Watch crystals, Swiss	17	118	132	Wooden cases, 200 pounds.
Water-closet tanks	17	118	132	Crated, 28 by 10½ by 21 inches.
Waterproof cloth:				
Containers for cement	15	133	149	Bales, 48 by 20 by 36 inches.
Made of cloth and rubber	40	50	56	Packages, 37 by 12 by 12 inches.
Rubber sheeting	33	61	68	Packages, 36 by 12 by 12 inches.
Tent and tarpaulin cloth	39	51	57	Rolls, 31 by 24 by 24 inches.
Wavellite ore	120	17	19	
Wax crayons. See Crayons.				
Wax, floor	32	62	70	
Waxing pads, used in ironing clothes	29	69	77	

[1] Weight, complete, 1246 pounds.

Table of Unit Displacement of Commodities—Concluded

Commodity	Weight per cubic foot	Space per short ton	Space per long ton	How packed for shipment
	Pounds	Cubic feet	Cubic feet	
Weather strips	48–50	40–42	45–47	Bundles containing 500-1000 linear feet; boxes about 22 by 35 by 6 inches.
Welding compound	90	22	25	Barrels, 550-650 pounds; half barrels; boxes.
Wheelbarrow hoppers	10–15	133–200	149–224	
Wheelbarrows:				
All steel	42	48	53	Knocked down. Trays nested 3 or more to the bundle. Frames, legs, and wheels bundled separately.
Steel and wood—				
Groups of 1 dozen	60	33	37	Knocked down; parts bundled and bodies nested.
Single	15	133	149	
Wheels. See Automobile wheels; Truck wheels; Wagon wheels.				
Whetstones, oilstones	125	16	18	Boxes or barrels with shavings and sawdust.
Sand whetstones	50–75	27–40	30–45	Cases, 10 by 12 by 23 inches.
White metal alloy	280	7	8	Slabs, 18 by 12 by 1½ inches.
Wind-shield frames, automobile	15	133	149	Crated, 16 by 21 by 48 inches.
Wind shields, automobile	23	87	97	Boxes, 27½ by 49½ by 6 inches.
Window bolts				9 pounds per gross.
Wire:				
Aluminum—				
Bare	65	31	34	Boxes; casks; coils; reels
Insulated	50	40	45	Do.
Fuse. See Fuse wire.				
German silver	77	26	29	Boxes; cases; barrles; reels; coils.
Lead. See Lead wire.				
Wire braid	125	16	18	On reels.
Wire brooms	10–18	111–200	125–224	Cases, 20-500 pounds.
Wire cloth:				
Ordinary screen wire—				
Copper or bronze	95	21	24	Rolls wrapped in paper or crated. Jobbers' rolls, 7 inches diameter, 30 inches long; screen-manufacturers' rolls, 21 inches diameter, 24 inches long.
Steel	50–65	31–40	34–45	Rolls wrapped in paper or crated, 6-7 inches diameter, 18-48 inches long.
Used in mining machinery, cement mills, fertilizer factories, and paper mills.	80–100	20–25	22–28	Boxes, 20 by 12 by 12 inches–36 by 24 by 24 inches; rolled on poles and boxed, 10 by 12 inches by 10–14 feet long.
Wire fabric and woven asbestos	32	63	70	
Wire fencing	10–22	91–200	102–224	
Wireless-telegraph equipment, complete	24	83	93	Total space required, 86 cubic feet, packed as follows: 1 case, 20 by 20 by 33 inches; 1 case, 30 by 20 by 10 inches; 1 crate, 30 by 30 by 48 inches; 1 bundle, 6 inches diameter, 13 feet 6 inches long; 1 case, 36 by 25 by 25 inches; 1 case, 34 by 26 by 18 inches; 1 case, 41 by 25 by 19 inches; 1 case, 36 by 34 by 19 inches.
Wood flour	16–35	56–125	62–140	Sacks; bales; boxes; 24 by 24 by 42 inches.
Wood pulp	16	125	140	
Wood-pulp dust	5	400	448	4 bushel, machine-pressed into burlap sacks.
Wool	11–16	125–182	140–204	Bales, 4 by 2½ by 2½ feet.
Wrenches, drop-forged end	100–120	17–20	19–22	
Xylol. See Toluol.				
Yarn:				
Asbestos. See Asbestos yarn.				
Coir. See Coir yarn.				
Paper	13–16	125–154	140–172	
Tow and hemp	22–26	77–91	86–102	
Zinc:				
Ammonium chloride	38–45	44–53	50–59	
Anodes				25 pounds each.
Battery zincs	150–200	10–13	11–15	Boxes; kegs; barrels, 450 pounds.
Concentrates	136	15	16	
Dross	248	8	9	Slabs, 3 by 11 by 16 inches.
Dust	150	13	15	In galvanized-iron containers, 12½ inches diameter, 19½ inches high.
Pigs or slabs	450	4.4	5	Slabs, 1¾ by 9 by 19 inches.
Plates	450	4.4	5	Boxes, 8 by 12 by 24 inches–6 by 24 by 48 inches.
Sherardizing	200	10	11	
Skimmings	190	11	12	Powder form in bulk.
Sulphate	86	23	26	Tank cars.
Wire	86	23	26	

APPENDIXES

Appendix No. 1—Unit Displacement of Canned Fruits and Vegetables Packed in Commercial Containers for Transportation.

CANS IN CASES

Commodity	Cans in case: Size	Cans in case: Number	Type of case	Weight of can contents	Weight per case: Net	Weight per case: Gross	Space per case	Space per short ton	Space per long ton
				Ounces	Pounds	Pounds	Cubic feet	Cubic feet	Cubic feet
Apples	2½	24	N. C.	26	39	55	1.38	50	56
Do	2½	24	W. B.	26	39	52	1.34	52	58
Do	3	24	N. C.	29	43	61	1.60	52	59
Do	3	24	W. B.	29	43	57	1.55	55	61
Do	10	6	N. C.	96	36	49	1.26	51	58
Do	10	6	W. B.	96	36	49	1.20	49	55
Apple butter	2	24	N. C.	20	30	43	.99	46	52
Do	2	24	W. B.	20	30	40	.96	48	53
Do	2½	24	N. C.	30	45	62	1.39	45	50
Do	2½	24	W. B.	30	45	58	1.34	46	52
Do	3	24	N. C.	33	50	68	1.60	47	53
Do	3	24	W. B.	33	50	64	1.55	48	54
Apple sauce	2	24	N. C.	19	28	41	.99	49	54
Do	2	24	W. B.	19	28	38	1.00	50	57
Do	2½	24	N. C.	30	45	62	1.39	45	50
Do	2½	24	W. B.	30	45	58	1.34	46	52
Do	10	6	N. C.	107	40	53	1.26	48	53
Do	10	6	W. B.	107	40	53	1.20	45	51
Artichokes	3	24	N. C.	32	48	66	1.60	49	54
Do	3	24	W. B.	32	48	62	1.55	50	56
Do	10	6	N. C.	102	38	51	1.26	49	55
Do	10	6	W. B.	102	38	51	1.20	47	53
Asparagus	2	24	N. C.	20	30	43	1.00	47	52
Do	2	24	W. B.	20	30	40	.96	48	53
Do	3	24	N. C.	32	48	66	1.60	48	54
Do	3	24	W. B.	32	48	65	1.55	48	53
Do	10	6	N. C.	100	38	51	1.26	49	55
Do	10	6	W. B.	100	38	51	1.20	47	53
Beans, baked	2	24	N. C.	20	30	43	1.00	47	52
Do	2	24	W. B.	20	30	40	.96	48	54
Do	3	24	N. C.	34	51	68	1.39	41	46
Do	3	24	W. B.	34	51	68	1.55	46	51
Do	10	6	N. C.	106	40	53	1.26	48	53
Do	10	6	W. B.	106	40	53	1.20	45	51
Beans, red kidney and lima	2	24	N. C.	20	30	43	1.00	47	52
Do	2	24	W. B.	20	30	40	.96	48	53
Do	3	24	N. C.	32	48	66	1.60	48	54
Do	3	24	W. B.	32	48	65	1.55	48	53
Do	10	6	N. C.	105	39	52	1.26	49	55
Do	10	6	W. B.	105	39	52	1.20	47	53
Beans, war and refugee	2	24	N. C.	19	28	41	1.00	49	55
Do	2	24	W. B.	19	28	38	.96	51	57
Do	3	24	N. C.	31	46	64	1.60	50	56
Do	3	24	W. B.	31	46	63	1.55	49	55
Do	10	6	N. C.	105	39	52	1.26	49	54
Do	10	6	W. B.	105	39	52	1.20	46	52
Beans and pork	2	24	N. C.	21	32	45	1.00	45	50
Do	2	24	W. B.	21	32	42	.96	46	51
Do	2½	24	N. C.	31	46	63	1.39	44	49
Do	2½	24	W. B.	31	46	59	1.34	45	51
Do	3	24	N. C.	34	51	69	1.60	46	52
Do	3	24	W. B.	34	51	68	1.55	46	51
Do	10	6	N. C.	110	41	54	1.26	47	52
Do	10	6	W. B.	110	41	54	1.20	45	50
Beets	2	24	N. C.	20	30	43	1.00	47	52
Do	2	24	W. B.	20	30	40	.96	48	54
Do	3	24	N. C.	33	50	68	1.60	47	53
Do	3	24	W. B.	33	50	67	1.55	46	52
Do	10	6	N. C.	106	40	53	1.26	47	52
Do	10	6	W. B.	106	40	53	1.20	45	51
Blackberries, heavy syrup	2	24	N. C.	21	32	45	1.00	44	50
Do	2	24	W. B.	21	32	42	.96	46	51
Do	2½	24	N. C.	30	45	62	1.39	45	50
Do	2½	24	W. B.	30	45	58	1.34	46	52
Blackberries, water	2	24	N. C.	19	28	41	1.00	49	55
Do	2	24	W. B.	19	28	38	96	51	57
Do	3	24	N. C.	29	44	52	1.60	52	58
Do	3	24	W. B.	29	44	61	1.55	51	57
Do	10	6	N. C.	104	39	52	1.26	48	54
Do	10	6	W. B.	104	39	52	1.20	46	52
Blueberries	2	24	N. C.	20	30	43	1.00	47	52
Do	2	24	W. B.	20	30	40	.96	48	54
Do	3	24	N. C.	33	50	68	1.60	47	53
Do	3	24	W. B.	33	50	67	1.55	46	52
Do	10	6	N. C.	106	40	53	1.26	48	53
Do	10	6	W. B.	106	40	53	1.20	45	51
California fruits: [a]									
Extra	2½	24	N. C.	30	45	62	1.39	45	50
Do	2½	24	W. B.	30	45	58	1.34	46	52
Extra standard and standard	2½	24	N. C.	29	44	61	1.39	46	51
Do	2½	24	W. B.	29	44	57	1.34	47	53
Water	2½	24	N. C.	28	42	59	1.39	47	53
Do	2½	24	W. B.	28	42	55	1.34	49	55
Extra, extra standard	3	24	N. C.	36	54	72	1.60	44	50
Do	3	24	W. B.	36	54	71	1.55	44	49
Do	10	6	N. C.	104	39	52	1.26	48	54
Do	10	6	W. B.	104	39	52	1.20	46	52
Standard, water	10	6	N. C.	100	38	51	1.26	49	55
Do	10	6	W. B.	100	38	51	1.20	47	53
Cabbage	3	24	N. C.	32	48	66	1.60	48	54

[a] California fruits, among others, include apricots, white and black cherries, grapes, loganberries, peaches, and strawberries. They are carefully graded; those with a heavier sirup give a heavier weight; this is indicated by the grade without repeating the names of the fruit.

N. C.=nailed construction; W. B.=wire bound.

Appendix No. 1—Unit Displacement of Canned Fruits and Vegetables Packed in Commercial Containers for Transportation—Continued.

CANS IN CASES—Continued

Commodity	Cans in case: Size	Cans in case: Number	Type of case	Weight of can contents	Weight per case: Net	Weight per case: Gross	Space per case	Space per short ton	Space per long ton
Cabbage	3	24	W. B.	32	48	65	1.55	48	53
Cauliflower	3	24	N. C.	32	48	66	1.60	48	54
Do	3	24	W. B.	32	48	65	1.55	48	53
Cherries	2	24	N. C.	20	30	43	1.00	47	52
Do	2	24	W. B.	20	30	40	.96	48	54
Do	2½	24	N. C.	29	44	61	1.39	46	51
Do	2½	24	W. B.	29	44	57	1.34	47	53
Do	10	6	N. C.	105	39	52	1.26	48	54
Do	10	6	W. B.	105	39	52	1.20	46	52
Condensed milk		48	N. C.	14	42	58	1.16	40	45
Do		48	W. B.	14	42	55	1.11	40	45
Corn	2	24	N. C.	20	30	43	1.00	47	52
Do	2	24	W. B.	20	30	40	.96	48	54
Do	10	6	N. C.	106	40	53	1.26	48	53
Do	10	6	W. B.	106	40	53	1.20	45	51
Evaporated milk		48	N. C.	16	48	68	1.47	43	48
Do		48	W. B.	16	48	64	1.41	44	49
Figs	2	24	N. C.	20	30	43	1.00	47	52
Do	2	24	W. B.	20	30	40	.96	48	54
Do	10	6	N. C.	104	39	52	1.26	48	54
Do	10	6	W. B.	104	39	52	1.20	46	52
Gooseberries	2	24	N. C.	20	30	43	1.00	47	52
Do	2	24	W. B.	20	30	40	.96	48	54
Do	10	6	N. C.	103	39	52	1.26	48	54
Do	10	6	W. B.	103	39	52	1.20	46	52
Hominy	2½	24	N. C.	31	46	63	1.39	44	49
Do	2½	24	W. B.	31	46	59	1.34	45	51
Do	3	24	N. C.	33	50	68	1.60	47	53
Do	3	24	W. B.	33	50	67	1.55	46	52
Do	10	6	N. C.	107	40	53	1.26	48	53
Do	10	6	W. B.	107	40	53	1.20	45	51
Okra	2	24	N. C.	19	28	41	1.00	49	55
Do	2	24	W. B.	19	28	38	.96	51	57
Do	3	24	N. C.	33	50	68	1.60	47	53
Do	3	24	W. B.	33	50	67	1.55	46	52
Do	10	6	N. C.	103	39	52	1.26	48	54
Do	10	6	W. B.	103	39	52	1.20	46	52
Okra and tomatoes	2	24	N. C.	19	28	41	1.00	49	55
Do	2	24	W. B.	19	28	38	.96	51	57
Do	3	24	N. C.	33	50	68	1.60	47	53
Do	3	24	W. B.	33	50	67	1.55	46	52
Peaches, heavy sirup	2	24	N. C.	20	30	43	1.00	47	52
Do	2	24	W. B.	20	30	40	.96	48	54
Do	2½	24	N. C.	30	45	62	1.39	45	50
Do	2½	24	W. B.	30	45	58	1.34	46	52
Do	3	24	N. C.	33	49	67	1.60	48	53
Do	3	24	W. B.	33	49	66	1.55	47	53
Do	10	6	N. C.	102	38	51	1.26	49	55
Do	10	6	W. B.	102	38	51	1.20	47	53
Peaches, water	2	24	N. C.	19	28	41	1.00	49	55
Do	2	24	W. B.	19	28	38	.96	51	57
Do	2½	24	N. C.	28	42	59	1.39	47	53
Do	2½	24	W. B.	28	42	55	1.34	49	55
Do	3	24	N. C.	31	46	64	1.60	50	56
Do	3	24	W. B.	31	46	63	1.55	49	55
Peach butter	2	24	N. C.	20	30	43	1.00	47	52
Do	2	24	W. B.	20	30	40	.96	48	54
Pears, heavy sirup	2	24	N. C.	20	30	43	1.00	47	52
Do	2	24	W. B.	20	30	40	.96	48	54
Do	2½	24	N. C.	30	45	62	1.39	45	50
Do	2½	24	W. B.	30	45	58	1.34	46	52
Do	3	24	N. C.	33	50	68	1.60	47	53
Do	3	24	W. B.	33	50	67	1.55	46	52
Do	10	6	N. C.	102	38	51	1.26	49	55
Do	10	6	W. B.	102	38	51	1.20	47	53
Pears, water	2½	24	N. C.	28	42	59	1.39	47	53
Do	2½	24	W. B.	28	42	55	1.34	49	55
Pineapples	2	24	N. C.	20	30	43	1.00	47	52
Do	2	24	W. B.	20	30	40	.96	48	54
Do	2½	24	N. C.	30	45	62	1.39	45	50
Do	2½	24	W. B.	30	45	58	1.34	46	52
Do	3	24	N. C.	33	50	68	1.60	47	53
Do	3	24	W. B.	33	50	67	1.55	46	52
Do	10	6	N. C.	110	41	54	1.26	47	52
Do	10	6	W. B.	110	41	54	1.20	44	50
Plums, heavy sirup	2	24	N. C.	20	30	43	1.00	47	52
Do	2	24	W. B.	20	30	40	.96	48	54
Do	2½	24	N. C.	30	45	62	1.39	45	50
Do	2½	24	W. B.	30	45	58	1.34	46	52
Do	3	24	N. C.	33	50	68	1.60	47	53
Do	3	24	W. B.	33	50	67	1.55	46	52
Do	10	6	N. C.	102	38	51	1.26	49	55
Do	10	6	W. B.	102	38	51	1.20	47	53
Plums, water	2½	24	N. C.	28	42	59	1.39	47	53
Do	2½	24	W. B.	28	42	55	1.34	49	55
Pork and beans. See Beans and pork.									
Prunes	2	24	N. C.	20	30	43	1.00	47	52
Do	2	24	W. B.	20	30	40	.96	48	54
Peas	2	24	N. C.	20	30	43	1.00	47	52
Do	2	24	W. B.	20	30	40	.96	48	54
Do	10	6	N. C.	108	40	53	1.26	48	53
Do	10	6	W. B.	108	40	53	1.20	45	51
Pumpkin	2	24	N. C.	19	28	41	1.00	49	55
Do	2	24	W. B.	19	28	38	.96	50	57
Do	2½	24	N. C.	30	45	62	1.39	45	50
Do	2½	24	W. B.	30	45	58	1.34	46	52
Do	3	24	N. C.	33	50	68	1.60	47	53
Do	3	24	W. B.	33	50	67	1.55	46	52
Do	10	6	N. C.	104	39	52	1.26	48	54

Appendix No. 1—Unit Displacement of Canned Fruits and Vegetables Packed in Commercial Containers for Transportation—Concluded.

CANS IN CASES—Continued

Commodity	Cans in case: Size	Cans in case: Number	Type of case	Weight of can contents	Weight per case: Net	Weight per case: Gross	Space per case	Space per short ton	Space per long ton
Pumpkin	10	6	W. B.	104	39	52	1.20	46	52
Raspberries, heavy sirup	2	24	N. C.	21	32	45	1.00	44	50
Do	2	24	W. B.	21	32	42	.96	46	51
Do	2½	24	N. C.	30	45	62	1.39	45	50
Do	2½	24	W. B.	30	45	58	1.34	46	52
Do	10	6	N. C.	106	40	53	1.26	48	53
Do	10	6	W. B.	106	40	53	1.20	45	51
Raspberries, water	2	24	N. C.	19	28	41	1.00	49	55
Do	2	24	W. B.	19	28	38	.96	51	57
Rhubarb	2½	24	N. C.	31	46	63	1.39	44	49
Do	2½	24	W. B.	31	46	59	1.34	45	51
Do	10	6	N. C.	100	38	51	1.26	49	55
Do	10	6	W. B.	100	38	51	1.20	47	53
Salmon	1 lb.	48	N. C.				1.52		
Do	1 lb.	48	W. P.				1.47		
Sauerkraut	2	24	N. C.	19	28	41	1.00	49	55
Do	2	24	W. B.	19	28	38	.96	51	57
Do	2½	24	N. C.	29	44	61	1.39	45	51
Do	2½	24	W. B.	29	44	57	1.34	47	53
Do	3	24	N. C.	32	48	66	1.60	48	54
Do	3	24	W. B.	32	48	65	1.55	48	53
Do	10	6	N. C.	100	38	51	1.26	49	55
Do	10	6	W. B.	100	38	51	1.20	47	53
Soups	10	6	N. C.	112	42	55	1.26	46	51
Do	10	6	W. B.	112	42	55	1.20	44	49
Spinach	2	24	N. C.	19	28	41	1.00	49	55
Do	2	24	W. B.	19	28	38	.96	51	57
Do	2½	24	N. C.	28	42	59	1.39	47	53
Do	2½	24	W. B.	28	42	55	1.34	49	55
Do	3	24	N. C.	30	45	63	1.60	51	57
Do	3	24	W. B.	30	45	62	1.55	50	56
Do	10	6	N. C.	100	38	51	1.26	49	55
Do	10	6	W. B.	100	38	51	1.20	47	53
Squash	2	24	N. C.	19	28	41	1.00	49	55
Do	2	24	W. B.	19	28	38	.96	51	57
Do	2½	24	N. C.	30	45	62	1.39	45	50
Do	2½	24	W. B.	30	45	58	1.34	46	52
Do	3	24	N. C.	33	50	68	1.60	47	53
Do	3	24	W. B.	33	50	67	1.55	46	52
Do	10	6	N. C.	104	39	52	1.26	48	54
Do	10	6	W. B.	104	39	52	1.20	46	52
Succotash	2	24	N. C.	20	30	43	1.00	47	52
Do	2	24	W. B.	20	30	40	.96	48	54
Do	10	6	N. C.	106	40	53	1.26	48	53
Do	10	6	W. B.	106	40	53	1.20	45	51
Sweet potatoes	2½	24	N. C.	28	42	59	1.39	47	53
Do	2½	24	W. B.	28	42	55	1.34	49	55
Do	3	24	N. C.	31	46	64	1.60	50	56
Do	3	24	W. B.	31	46	63	1.55	49	55
Do	10	6	N. C.	100	38	51	1.26	49	55
Do	10	6	W. B.	100	38	51	1.20	47	53
Tomatoes and tomato sauce	2	24	N. C.	19	28	41	1.00	49	55
Do	2	24	W. B.	19	28	38	.96	51	57
Do	2½	24	N. C.	28	42	59	1.39	47	53
Do	2½	24	W. B.	28	42	55	1.34	49	55
Do	3	24	N. C.	33	50	68	1.60	47	53
Do	3	24	W. B.	33	50	67	1.55	46	52
Do	10	6	N. C.	103	39	52	1.26	48	54
Do	10	6	W. B.	103	39	52	1.20	46	52

EXPORT BOXES

Size of can	Number per case	Space per case	Case displacement filled by can contents	Tin plate per cubic foot displacement	Tin plate per cubic foot of can contents	Wood in one case	White pine (27 lbs. per cubic foot)	Yellow pine (40 lbs. per cubic foot)	Cottonwood (33 lbs. per cubic foot)	Red gum (35 lbs. per cubic foot)	Black gum (35 lbs. per cubic foot)	Birch and beech (41 lbs. per cubic foot)
Nailed construction: [a]		Cu. ft.	P. ct.	Sq. ft.	Sq. ft.	Cu. ft.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
1	24	0.598	52.7	12.6	23.9	0.152	4.1	6.1	4.3	5.2	5.3	6.7
1	48	1.106	57.0	13.6	23.9	.232	6.3	9.3	6.5	7.9	8.1	10.2
1 tall	24	.631	53.2	12.5	23.5	.158	4.3	6.3	4.4	5.4	5.5	7.0
1 tall	48	1.167	57.5	13.5	23.5	.240	6.5	9.6	6.7	8.2	8.4	10.6
2	24	1.005	56.4	11.0	19.5	.218	5.9	8.7	6.1	7.4	7.6	9.6
1-pound salmon	48	1.538	59.0	12.5	21.2	.293	7.9	11.7	8.2	9.9	10.2	12.8
Condensed milk	48	1.173	57.2	13.2	23.1	.240	6.5	9.9	6.9	8.4	8.6	10.9
Evaporated milk	48	1.480	58.8	11.8	21.5	.287	7.7	11.4	8.0	9.7	9.9	12.5
2½	24	1.399	58.4	10.3	17.1	.274	7.4	11.0	7.7	9.3	9.6	12.0
3	24	1.618	59.3	9.6	16.2	.304	8.2	12.2	8.5	10.3	10.6	13.4
8	6	1.109	56.6	6.6	11.8	.238	6.4	9.5	6.7	8.1	8.3	10.5
10	6	1.270	57.5	6.4	11.2	.259	6.9	10.2	7.2	8.7	9.0	11.3
Wire bound: [b]												
1	24	.566	55.7	13.3	23.9	.104	2.8	4.2	2.9	3.5	3.6	4.6
1	48	1.048	60.0	14.3	23.9	.140	3.8	5.6	3.9	4.8	4.9	6.2
1 tall	24	.599	56.0	13.1	23.3	.106	2.9	4.2	3.0	3.6	3.7	4.7
1 tall	48	1.108	60.5	14.2	23.5	.160	4.3	6.4	4.5	5.4	5.6	7.0
2	24	.959	59.2	11.5	19.5	.146	3.9	5.8	4.1	5.0	5.1	6.4
1-pound salmon	48	1.466	61.4	13.1	21.2	.192	5.2	7.7	5.4	6.5	6.7	8.4
Condensed milk	48	1.107	60.6	14.0	23.1	.164	4.4	6.6	4.6	5.6	5.7	7.2
Evaporated milk	48	1.411	61.7	12.3	21.5	.187	5.0	7.5	5.2	6.4	6.5	8.2
2½	24	1.337	61.2	10.8	17.1	.180	4.9	7.2	5.0	6.1	6.3	7.9
3	24	1.550	61.6	10.0	16.2	.198	5.3	7.9	5.5	6.7	6.9	8.7
8	6	1.041	60.4	7.1	11.8	.161	4.3	6.4	4.5	5.5	5.6	7.1
10	6	1.198	61.0	6.8	11.2	.244	6.6	9.8	6.8	8.3	8.5	10.7

[a] These boxes are of styles 1 and 2, constructed ⅞-inch ends and ⅝-inch sides, tops, and bottoms.

[b] This group constructed of ⅞-inch material, bound with ¾ by ⅛-inch cleats and 13-gage wire.

Appendix No. 2—Stowage Data on Fresh Fruits and Vegetables, Largely Taken from the Western Weighing and Inspection Bureau.

Commodity	Weight per cubic foot	Space per short ton	Space per long ton	How packed for shipment
	Pounds	Cubic feet	Cubic feet	
Apples	21–23	87–95	97–107	Standard barrels, 28½ inch staves, 17⅛ inch heads, 64 inches outside bilge circumference; average weight 150–160 pounds.
Do				Bushel baskets, 47 pounds; standard boxes, 50 pounds.
Apricots				Bushel baskets, 51 pounds.
Do	28	71	80	4-basket crates, 5 by 16½ by 17⅞ inches.
Do	34	59	66	Boxes, 3 by 12 by 19⅞ inches and 4½ by 12 by 20 inches.
Do	35	57	64	Boxes, 5 by 12 by 19⅞ inches.
Do	26	77	86	Boxes, 5½ by 16½ by 20 inches.
Beans, green	23	87	98	Hampers, 9 by 13 by 13½ inches and 10½ by 15½ by 18½ inches.
Beets	26	77	86	Hampers, 10½ by 15½ by 18 inches.
Blackberries. Same as Strawberries.				
Cabbage	26	77		Crates, 20 by 20 by 28 inches.
Cantaloupes	27	74	83	Hampers, 10½ by 15½ by 18½ inches.
Do	31	65	72	Crates, 4½ by 12⅞ by 23½ inches.
Do	28–35	57–71	70–80	Crates, 5–5½ by 13½–15½ by 22½–24 inches.
Do	30–31	65–67	72–75	Crates, 11½–12⅞ by 11½–12⅞ by 22–24 inches.
Carrots	21	95	107	Hampers, 10½ by 15½ by 18½ inches.
Cherries	26	77		Pint cups in crates, 6½–7⅜ by 14½–14⅞ by 19⅞ inches.
Do	30	67	75	24-pint boxes, 2-deck crates, 6–6½ by 13½–14⅞ by 19⅞ inches.
Do	32	63	70	16 baskets, 2-deck crates, 7½ by 10½ by 22 inches.
Do	24–29	69–83	77–93	Quart cups in crates, 7⅞–7⅞ by 10⅞–15⅞ by 22 inches.
Do	23–25	80–87	90–97	16-quart boxes in crates, 8⅞ by 10½ by 22½–23 inches.
Do	27	74	83	16 quarts in overhandled splint baskets, 7½ by 9 by 19½ inches.
Do	29	69	77	24-quart boxes, 2-deck crates, 7⅞–8½ by 15½–15⅞ by 22–22½ inches.
Do	26	77	86	24-quart boxes, 3-deck crates, 11⅛–11⅞ by 11⅛–11⅞ by 23⅜–23⅝ inches.
Do	25–35	57–80	64–90	In bulk in boxes, 2½–7½ by 9½–14½ by 19⅞–22 inches.
Crabapples	37	54	61	In bulk, 4½ by 12 by 20 inches.
Cranberries	20	100	112	Standard barrels, 28½ inch staves, 16½ inch heads, 58½ inches outside bilge circumference; average weight, 120 pounds.
Currants	21	95	107	16-quart boxes in crates, 8⅞ by 10½ by 22½ inches.
Do	20	100	112	24-quart boxes in crates, 8½ by 15⅞ by 22½ inches.
Gooseberries	23	87	98	16-quart boxes in crates, 8⅞ by 10½ by 22½ inches.
Do	24	83	93	24-quart boxes in crates, 8½ by 15⅞ by 22½ inches.
Grapefruit	29	69	77	Boxes, 13 by 13 by 27 inches.
Do	30	67	75	Boxes, 12½ by 13 by 27 inches.
Do	32	63	70	Boxes, 12½–12⅞ by 12½–12⅞ by 27 inches.
Do	33	61	68	Boxes, 12 by 12 by 26 inches; 12½ by 12½ by 27 inches; and 12½ by 12½ by 27 inches.
Do	34	59	66	Boxes, 12½ by 12½ by 28 inches.
Do	35	57	64	Boxes, 12 by 12 by 27–28 inches.
Grapes				In drums, 14-16½ inches diameter, not over 17 inches high; weight, 50 pounds.
Do				In Climax shipping baskets, top 6½ by 14½ inches, bottom 5 by 12½ inches, depth 5½ inches, weight 7 pounds.
Do	34–37	54–59	61–66	4-basket crates, 5–6 by 16–17 by 17½–18 inches.
Lemons	36	55	62	Boxes 11½ by 14 by 27 inches, 12 by 13½ by 27 inches; or 12 by 14½ by 27 inches.
Do	37	54	61	Boxes 10⅞–11⅛ by 14 by 27 inches; or 12½ by 12½ by 28 inches.
Do	39	51	57	Boxes 10½ by 14 by 27 inches.
Do	40	50	56	Boxes 10½ by 13 by 27 inches.
Do	44	45	51	Boxes 10 by 13½ by 27 inches.
Lettuce	17	117	132	In hampers 10½ by 15½ by 18½ inches.
Melons, Casaba	28	72	80	In crates 7½ by 17 by 23½ inches.
Do	29	69	77	In crates 8½ by 17 by 23½ inches.
Do	30	67	75	In crates 8 by 17 by 23½ inches.
Melons, honey dew	24	83	94	In crates 12½ by 12½ by 23½ inches.
Do	25	80	90	In crates 8 by 17 by 23½ inches or 9 by 17 by 23½ inches.
Do	26	77	86	In crates 7½ by 17 by 23½ inches or 8½ by 17 by 23½ inches.
Do	30	67	75	In crates 6½ by 15 by 23½ inches or 6½ by 15½ by 23½ inches.
Onions	50	40	45	In crates 9½ or 10½ by 11 or 11½ by 19½ inches.
Oranges	30	67	75	In boxes 12½ by 14 by 26 inches.
Do	31	65	72	In boxes 12 by 14½ by 26 inches.
Do	34	59	66	In boxes 13 by 13 by 27 inches.

Appendix No. 2—Stowage Data on Fresh Fruits and Vegetables, Largely Taken from the Western Weighing and Inspection Bureau—Concluded.

Commodity	Weight per cubic foot	Space per short ton	Space per long ton	How packed for shipment
	Pounds	Cubic feet	Cubic feet	
Oranges	37	54	61	In boxes 11 by 14 by 27 inches, 11½ by 14 by 27 inches, 12 by 12 by 26 inches, 12 by 12½ by 26 inches, or 12 by 12 by 26½ inches.
Do	38	53	59	In boxes 11½ by 12 by 26½ inches.
Do	39	51	57	In boxes 12 by 12 by 26½ inches or 12 by 12 by 28 inches.
Do	43	47	52	In boxes 11½ by 11½ by 26 inches.
Parsnips				In bushel baskets, average weight 43 pounds.
Peaches	33	62	68	In boxes or crates, 5½ by 12 by 20 inches.
Do	34	61	66	In boxes or crates, 5 by 12 by 20 inches.
Do	35	59	64	In boxes or crates, 4½ by 12 by 19½ inches.
Grown in Idaho				In bushel baskets, average weight 52 pounds.
Grown in Arkansas, Colorado, Oklahoma, and Utah.				In bushel baskets, average weight 53 pounds.
Grown in Missouri and Texas.				In bushel baskets, average weight 54 pounds.
Pears				In barrels, average weight 187 pounds.
Do				In bushel baskets, average weight 56 pounds.
Do	33	62	68	In boxes 11 by 12 by 19⅞ inches.
Do	38	54	59	In boxes 5 by 12 by 19⅞ inches.
Do	39	53	58	In boxes 9½ by 12 by 20 inches.
Do	40	50	56	In boxes 9 by 12 by 20 inches.
Do	42	49	53	In boxes 9 by 12 by 19⅞ inches.
Pineapples, Cuban	27	76	83	4-basket crates.
Do	27	76	83	In crates 11 by 13 by 36 inches.
Plums				In bushel baskets, average weight 60 pounds.
Do	30	67	75	4-basket crates 5 by 16½ by 17½ inches.
Do	38	54	59	4-basket crates 4 by 16 by 17 inches.
Do	31	67	72	In bulk in boxes or crates 5½ by 16½ by 18 inches.
Do	37	56	61	In bulk in boxes or crates 5 by 12 by 19⅞ inches.
Do	39	53	58	In bulk in boxes or crates 3 by 12 by 19⅞ inches.
Potatoes	37	54	60	Standard barrels.
Do	42	41	55	Bags, 150 pounds.
Potatoes, sweet	23	87	97	Standard barrels, 28½ inch staves, 17⅛ inch heads, 64 inches, outside bilge circumference; average weight, 164 pounds
Potatoes, sweet				In bushel baskets, average weight 52 pounds.
Prunes:				
German	47	43	48	In bulk in boxes, 3½ by 11⅞ by 19⅞ inches.
Hungarian	35	57	64	4-basket crates, 5 by 16½ by 17⅛ inches.
Italian	32	62	70	In bulk in boxes, 5 by 16½ by 17¼ inches.
Do	34	59	66	In bulk in boxes, 4½ by 12 by 19⅞ inches.
Do	42	48	53	In bulk in boxes, 3½ by 12 by 19⅞ inches.
Silver	33	61	68	4-basket crates, 4½ by 16½ by 17⅞ inches.
Radishes				In barrels with cloth tops, packed in ice, average weight 210 pounds.
Do	22	91	102	Standard barrels with cloth tops, 28½ inch staves, 17⅛ inch heads, 64 inches outside bilge diameter; average weight not packed in ice, 158 pounds.
Raspberries. See Strawberries.				
Spinach	20	100	112	With ice, in hampers, 10½ by 15½ by 18½ inches.
Do	17	117	132	Without ice, in hampers, 10½ by 15½ by 18½ inches.
Strawberries, blackberries, and raspberries.	14	143	160	In cups in crates, 7½ by 14½ by 19⅞ inches.
Do	26	77	86	16-quart boxes in crates, 7½ by 9½ by 22 inches.
Do	21	95	107	16-quart boxes in crates, 8⅞ by 10½ by 22½ inches.
Do	22	91	102	24-quart boxes in crates, 8½ by 15½ by 22½ inches.
Do	19–22	91–105	102–118	24-quart boxes in crates, 11–12 by 13 by 22–24 inches.
Tomatoes				In bushel baskets, average weight 56 pounds.
Do	30	67	75	In crates, 10½ by 11 by 23 inches.
Do	37	54	61	In crates, 4½ by 12 by 20 inches.
Do	39	51	57	In crates, 10⅞ by 12½ by 19⅞ inches.
Do				In crates, top 13½ by 22 inches, bottom 11½ by 22 inches, depth 5 inches.
Do	27–35	57–74	64–83	In crates, 5 by 12–14 by 19½–22 inches.

SHIP PLANS

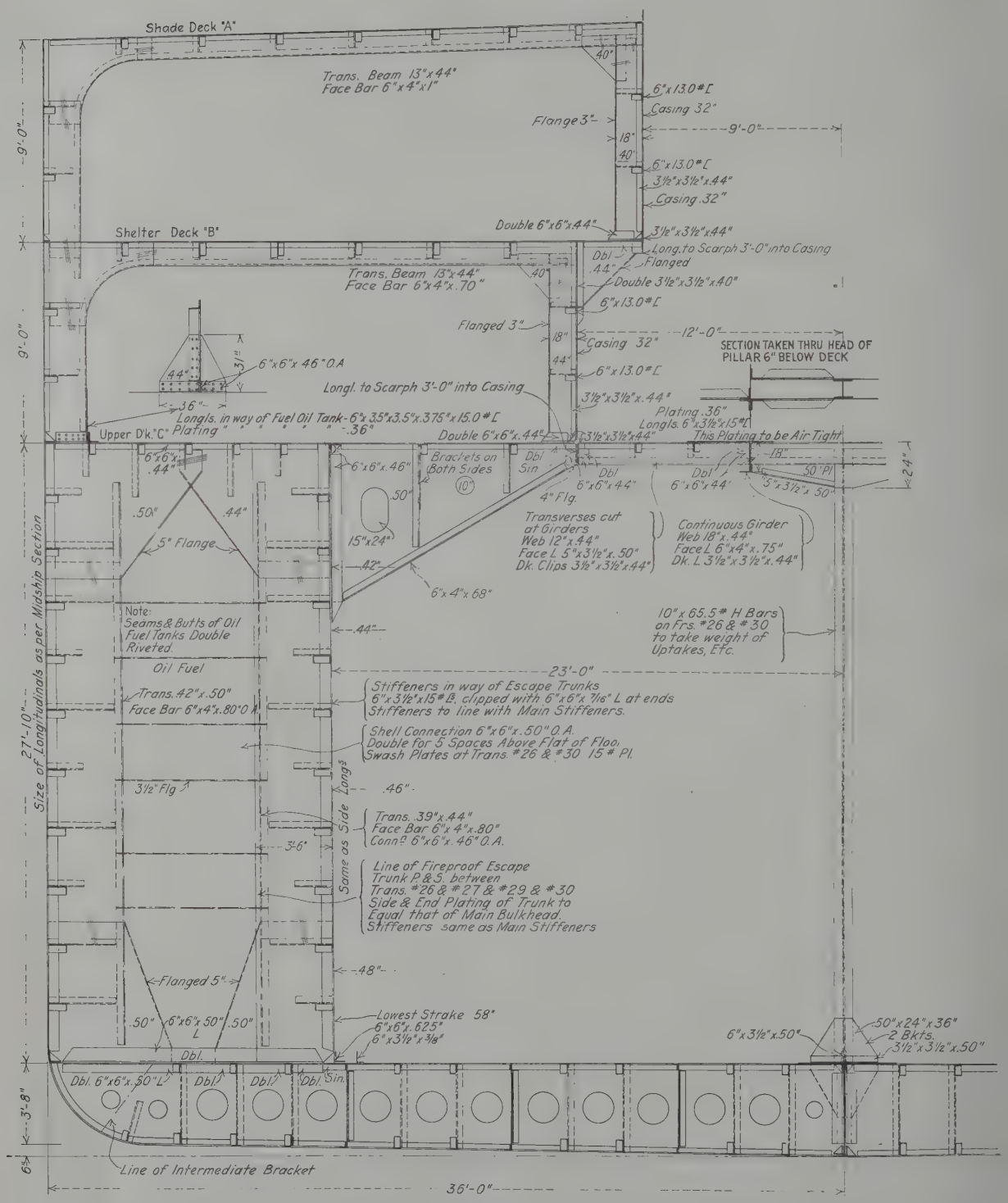
The plans in this Section are divided into two general groups. The arrangement, contract, capacity and midship section plans of the various types of vessels are placed in the first group, and the detail working drawings in the second group. This method, while separating the arrangement and detail plans of a particular vessel, makes it possible to assemble a fairly complete set of typical working drawings in a logical sequence.

In the first group, however, all the arrangement, capacity and midship section plans of a particular vessel are kept together. In addition to this, all the vessels of a class, starting with Passenger, Freighter, Tanker, etc., follow one another in the order of their deadweight tonnage or size.

In the second group, the detail working drawings are placed in the order in which a vessel is constructed and, therefore, in the sequence that they should be made. In addition to this system, the references in the Dictionary Section will enable one readily to find any plan desired, and for this reason it is believed that an index to the plans is unnecessary.

The editors desire to express their appreciation to the Emergency Fleet Corporation, the Naval Architects, and the Shipyards for the drawings furnished. Acknowledgment has been made on each plan where so desired.

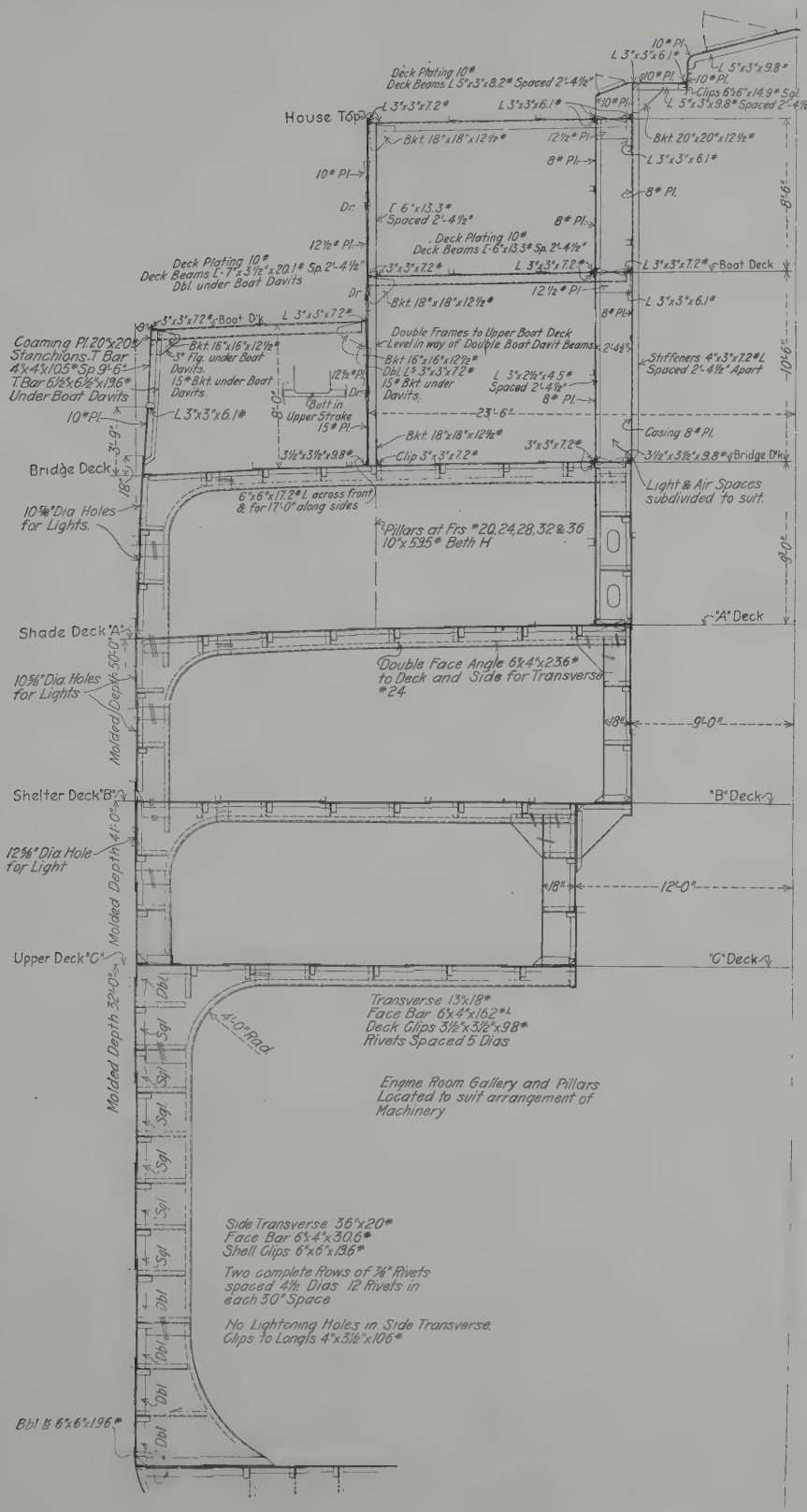
SECTION THRU BOILER ROOM



13,000-TON D. W. COMBINED PASSENGER AND FREIGHTER

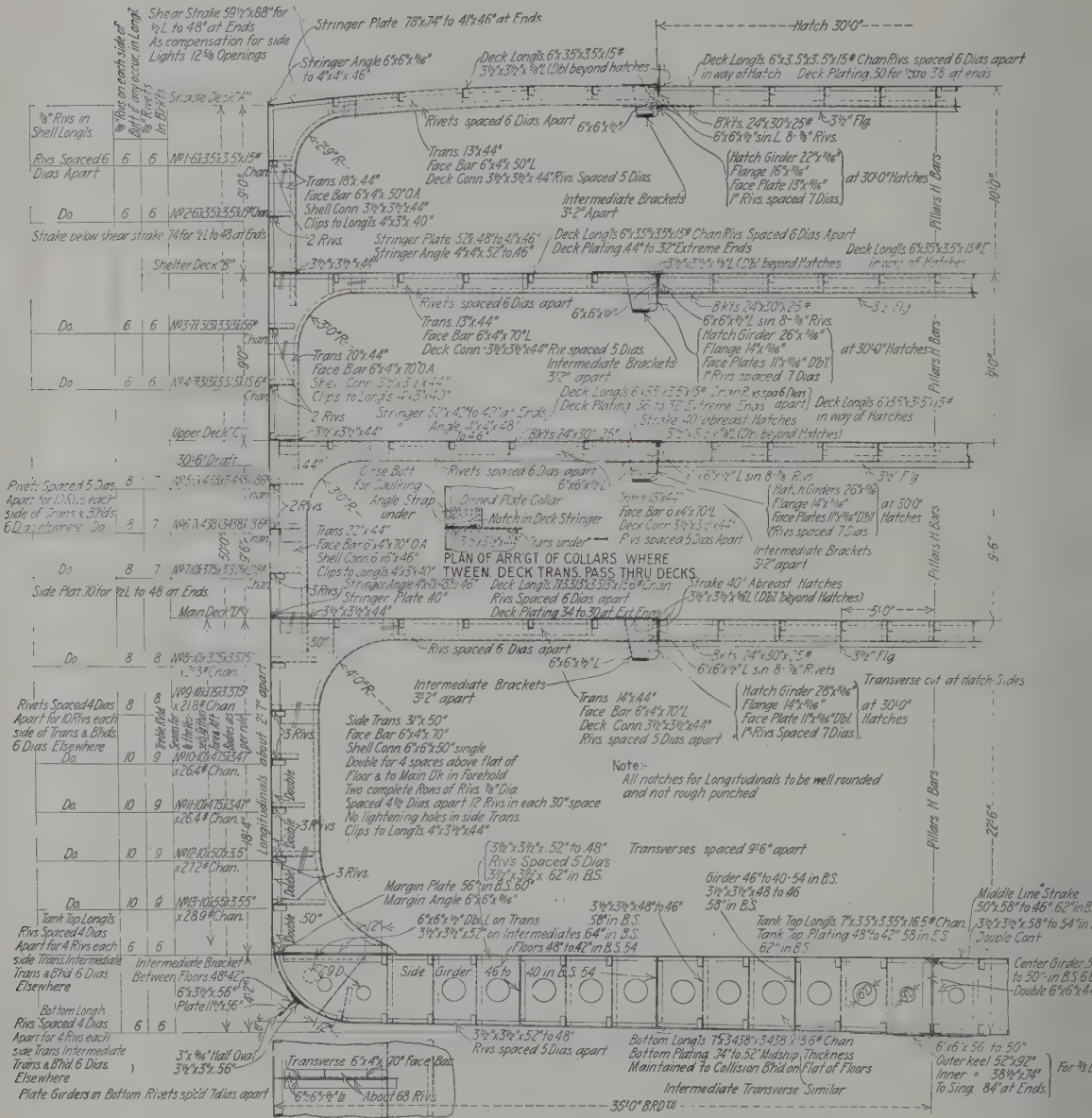
Builders, Bethlehem Shipbuilding Corp.
New York Shipbuilding Corp.

SECTION THRU BRIDGE AND ENGINE ROOM



13,000-TON D. W. COMBINED PASSENGER AND FREIGHTER

Builders, Bethlehem Shipbuilding Corp.
New York Shipbuilding Corp.


Hatch 30'0"
Stringer Plate 78"x.74" to 41"x.46" at Ends
Shear Strake 59½"x.88" for ½L to 48' at Ends. As compensation for side Lights 12⅜ Openings
Stringer Angle 6"x6"x⅝" to 4"x4"x.46"
Deck Long'ls. 6"x.35"x3.5"x.15# Chan Rivs. spaced 6 Dias apart in way of Hatch
Deck Plating .50 for ½L to 38' at ends
Rivets spaced 6 Dias. Apart
6"x6"x½"
8 K'ls. 24"x.30"x.25#
3½" Flg
6"x6"x½" sin. L. 8-⅞" Rivs.
Hatch Girder 22"x⅝"
Flange 16"x⅝"
Face Plate 13"x⅝"
1st Rivs. spaced 7 Dias.
at 30'-0" Hatches
Trans. 13"x.44"
Face Bar 6"x.4"x.50"L
Deck Conn. 3½"x3½"x.44" Rivs. Spaced 5 Dias.
Trans. 18"x.44"
Face Bar 6"x.4"x.50" O.A.
Shell Conn 3½"x3½"x.44"
Clips to Long'ls 4"x3"x.40"
Intermediate Brackets 3'-2" Apart
Pillars H Bars
2 Rivs.
Stringer Plate 52"x.48" to 41"x.46"
Stringer Angle 4"x4"x.52" to .46"
Deck Long'ls 6"x.35"x3.5"x.15# Chan Rivs Spaced 6 Dias Apart
Deck Plating .44" to .32" Extreme Ends
Deck Long'ls 6"x.35"x3.5"x.15#L (Obl beyond Hatches
in way of Hatches
Shelter Deck "B"
Trans. 13"x.44"
Face Bar 6"x.4"x.70"L
Deck Conn. 3½"x3½"x.44" Riv. spaced 5 Dias.
Trans. 20"x.44"
Face Bar 6"x.4"x.70" O.A.
Clips to Long'ls 4"x3"x.40"
Intermediate Brackets 3'-2" apart
Deck Long'ls 6"x.35"x3.5"x.15# Chan Rivs spaced 6 Dias
Deck Plating .36 to .32" Extreme Ends apart
Deck Long'ls 6"x.35"x3.5"x.15# in way of Hatches
Strake 40' abreast Hatches
3½"x3"x⅞" (Obl beyond Hatches)
Upper Deck "C"
30'-6" Draft
Rivets spaced 6 Dias. apart
Close Butt for Caulking
Raised Plate Collar
Notch in Deck Stringer
Angle Strap under
Trans. under
PLAN OF ARR'GT OF COLLARS WHERE TWEEN DECK TRANS. PASS THRU DECKS
Trans. 18"x.44"
Face Bar 6"x.4"x.70"L
Deck Conn. 3½"x3½"x.44"
Rivs. spaced 5 Dias Apart
Hatch Girders 26"x⅝"
Flange 14"x⅝"
Face Plates 11"x⅝" Obl
(Rivs spaced 7 Dias.)
at 30'-0" Hatches
Intermediate Brackets 3'-2" apart
Strake 40' Abreast Hatches
3½"x3½"x⅝"L (Obl beyond Hatches)
Side Plat. 10 for ½L to 48 at Ends.
Main Deck "D"
Deck Long'ls 7"x3.5"x3.5"x.15# Chan
Rivs Spaced 6 Dias apart
Deck Plating .34 to .30 at Ext. Ends
Rivs spaced 6 Dias. apart
8 K'ls. 24"x.30"x.25#
6"x6"x⅝"L sin 8-⅞" Rivets
3½" Flg
Transverse cut at Hatch Sides
Intermediate Brackets 3'-2" apart
Trans. 14"x.44"
Face Bar 6"x.4"x.70"L
Deck Conn. 3½"x3½"x.44"
Rivs. spaced 5 Dias apart
Hatch Girder 28"x⅝"
Flange 14"x⅝"
Face Plate 11"x⅝" Obl
1st Rivs Spaced 7 Dias.
at 30'-0" Hatches
Side Trans. 31"x.50"
Face Bar 6"x.4"x.70"
Shell Conn. 6"x6"x.50" single
Double for 4 spaces above flat of Floor & to Main Dk in Forehold
Two complete Rows of Rivs. ⅞" Dia.
Spaced 4½ Dias. apart 12 Rivs in each 30" space
No lightening holes in side Trans.
Clips to Long'ls. 4"x3½"x.44"
Note:- All notches for Longitudinals to be well rounded and not rough punched
Longitudinals about 2'-1" apart
3 Rivs.
Transverses spaced 9'-6" apart
3½"x3½"x.52" to .48" Rivs Spaced 5 Dias
3½"x3½"x.62" in B.S.
Margin Plate 56" in B.S. 60"
Margin Angle 6"x6"x⅝"
Girder 46" to 40-54 in B.S.
3½"x3½"x48 to 46
58" in B.S.
Middle Line Strake .50" 58" to 46" .62" in B
3½"x3½"x.58" to 54" in
Double Cont
6"x6"x⅝" Obl L on Trans
3½"x3½"x.52" on Intermediates 64" in B.S.
Floors 48" to 42" in B.S. 54
Tank Top Long'ls 7"x3.5"x3.5"x16.5# Chan.
Tank Top Plating 48" to 42" 58 in B.S.
62" in B.S.
Intermediate Bracket Between Floors 48"-42"
6"x3½"x.56"
Plate 11"x.56"
Side Girder 46" to 40 in B.S. 54
Center Girder 5
to 50"-in B.S. 6
Double 6"x6"x.4
Bottom Long'ls
Rivs Spaced 4 Dias Apart for 4 Rivs each side Trans. Intermediate Trans. & Bhd. 6 Dias Elsewhere
3"x⅝" Half Oval
3½"x3"x.56"
3½"x3½"x.52" to 48" Rivs spaced 5 Dias. apart
Bottom Long'ls 7"x3438"x3438"x.36# Chan
Bottom Plating .74" to .52" Midship Thickness
Maintained to Collision Bhd. on Flat of Floors
Intermediate Transverse Similar
6"x16"x.56" to 50"
Outer keel 52"x.92"
Inner " 38½"x.74"
To Sing. 84" at Ends.
Plate Girders in Bottom Rivets spc'd 7 dias apart
Transverse 6"x4"x.70" Face Bar
6"x6"x½"L
About 68 Rivs.
35'-0" B.R.D.
Rivets in Shell Long'ls.
Rivs Spaced 6 Dias Apart
Strake Deck "A"
Strake below shear strake 74 for ½L to 48 at Ends
Shelter Deck "B"
Upper Deck "C"
Main Deck "D"
Tank Top Long'ls
Rivs Spaced 4 Dias Apart for 4 Rivs each side Trans. Intermediate Trans. & Bhd. 6 Dias Elsewhere
Bottom Long'ls
Rivs Spaced 4 Dias Apart for 4 Rivs each side Trans. Intermediate Trans. & Bhd. 6 Dias Elsewhere
Rivets Spaced 4 Dias Apart for 10 Rivs each side of Trans. & Bhds. 6 Dias. Elsewhere
Double
Treble Flat Seamless & Welded Strake at Sheer Strake as required
Rivs on each side of Butt if any occur in Long'l
⅞" Rivets
In Bhds

PLAN OF TRANSVERSE CONNECTION TO TANK TOP

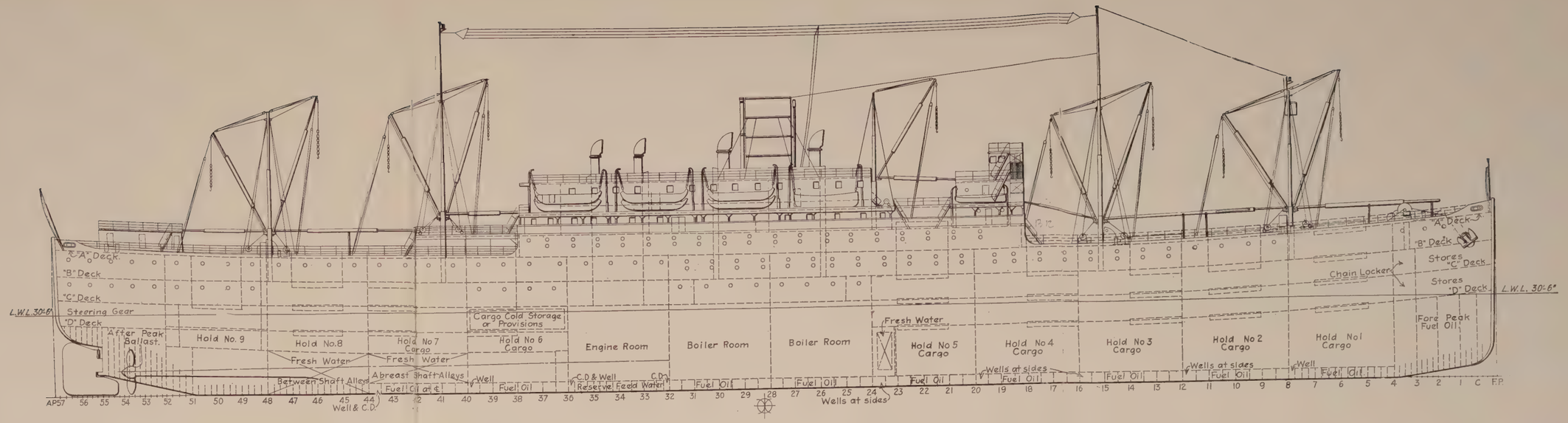
Dimensions

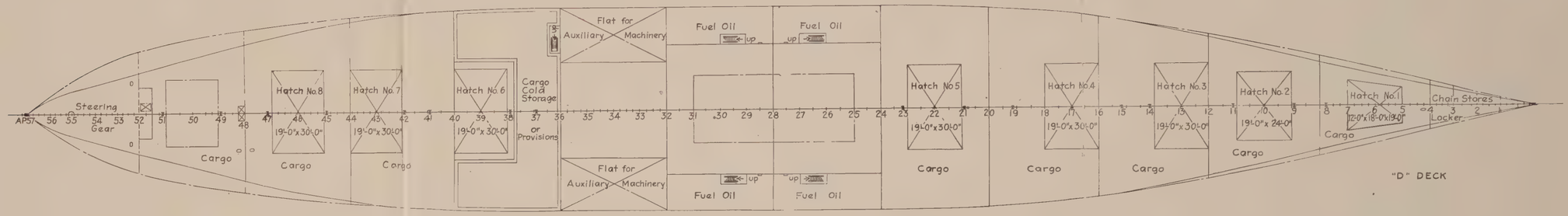
Length O. A.	535' 0"
Length B. P.	534' 0"
Beam, molded	72' 0"
Depth to "C" deck	32' 0"
Equipment numeral, A. B. S.	12,854
Equipment numeral, Lloyd's	63,777

Equipment

2 Bower anchors, stockless	11,704 lbs.	each
1 Bower anchor, stockless	9,968 lbs.	
1 Stream anchor, stockless	4,340 lbs.	
1 Kedge anchor, stockless	2,240 lbs.	
Chain cable	330 fathoms	2 1/8" dia.
Stream wire	120 fathoms	6" circ.
Towline	130 fathoms	7" circ.
2 Hawsers	120 fathoms each	8" circ.
2 Warps	120 fathoms each	8" circ.

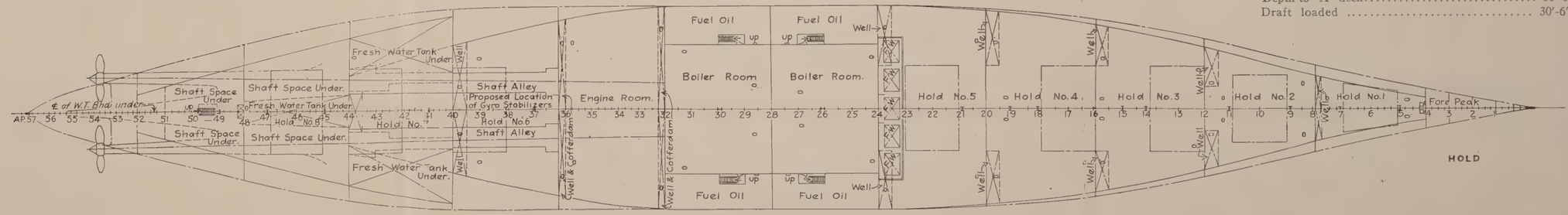
13,000-TON D. W. COMBINED PASSENGER AND FREIGHTER
Builders, Bethlehem Shipbuilding Corp.
New York Shipbuilding Corp.





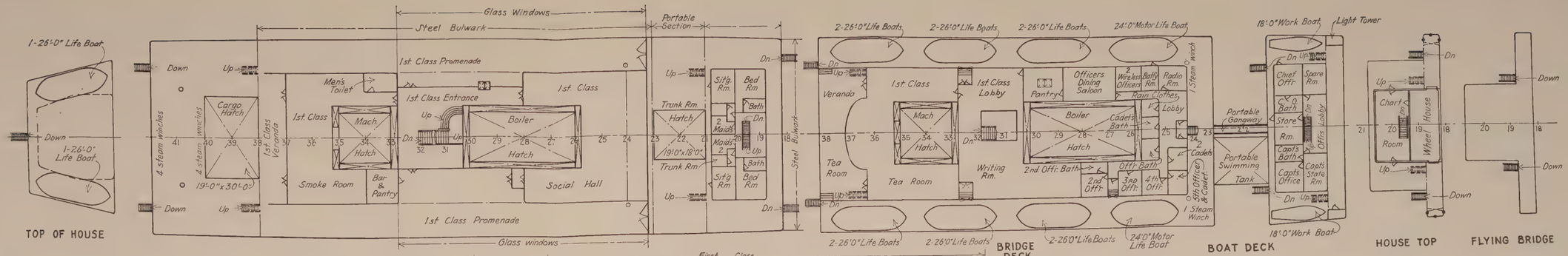
Principal Dimensions

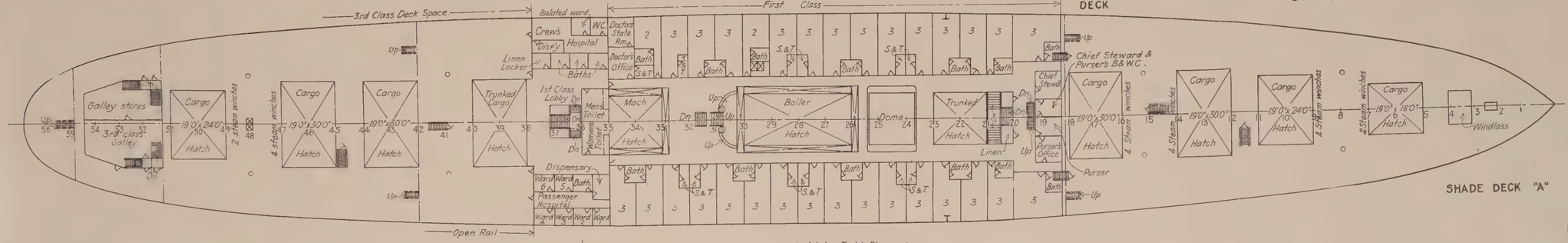
Length O. A.	535'-0"
Length B. P.	534'-0"
Beam molded	72'-0"
Depth to "A" deck	50'-0"
Draft loaded	30'-6"

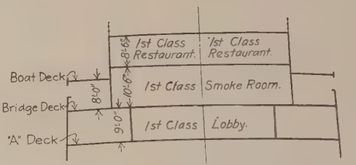


PROFILE, PLATFORM DECK AND HOLD PLANS
13,000-TON D.W. COMBINED PASSENGER AND FREIGHTER
Builders, Bethlehem Shipbuilding Corp.
New York Shipbuilding Corp.

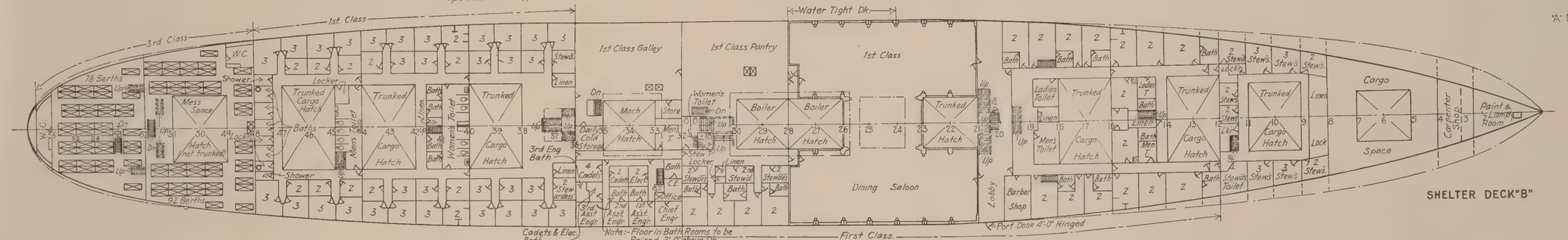
PLATE V

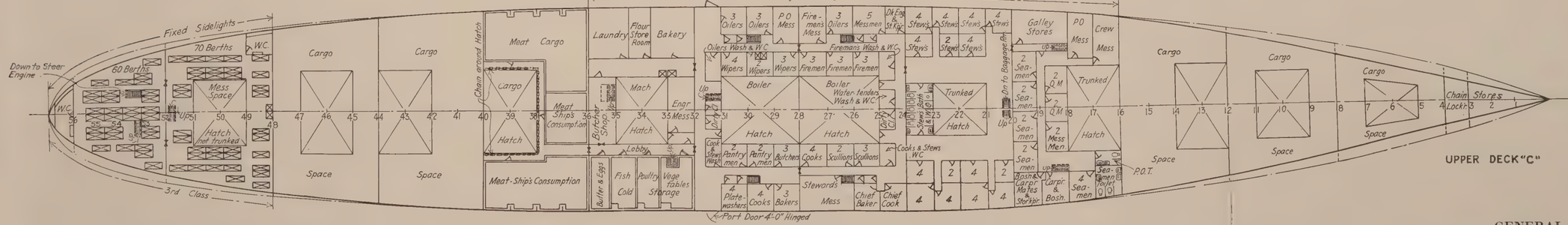






SECTION THRU PUBLIC ROOMS





Dimensions:-

Length O.A	535'-0"
Breadth Mld	72'-0"
Depth Shade Dk	50'-0"

Passenger List:-

1st Class		253
3rd Class		300
	Total	553
Maids		4
	Total	557

Crew List:-

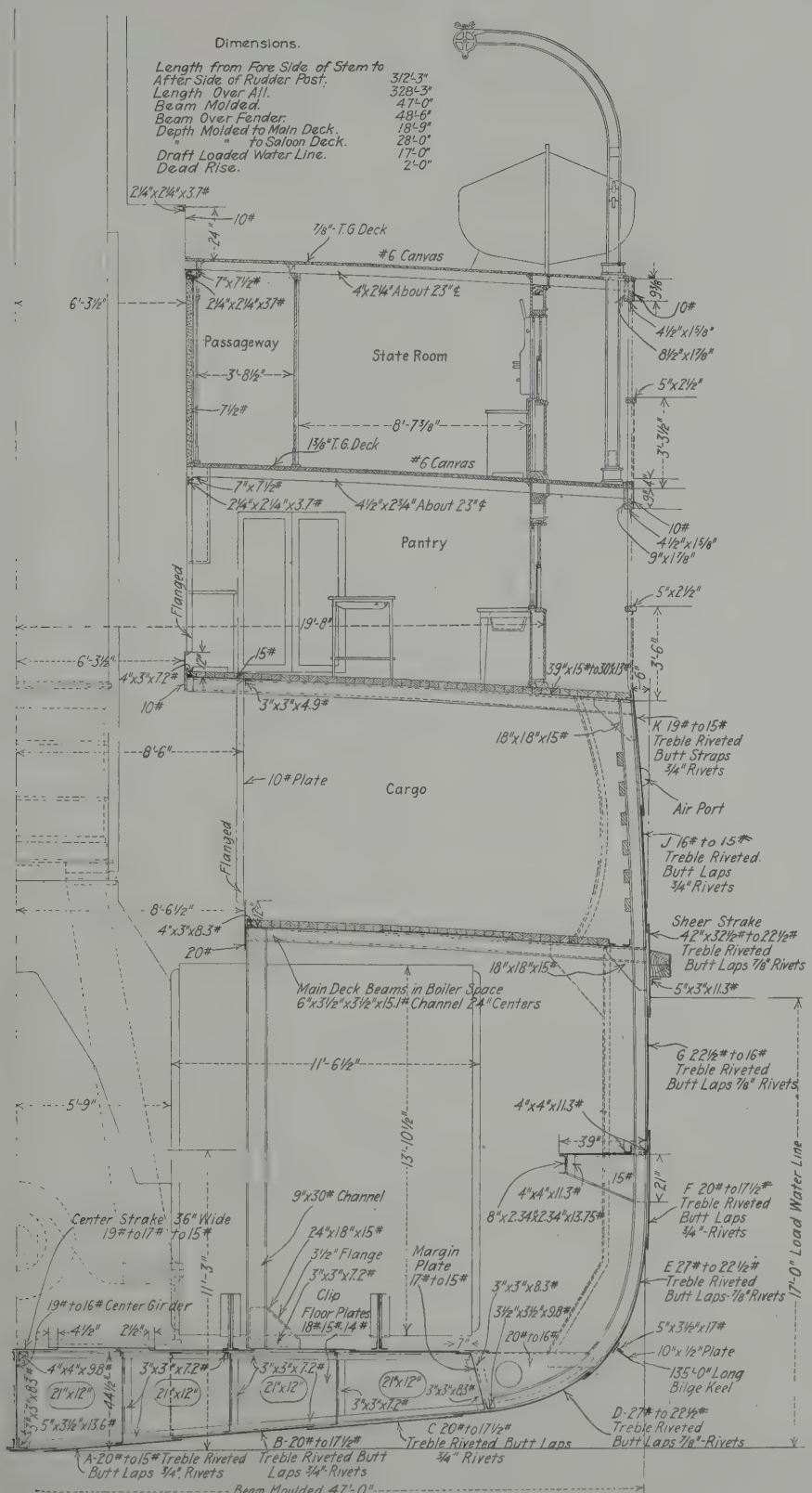
Spare Room		1
Deck Dept		33
Eng Dept		46
Stewards Dept		117
	Total	197
	Total	754

Boat Dk { 12 - 26'-0" Life Boats @ 50 Pass Each 600
2 - 24'-0" Motor Life Boats @ 35 Pass Each 70
Aft Dk House - 2 - 26'-0" Life Boats @ 50 Pass. Each 100
Total 770

Note:- Doors shown in Bhds Nos 20, 24, 28, 32, 36 & 54 above "C" Dk to be 26"x60" Hor Sliding W.T. Doors, and to be operated from "B" Deck. Doors shown in Bhds Nos 12, 16, 20, 28, 32, 36, 40 & 44 above "B" Dk to be 26"x60" hinged W.T. Doors.

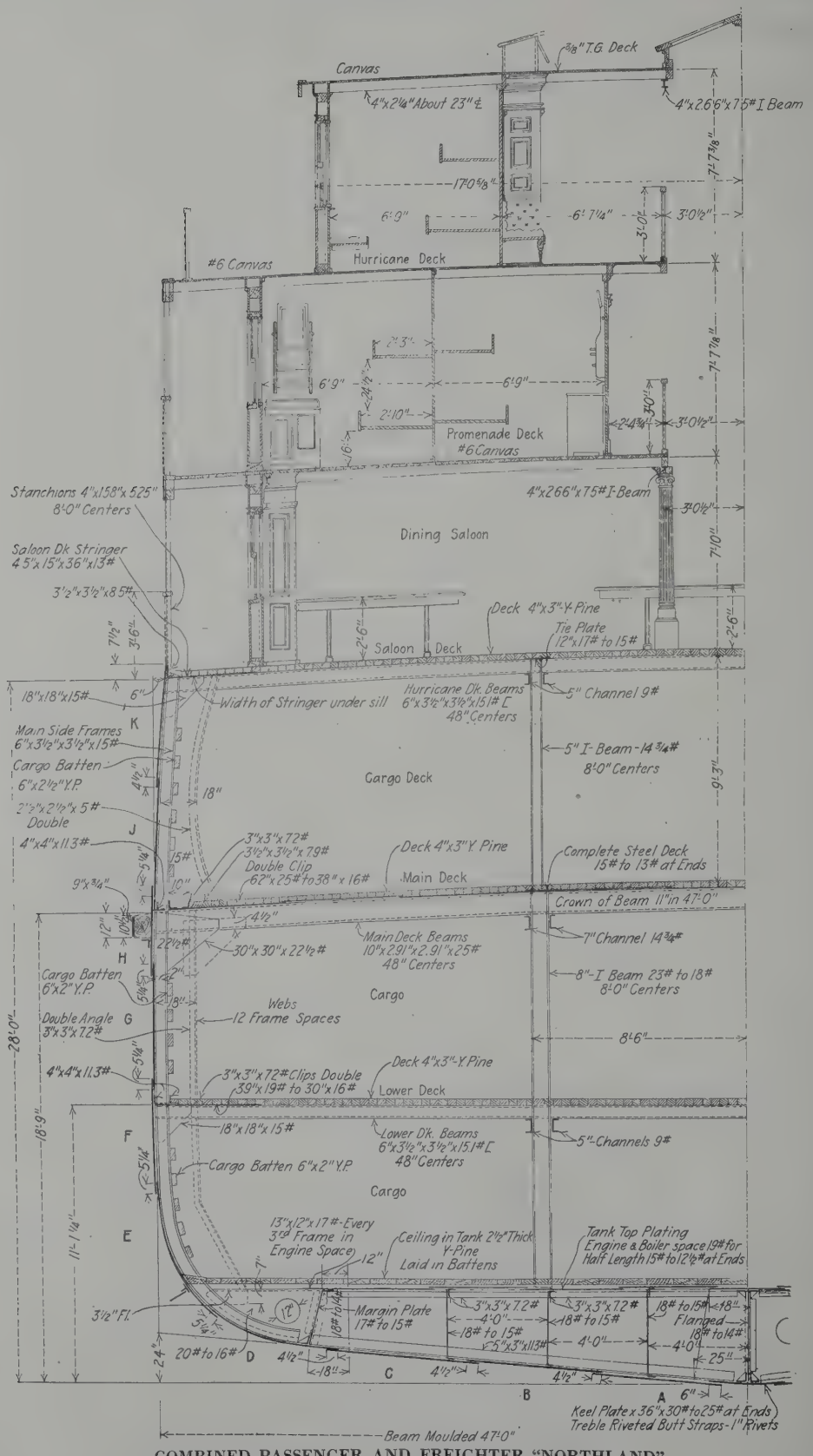
GENERAL ARRANGEMENT OF DECKS
13,000-TON D.W. COMBINED PASSENGER AND FREIGHTER
Builders, Bethlehem Shipbuilding Corp.
New York Shipbuilding Corp.

PLATE VI

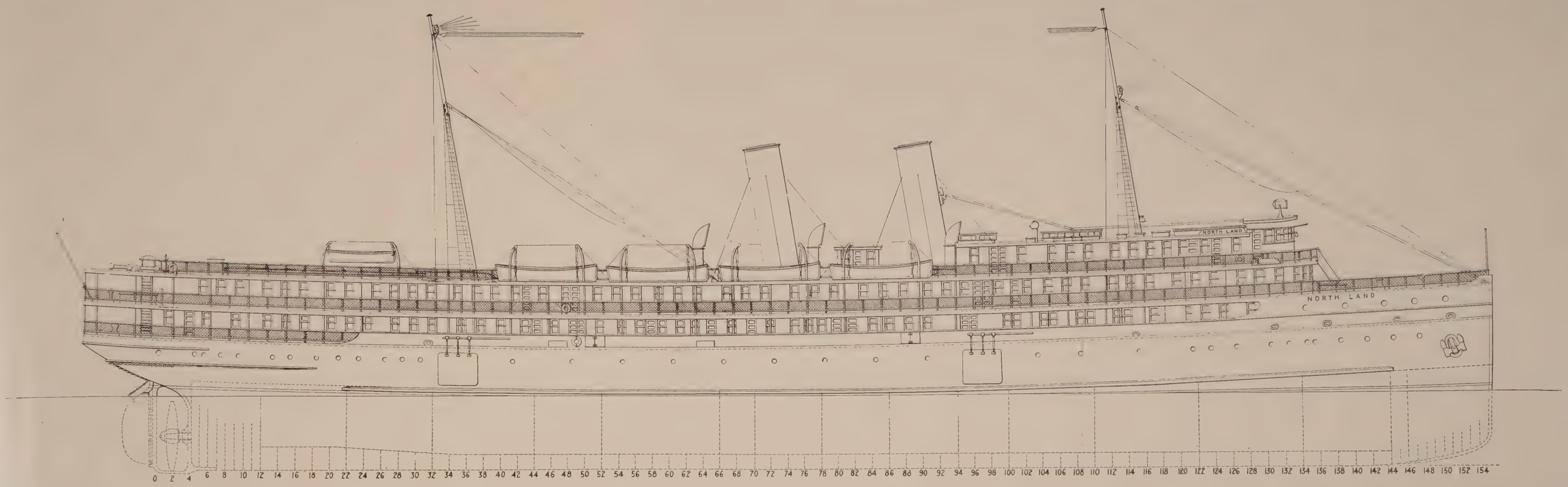

Dimensions.
Length from Fore Side of Stem to After Side of Rudder Post. 312'-3"
Length Over All. 328'-3"
Beam Molded. 47'-0"
Beam Over Fender. 48'-6"
Depth Molded to Main Deck. 18'-9"
" " to Saloon Deck. 28'-0"
Draft Loaded Water Line. 17'-0"
Dead Rise. 2'-0"
Passageway
State Room
Pantry
Cargo
#6 Canvas
7/8"-T.G Deck
1 3/8"T.G Deck
Flanged
Air Port
Sheer Strake 42"x32½#to22½# Treble Riveted Butt Laps 7/8" Rivets
K 19# to 15# Treble Riveted Butt Straps ¾" Rivets
J 16# to 15# Treble Riveted Butt Laps ¾" Rivets
G 22½# to 16# Treble Riveted Butt Laps 7/8" Rivets
F 20# to 17½# Treble Riveted Butt Laps ¾"-Rivets
E 27# to 22½# Treble Riveted Butt Laps-7/8"Rivets
D-27# to 22½# Treble Riveted Butt Laps 7/8"-Rivets
C 20# to 17½# Treble Riveted Butt Laps ¾" Rivets
B-20# to 17½# Treble Riveted Butt Laps ¾"-Rivets
A-20# to 15# Treble Riveted Butt Laps ¾" Rivets
Main Deck Beams in Boiler Space 6"x3½"x3½"x15.1# Channel 24" Centers
Center Strake 36" Wide 19# to 17# to 15#
19# to 16# Center Girder
Margin Plate 17# to 15#
Clip
Floor Plates 18#-15#-14#
10" x ½" Plate
135'-0" Long Bilge Keel
17'-0" Load Water Line
Beam Moulded 47'-0"

COMBINED PASSENGER AND FREIGHTER, "NORTHLAND"

Builders, Bethlehem Shipbuilding Corp.



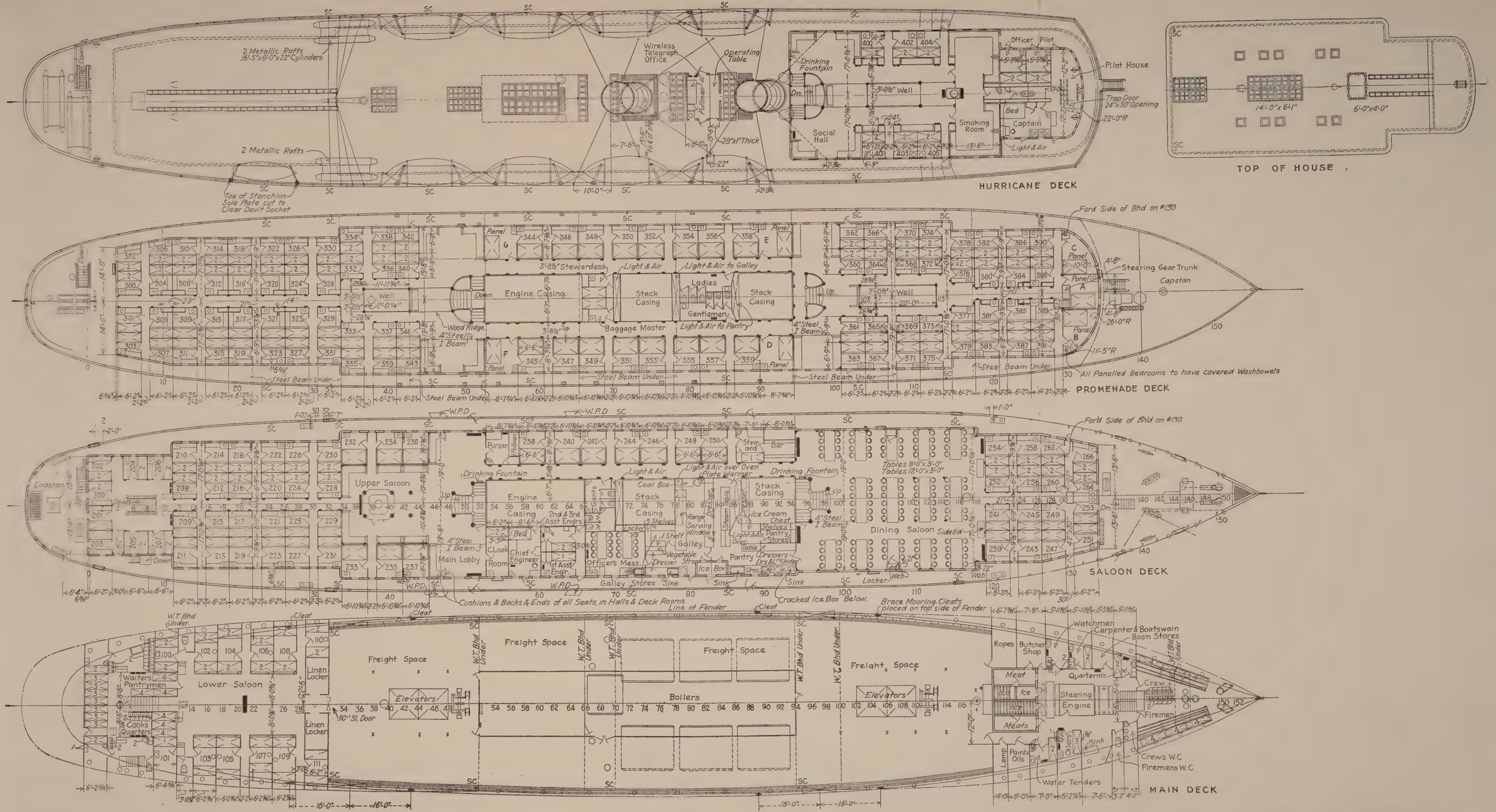
COMBINED PASSENGER AND FREIGHTER "NORTHLAND"
Builders, Bethlehem Shipbuilding Corp.



Principal Dimensions

Length over all	328′—3″
Length B. P.	312′—3″
Beam molded	47′—0″
Beam over Fender	48′—6″
Depth molded to Main Deck	18′—9″
Depth molded to Saloon Deck	28′—0″
Draft loaded Water Line	17′—0″
Dead Rise	2′—0″

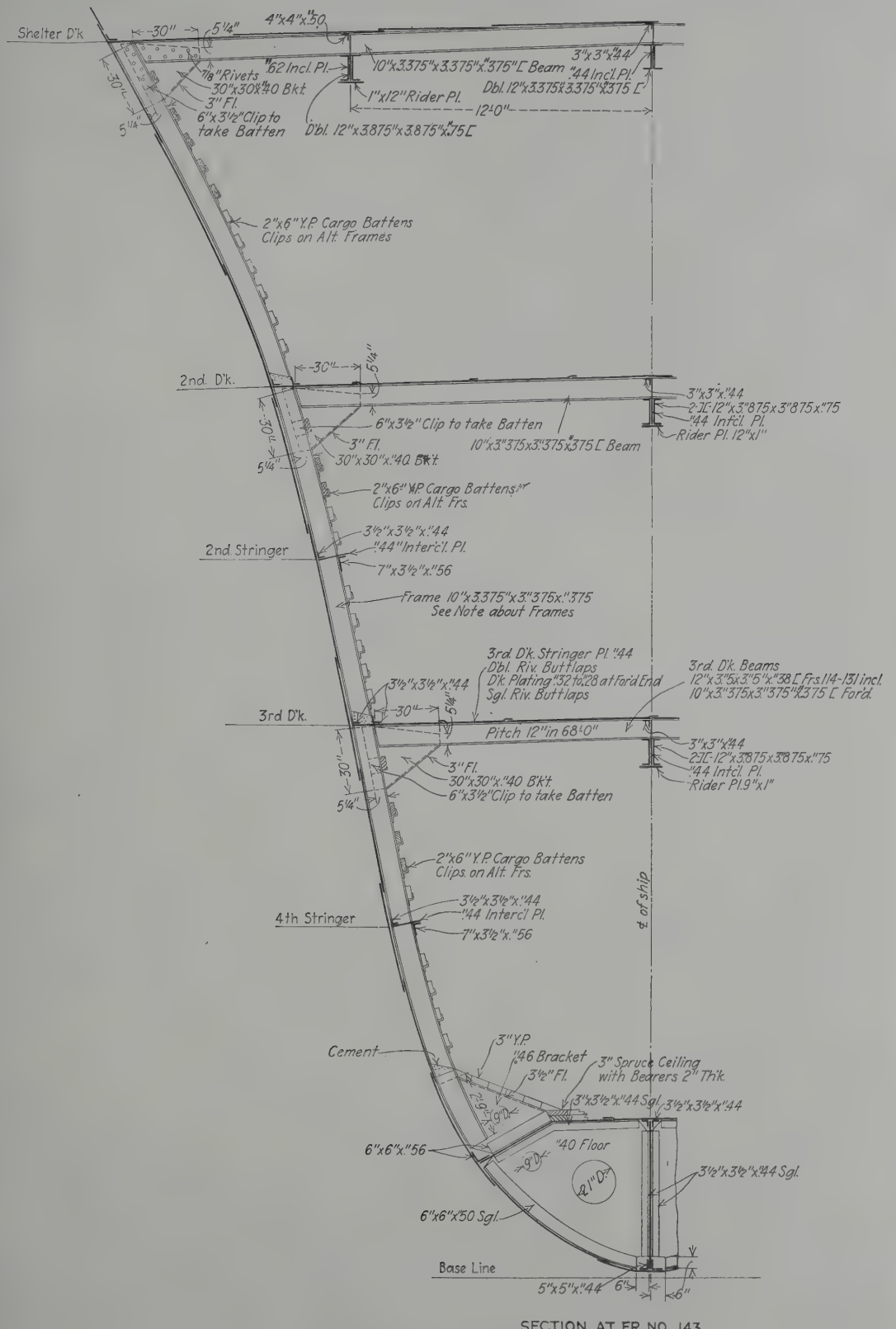
PROFILE OF COMBINED PASSENGER AND FREIGHTER "NORTHLAND"
Builders, Bethlehem Shipbuilding Corp.



GENERAL ARRANGEMENT PLAN
COMBINED PASSENGER AND FREIGHTER "NORTHLAND"
Builders, Bethlehem Shipbuilding Corp.

PLATE VIII

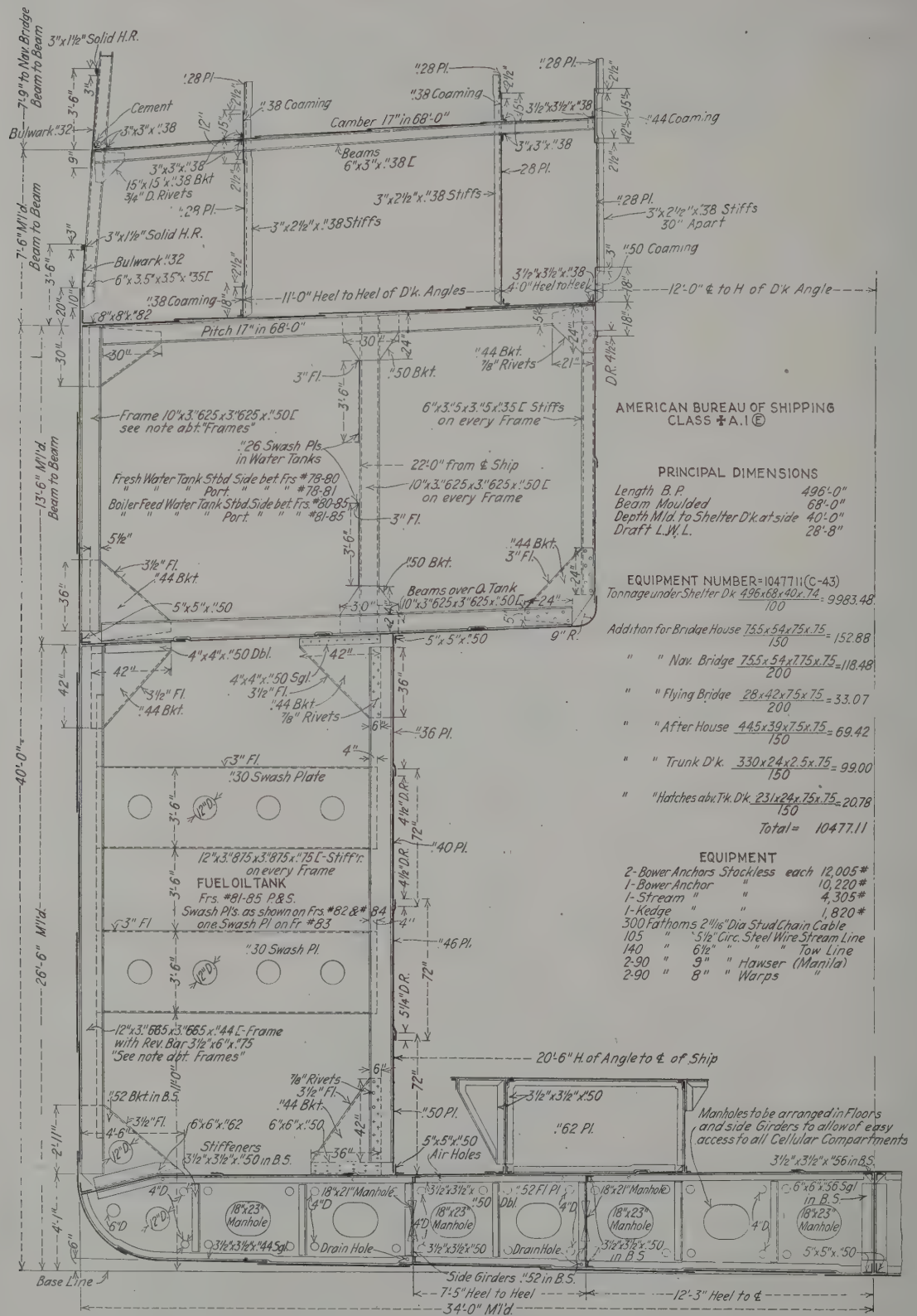
TYPICAL FRAMING, FORWARD



SECTION AT FR. NO. 143
LOOKING FORD.

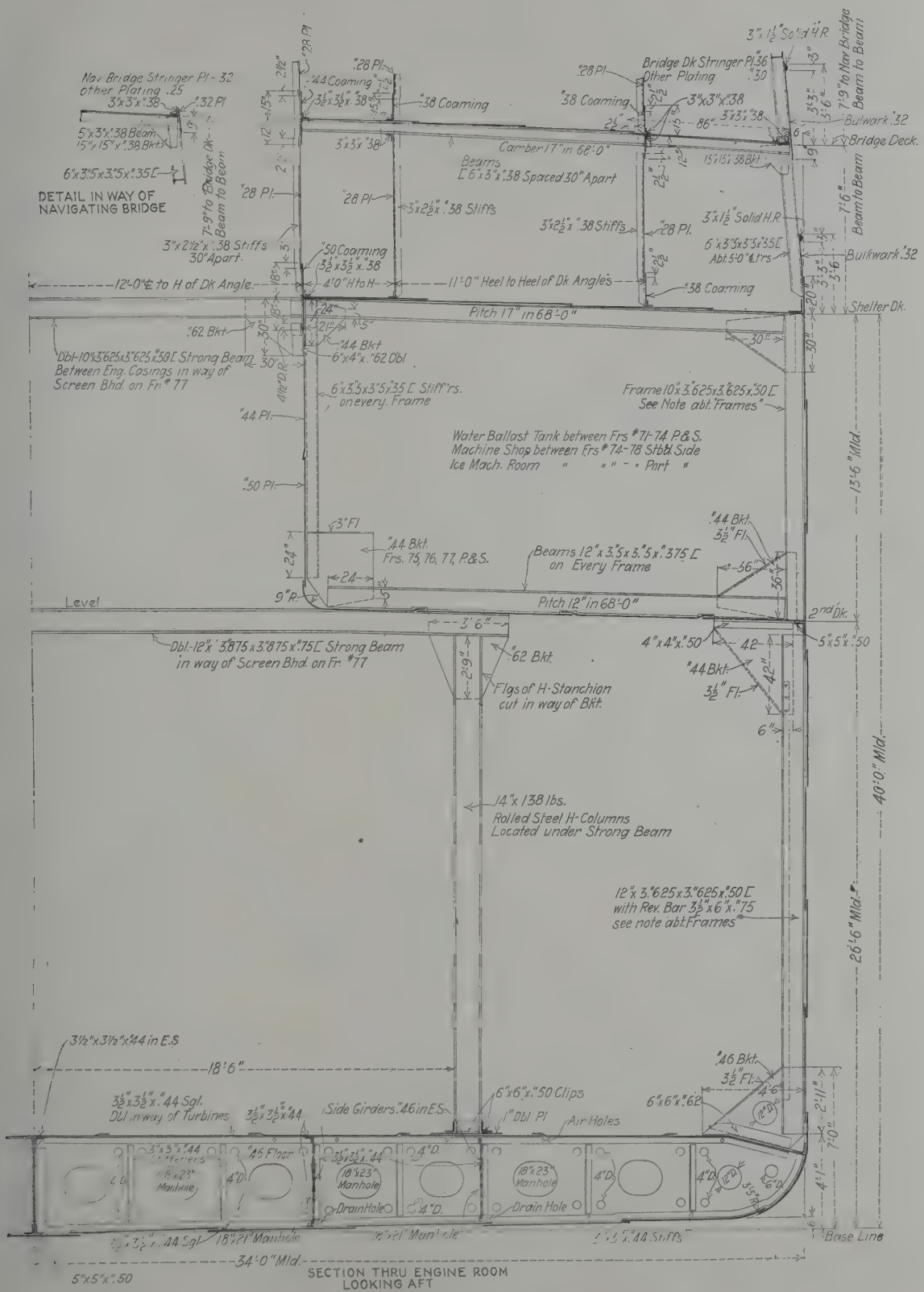
14,243-TON D. W. FREIGHTER
Builders, Bethlehem Shipbuilding Corp.

SECTION THRU BOILER ROOM


AMERICAN BUREAU OF SHIPPING
CLASS ✠A.1 Ⓔ
PRINCIPAL DIMENSIONS
Length B. P. 496'-0"
Beam Moulded 68'-0"
Depth M/d. to Shelter D'k. at side 40'-0"
Draft L.W.L. 28'-8"
EQUIPMENT NUMBER = 1047711 (C-43)
Tonnage under Shelter D'k 496x68x40x.74 / 100 = 9983.48
Addition for Bridge House 75.5x54x75x.75 / 150 = 152.88
" " Nav. Bridge 75.5x54x7.75x.75 / 200 = 118.48
" " Flying Bridge 28x42x7.5x.75 / 200 = 33.07
" " After House 44.5x39x7.5x.75 / 150 = 69.42
" " Trunk D'k. 330x24x2.5x.75 / 150 = 99.00
" "Hatches abv. T'k. D'k. 231x24x.75x.75 / 150 = 20.78
Total = 10477.11
EQUIPMENT
2-Bower Anchors Stockless each 12,005#
1-Bower Anchor " 10,220#
1-Stream " " 4,305#
1-Kedge " " 1,820#
300 Fathoms 2 11/16" Dia Stud Chain Cable
105 " 5½" Circ. Steel Wire Stream Line
140 " 6½" " " " Tow Line
2-90 " 9" " Hawser (Manila)
2-90 " 8" " Warps "
FUEL OIL TANK
Frs. #81-85 P.&S.
Swash Pl's. as shown on Frs. #82 & #84
one Swash Pl on Fr #83
Manholes to be arranged in Floors and side Girders to allow of easy access to all Cellular Compartments
Base Line
34'-0" M'l'd.
SECTION THRU BOILER ROOM
LOOKING FOR'D

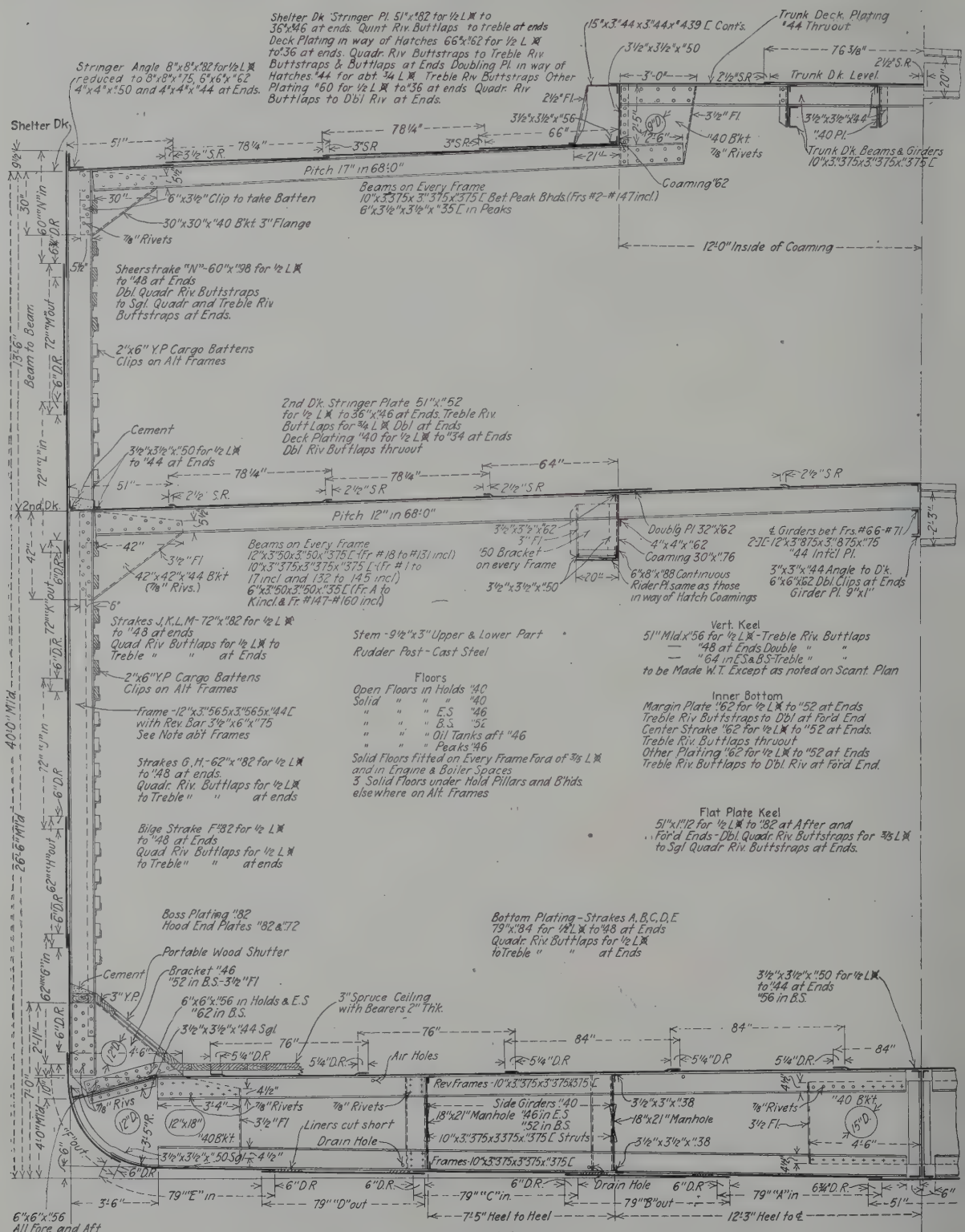
14,243-TON D. W. FREIGHTER
Builders, Bethlehem Shipbuilding Corp.

SECTION THRU ENGINE ROOM



14,243-TON D. W. FREIGHTER
Builders, Bethlehem Shipbuilding Corp.

SECTION THRU FOR'D HOLD

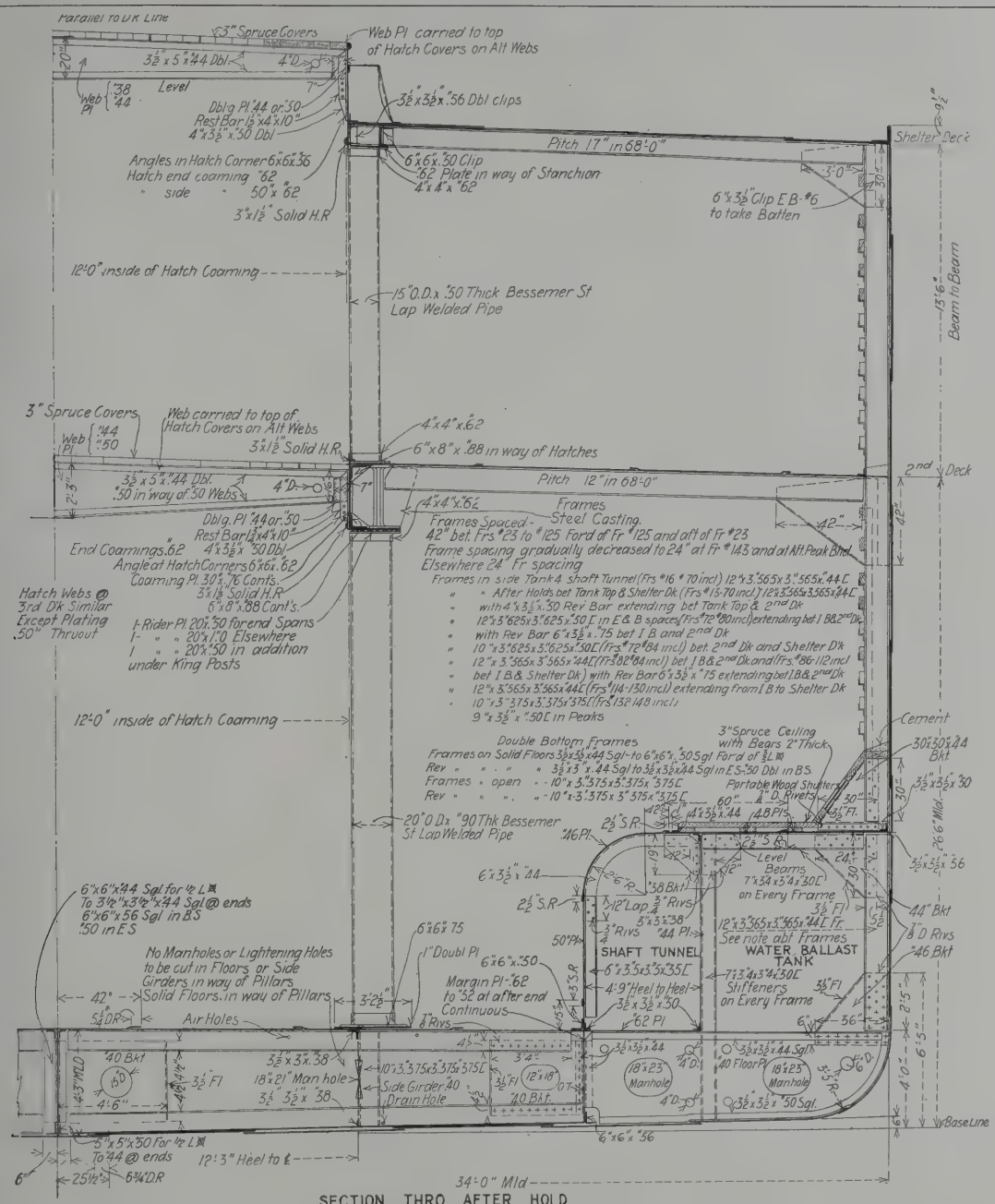

Shelter Dk.
Stringer Angle 8"x8"x.82 for ½ L reduced to 8"x8"x.75, 6"x6"x.62 4"x4"x.50 and 4"x4"x.44 at Ends.
Shelter Dk. Stringer Pl. 51"x.82 for ½ L to 36"x.46 at ends. Quint. Riv. Buttlaps to treble at ends Deck Plating in way of Hatches 66"x.62 for ½ L to .36 at ends. Quadr. Riv. Buttstraps to Treble Riv. Buttstraps & Buttlaps at Ends Doubling Pl. in way of Hatches .44 for abt. ¾ L Treble Riv. Buttstraps Other Plating .50 for ½ L to .36 at ends Quadr. Riv. Buttlaps to D'bl Riv. at Ends.
15"x3"x.44 x3"x.44x.439 L Cont's.
Trunk Deck Plating .44 Thruout
3½"x3½"x.50
76 3/8"
Trunk D.k. Level
2½" S.R.
20"
3'-0"
2½" S.R
2½" Fl.
3½"x3½"x.56
66"
78¼"
3" S.R.
3½" Fl
.40 B'kt.
7/8" Rivets
3½"x3½"x.44
.40 Pl.
Trunk D'k. Beams & Girders 10"x3".375x3".375x.375 L
Pitch 17" in 68'-0"
Beams on Every Frame 10"x3.375x 3" 375x.375 L Bet Peak Bhds. (Frs #2-#147 incl.) 6"x3½"x3½"x.35 L in Peaks
Coaming .62
6"x3½" Clip to take Batten
30"x30"x.40 B'kt. 3" Flange
7/8" Rivets
12'-0" Inside of Coaming
Sheerstrake "N" 60"x.98 for ½ L to .48 at Ends Dbl. Quadr. Riv. Buttstraps to Sgl. Quadr. and Treble Riv. Buttstraps at Ends.
2"x6" Y.P. Cargo Battens Clips on Alt. Frames
2nd D'k. Stringer Plate 51"x.52 for ½ L to 36"x.46 at Ends. Treble Riv. Butt Laps for ¾ L Dbl. at Ends Deck Plating .40 for ½ L to .34 at Ends Dbl. Riv. Buttlaps thruout
Cement
3½"x3½"x.50 for ½ L to .44 at Ends
64"
2½" S.R
Pitch 12" in 68'-0"
Beams on Every Frame 12"x3"50x3"50x"375 L (Fr #18 to #131 incl.) 10"x3"375x3"375x"375 L (Fr #1 to 17 incl and 132 to 145 incl.) 6"x3"50x3"50x".35 L (Fr. A to K incl. & Fr. #147-#160 incl.)
3½"x3½"x.62
3" Fl.
.50 Bracket on every Frame
3½"x3½"x.50
Doubl'g Pl. 32"x.62
4"x4"x.62 Coaming 30"x.76
6"x8"x.88 Continuous Rider Pl. same as those in way of Hatch Coamings
2nd D'k.
42"
3½" Fl
42"x42"x.44 B'kt (7/8" Rivs.)
Strakes J.K.L.M-72"x.82 for ½ L to .48 at ends Quad Riv Buttlaps for ½ L to Treble " " at Ends
2"x6" Y.P. Cargo Battens Clips on Alt. Frames
Frame -12"x3".565x3".565x.44 L with Rev. Bar 3½"x6"x.75 See Note abt. Frames
Strakes G.H.-62"x.82 for ½ L to .48 at ends. Quadr. Riv. Buttlaps for ½ L to Treble " " at ends
Bilge Strake F"82 for ½ L to .48 at Ends Quad Riv. Buttlaps for ½ L to Treble " " at ends
Stem -9½"x3" Upper & Lower Part
Rudder Post - Cast Steel
Floors
Open Floors in Holds .40
Solid " " " .40
" " " E.S. .46
" " " B.S. .52
" " " Oil Tanks aft .46
" " " Peaks .46
Solid Floors fitted on Every Frame Fore of 3/8 L and in Engine & Boiler Spaces
3 Solid Floors under Hold Pillars and B'hds. elsewhere on Alt. Frames
Vert. Keel
51" Mld. x.56 for ½ L - Treble Riv. Buttlaps
" .48 at Ends Double " "
" .64 in E.S. & B.S. Treble " "
to be Made W.T. Except as noted on Scant. Plan
Inner Bottom
Margin Plate .62 for ½ L to .52 at Ends Treble Riv. Buttstraps to Dbl. at For'd End
Center Strake .62 for ½ L to .52 at Ends. Treble Riv. Buttlaps thruout
Other Plating .62 for ½ L to .52 at Ends Treble Riv. Buttlaps to D'bl. Riv. at For'd End.
Flat Plate Keel
51"x1".12 for ½ L to .82 at After and For'd Ends - Dbl. Quadr. Riv. Buttstraps for 3/8 L to Sgl. Quadr. Riv. Buttstraps at Ends.
Boss Plating .82
Hood End Plates .82 & .72
Portable Wood Shutter
Cement
Bracket .46 .52 in B.S-3½" Fl
3" Y.P.
6"x6"x.56 in Holds & E.S .62 in B.S.
3" Spruce Ceiling with Bearers 2" Thk.
3½"x3½"x.44 Sgl.
Bottom Plating - Strakes A.B.C.D.E 79"x.84 for ½ L to .48 at Ends Quadr. Riv. Buttlaps for ½ L to Treble " " at Ends
3½"x3½"x.50 for ½ L to .44 at Ends .56 in B.S.
76"
84"
5¼" D.R
Air Holes
4'-6"
4½"
7/8" Rivs
3'-4"
7/8" Rivets
3½" Fl
Liners cut short
Drain Hole
Rev. Frames -10"x3".375x3".375x.375 L
Side Girders .40
18"x21" Manhole .46 in E.S .52 in B.S.
10"x3".375x3.375x.375 L Struts
Frames -10"x3".375x3".375x.375 L
3½"x3"x.38
18"x21" Manhole
3½"x3½"x.38
7/8" Rivets
3½" Fl
.40 B'kt.
4'-6"
6" D.R
79" "E" in
79" "D" out
79" "C" in.
79" "B" out
79" "A" in
7'-5" Heel to Heel
12'-3" Heel to ℄
34'-0" M'ld
6"x6"x.56 All Fore and Aft
Beam to Beam
72" M'ld
72" M'out
72" M'in
62" M'ld
62" M'out
62" M'in
40'-0" M'ld
26'-6" M'ld
7'-0"
4'-0" M'ld
2'-11"
1'-1" out
6" D.R

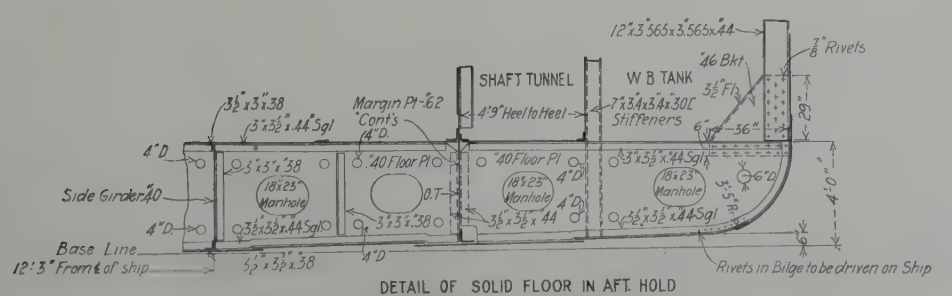
SECTION FOR'D HOLD
LOOKING FOR'D.

14,243-TON D. W. FREIGHTER

Builders, Bethlehem Shipbuilding Corp.

SECTION THRU AFTER HOLD


Parallel to D/K Line
3" Spruce Covers
Web Pl carried to top of Hatch Covers on Alt Webs
3½" x 5" x 44 Dbl
4'D
Level
Web Pl .38 .44
Dblg Pl .44 or .50
Rest Bar ½" x 4" x 10"
4" x 3½" x .50 Dbl
3½" x 3½" x .56 Dbl clips
Shelter Deck
Pitch 17" in 68'-0"
Angles in Hatch Corner 6" x 6" x .56
Hatch end coaming .62
" side " 50" x .62
3" x ½" Solid H.R
6" x 6" x .50 Clip
.62 Plate in way of Stanchion
4" x 4" x .62
6" x 3½" Clip E.B. #6 to take Batten
3'0"
30"
12'-0" inside of Hatch Coaming
15" O.D. x .50 Thick Bessemer St Lap Welded Pipe
13'6" Beam to Beam
3" Spruce Covers
Web carried to top of Hatch Covers on Alt Webs
Web Pl .44 .50
3" x ½" Solid H.R
4" x 4" x .62
6" x 8" x .88 in way of Hatches
2nd Deck
3½" x 5" x .44 Dbl
.50 in way of .50 Webs
Pitch 12" in 68'-0"
Frames
Steel Casting.
Frames Spaced 42" bet. Frs. #23 to #125 Fwd of Fr #125 and aft of Fr #23
Frame spacing gradually decreased to 24" at Fr #143 and at Aft Peak Bhd
Elsewhere 24" Fr. Spacing
42"
Dblg. Pl .44 or .50
Rest Bar ½" x 4" x 10"
End Coamings .62
4" x 3½" x .50 Dbl
Angle at Hatch Corners 6" x 6" x .62
Coaming Pl. 30" x .76 Conts.
3" x ½" Solid H.R
6" x 8" x .88 Cont's.
Hatch Webs @ 3rd Dk Similar Except Plating .50" Thruout
Frames in side Tank 4 shaft Tunnel (Frs #16 to #70 incl) 12" x 3" x .565 x 3" x .565 x .44 L
" " After Holds bet Tank Top & Shelter Dk. (Frs #15-70 incl.) 12" x 3.565 x 3" x .565 x .44 L
" with 4" x 3½" x .50 Rev Bar extending bet Tank Top & 2nd Dk
" 12" x 3" x .625 x 3" x .625 x .50 L in E & B spaces (Frs #72 to #80 incl) extending bet I B & 2nd Dk
" with Rev Bar 6" x 3½" x .75 bet I B and 2nd Dk
" 10" x 3" x .625 x 3" x .625 x .50 L (Frs #72 to #84 incl.) bet 2nd Dk and Shelter D'k
" 12" x 3" x .565 x 3" x .565 x .44 L (Frs #82 to #84 incl) bet I B & 2nd Dk and Frs #86-112 incl bet I B & Shelter Dk) with Rev Bar 6" x 3½" x .75 extending bet I B & 2nd Dk
" 12" x 3.565 x 3" x .565 x .44 L (Frs #114-130 incl) extending from I B to Shelter Dk
" 10" x 3" x .375 x 3" x .375 x .375 L (Frs #132 148 incl)
9" x 3½" x .50 L in Peaks
1 - Rider Pl. 20" x .50 for end Spans
1 " " 20" x 1'0 Elsewhere
1 " " 20" x .50 in addition under King Posts
12'-0" inside of Hatch Coaming
Double Bottom Frames
Frames on Solid Floors 3½" x 3½" x .44 Sgl - to 6" x 6" x .50 Sgl for aft of ¾ L
Rev " " " " 3½" x 3½" x .44 Sgl in E.S - .50 Dbl in B.S.
Frames " open " - 10" x 3.375 x 3" x .375 x .375 L
Rev " " " " - 10" x 3.375 x 3" x .375 x .375 L
3" Spruce Ceiling with Bears 2" Thick
Portable Wood Shutter
60" D. Rivets
Cement
30" x 30" x .44 Bkt
3½" x 3½" x .30
Wld
20'0 D x .90 Thk Bessemer St Lap Welded Pipe
46 Pl
2½" S.R
48 Pl's
24"
Level Beams 7" x 3.4" x 3.4" x .30 L on Every Frame
6" x 3½" x .44
6" R
38 Bkt
12" Lap
⅞" Rivs
5" x 3" x .38
44 Pl
SHAFT TUNNEL
6" x 3" x 3" x .35 L
4'-9" Heel to Heel
3½" x 3½" x .50
62 Pl
WATER BALLAST TANK
7" x 3.4" x 3.4" x .30 L Stiffeners on Every Frame
See note abt Frames
12" x 3.565 x 3" x .565 x .44 L Fr.
3½ Fl
44" Bkt
8" D Rivs
46 Bkt
6" x 6" x .75
1" Doubl Pl
6" x 6" x .50
Margin Pl - .62 to .52 at after end Continuous
No Manholes or Lightening Holes to be cut in Floors or Side Girders in way of Pillars
Solid Floors in way of Pillars
42"
5¼ DR
Air Holes
3½" x 3" x .38
18" x 21" Man hole
Side Girder .40 Drain Hole
40 Bkt
3½ Fl
3'-2¾"
4'-6"
43" Wld
3'-4"
12" x 18" O.T
40 Bkt.
40 Floor Pl
18" x 23" Manhole
4'D
6'D
3½" x 3½" x .44 Sgl
3½" x 3½" x .50 Sgl
6" x 6" x .56
6" x 6" x .44 Sgl for ½ L to 3½" x 3½" x .44 Sgl @ ends
6" x 6" x .56 Sgl in B.S
.50 in E.S
5" x 5" x .50 for ½ L to .44 @ ends
12'-3" Heel to ℄
6"
25½"
6¾ D.R
34'-0" Mld
2'-5"
6'-5"
4'-0"
6" Base Line
SECTION THRO AFTER HOLD
LOOKING AFT



DETAIL OF SOLID FLOOR IN AFT HOLD

14,243-TON D. W. FREIGHTER

Builders, Bethlehem Shipbuilding Corp.

14,243-TON D. W. FREIGHTER

For Arrangement Plan
See Plate IX opposite Page 380

CHARACTERISTICS

Length Overall	527'-6"
Breadth Molded	68'-0"
Depth Molded	40'-0"
Draft	28'-0"
Displacement in Tons	20313
Block Coefficient	0.728
Speed in Knots About	13.5
I. H. P. About	5000
Water Tube Boilers	4
Total Heating Surface in Sq. Ft.	14000

NAVIGATING BRIDGE

1 Owner's Saloon
2 Owner's State Room
3 Owner's Bath
4 Chart Room
5 Captain's Office
6 Captain's Bath
7 Captain's Stateroom

BRIDGE DECK

1 Chief Engineer's Office
2 Chief Engineer's Stateroom
3 Chief Engineer's Bath
4 Chief Officer
5 Pilot
6 Two Radio Operators
7 Saloon
8 Pantry
9 Officer's Mess
10 Third Officer
11 Second Officer
12 Linen Locker
13 Jun. Third Asst. Engineer
14 Jun. Third Asst. Engineer
15 Jun. Third Asst. Engineer
16 Third Asst. Engineer
17 Officer's Bath
18 Second Asst. Engineer
19 First Asst. Engineer
20 Radio Room
21 Battery Room
22 Hospital

SHELTER DECK AMIDSHIPS

1 Refrigerator
2 Chill Room
3 Butcher Shop
4 Steward's Bath
5 Four Boys
6 Two Cooks
7 Bakery
8 Steward
9 Linen Locker
10 Steward's Stores
11 Petty Officer's Mess
12 Galley
13 Three Q'Masters
14 Bos'n & Carpenter
15 Four Apprentices
16 Petty Officer's Bath
17 Three Water Tenders
18 Three Oilers—One Storekeeper
19 Engineer's Stores
20 Crews' Mess

SHELTER DECK AFT

21 Two Firemen
22 Two Seamen
23 Seamen's Toilet
24 Firemens' Toilet

TANK CAPACITIES

	Salt Water Tons	Fuel Oil Tons
Fuel Oil Tank, Frames 15-26		205.20
Fore Peak Tank	186.9	163.50
After Peak Tank	407.7	356.75
Tank No. 1 Between Frames 146-130 C. L.	74.2	64.93
Tank No. 2 Between Frames 130-113 P & S.	208.4	182.44
Tank No. 3 Between Frames 113-85 P & S.	620.0	542.60
Tank No. 4 Between Frames 85-71 P & S.	354.6	310.00
Tank No. 5 Between Frames 71-43 P & S.	439.4	384.44
Tank No. 6 Between Frames 41-26 P & S.	143.0	126.82
Fuel Oil Settling Tank 2nd Dk. P & S.		214.32

WATER BALLAST

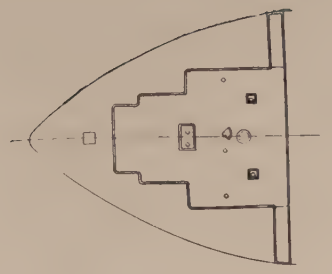
	Salt Water Tons
Side Ballast Frames 72-42 P & S.	575.6
Water Ballast Frames 74-71 P & S 2nd Dk.	180.6

FRESH WATER

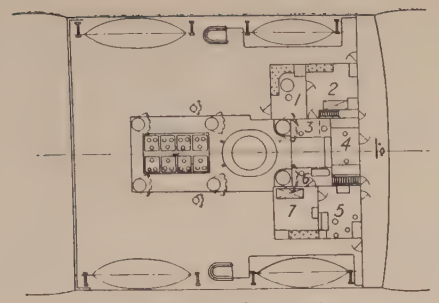
	Fresh Water Tons
Boiler Feed Frames 85-80 S	146.5
Boiler Feed Frames 85-81 P	117.2
Fresh Water Frames 80-78 S	87.8
Fresh Water Frames 81-78 P	58.6

CUBIC CAPACITIES

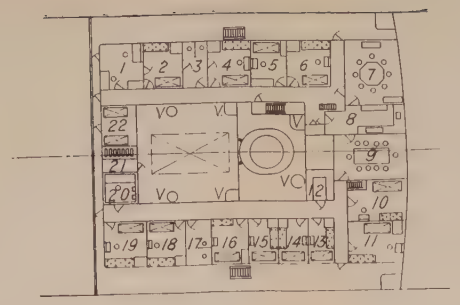
	Grain Cargo Cu. Ft.	Bale Cargo Cu. Ft.
Cargo Hold No. 1	193800	161906
Cargo Hold No. 2	250680	220409
Cargo Hold No. 3	229580	203735
Cargo Hold No. 4	191800	164950



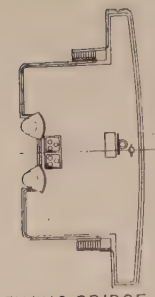
TOP OF AFTER DECK HOUSE



NAVIGATING BRIDGE



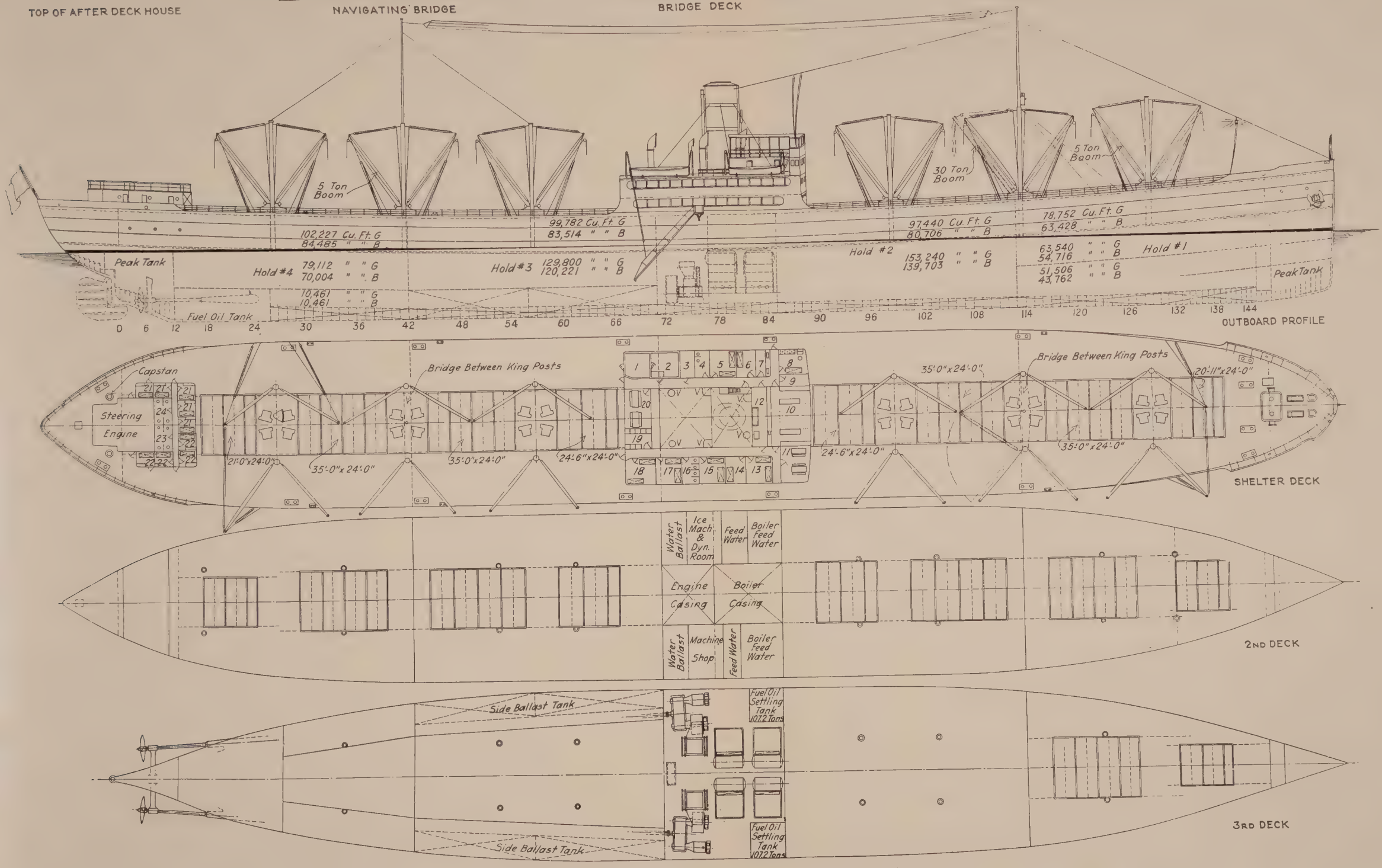
BRIDGE DECK



FLYING BRIDGE

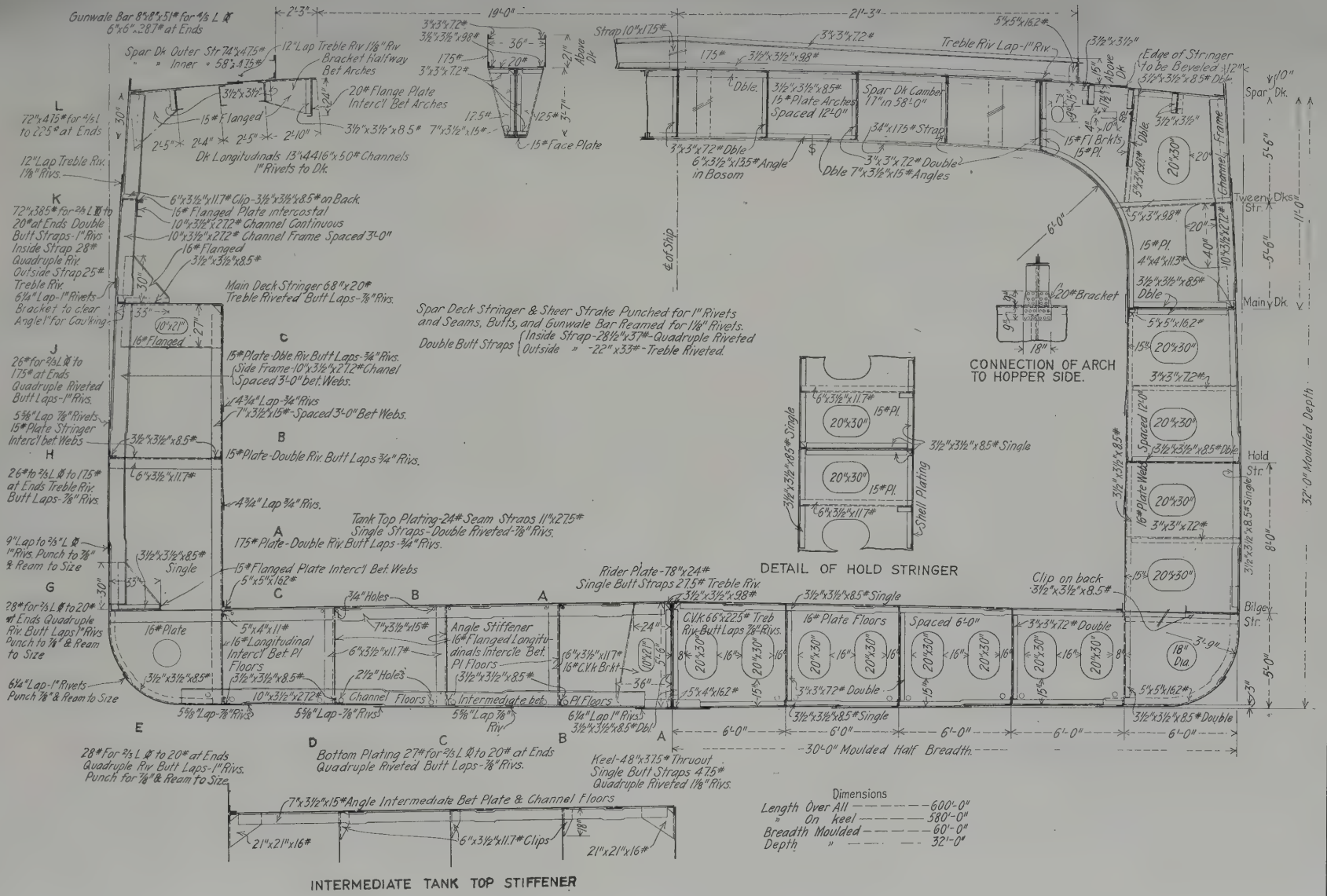
Principal Dimensions

Length B. P.	496′—0″
Beam Molded	68′—0″
Depth Molded to Shelter Deck at Sides	40′—0″
Draft L. W. L.	28′—8″



PROFILE AND DECK PLAN, 14,243-TON D. W. FREIGHTER
Builders, Bethlehem Shipbuilding Corp.

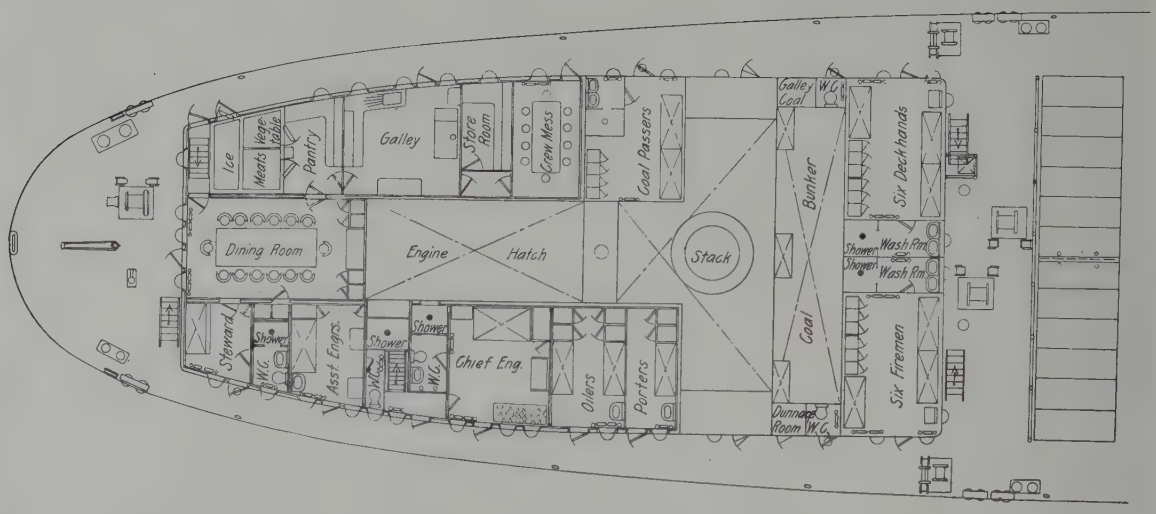
PLATE IX


Gunwale Bar 8"x8"x51# for 4½ L ℄ 6"x6"-28.7# at Ends
Spar Dk Outer Str 74"x.475"
" " Inner " 58"x.475"
12" Lap Treble Riv 1⅛" Riv
Bracket halfway Bet Arches
20# Flange Plate Interc'l Bet Arches
15# Flanged
Dk Longitudinals 13"x4.416"x.50# Channels
1" Rivets to Dk.
12" Lap Treble Riv. 1⅛" Rivs.
72"x.475# for 4½ L to 27.5# at Ends
72"x.385# for 2½ L ℄ to 20# at Ends Double Butt Straps-1" Rivs
Inside Strap 28# Quadruple Riv.
Outside Strap 25# Treble Riv.
6¼" Lap-1" Rivets
Bracket to clear Angle 1" for Caulking
6"x3½"x11.7# Clip-3½"x3½"x.85# on Back.
16# Flanged Plate intercostal
10"x3½"x27.2# Channel Continuous
10"x3½"x27.2# Channel Frame Spaced 3'-0"
16# Flanged
3½"x3½"x.85#
Main Deck Stringer 68"x20# Treble Riveted Butt Laps-⅞" Rivs.
15# Plate-Dble. Riv. Butt Laps-¾" Rivs.
Side Frame-10"x3½"x27.2# Chanel
Spaced 3'-0" bet. Webs.
4¾" Lap-¾" Rivs
7"x3½"x15.5# Spaced 3'-0" Bet Webs.
15# Plate-Double Riv. Butt Laps ¾" Rivs.
6"x3½"x11.7#
4¾" Lap ¾" Rivs.
26# for 2½ L ℄ to 175# at Ends Quadruple Riveted Butt Laps-1" Rivs.
5⅝" Lap ⅞" Rivets
15# Plate Stringer Interc'l bet Webs
26# for 2½ L ℄ to 175# at Ends Treble Riv. Butt Laps-⅞" Rivs.
175# Plate-Double Riv. Butt Laps-¾" Rivs.
Tank Top Plating-24# Seam Straps 11"x27.5#
Single Straps-Double Riveted-⅞" Rivs.
9" Lap to 2½ L ℄ 1" Rivs. Punch to ⅞" & Ream to Size
15# Flanged Plate Interc'l Bet Webs
5"x5"x.162#
28# for 2½ L ℄ to 20# at Ends Quadruple Riv. Butt Laps 1" Rivs Punch to ⅞" & Ream to Size
16# Plate
5"x4"x11#
16# Longitudinal Interc'l Bet. Pl Floors
3½"x3½"x.85#
6¼" Lap-1" Rivets Punch ⅞" & Ream to Size
10"x3½"x27.2#
7"x3½"x15#
6"x3½"x11.7#
2½" Holes
Channel Floors
Angle Stiffener
16# Flanged Longitudinals Intercle Bet. Pl Floors
Intermediate bet. Pl Floors
5⅝" Lap-⅞" Rivs
Rider Plate-78"x24" Single Butt Straps 27.5# Treble Riv.
3½"x3½"x.98#
CVK 66"x22.5# Treb Riv. Butt Laps ⅞" Rivs.
16# Plate Floors
Spaced 6'-0"
3"x3"x.72# Double
3½"x3½"x.85# Single
3½"x3½"x.85# Dble
Clip on back 3½"x3½"x8.5#
Edge of Stringer to be Beveled 1½" 3½"x3½"x.85# Dble
Spar Dk.
Channel Frame
Tween Dks
Str.
Main Dk.
Hold Str.
Bilge Str.
Shell Plating
Spar Dk Camber 17" in 58'-0"
34"x.175# Strap
3"x5"x.72" Dble 6"x3½"x.135# Angle in Bosom
3"x3"x.72" Double
Dble 7"x3½"x.15# Angles
15# Face Plate
3"x3"x.72#
3½"x3½"x.98#
3½"x3½"x.85# 15# Plate Arches Spaced 12'-0"
15# Fl Brkts 15# Pl.
3½"x3½"x.85# Dble
5"x3"x.98#
15# Pl.
4"x4"x.113#
20"x30"
Spaced 12'-0"
3½"x3½"x.85# Dble
3"x3"x.72#
5"x5"x.162#
6'-0"
20# Bracket
CONNECTION OF ARCH TO HOPPER SIDE.
DETAIL OF HOLD STRINGER
6"x3½"x11.7#
3½"x3½"x.85# Single
3½"x3½"x.85# Dble
16# Plate Webs
3"x3½"x8.5# Single
Deck Beam 10"x21"
Tank Top Plating 27# for 2½ L ℄ to 20# at Ends Quadruple Riveted Butt Laps-⅞" Rivs.
28# for 2½ L ℄ to 20# at Ends Quadruple Riv Butt Laps-1" Rivs Punch for ⅞" & Ream to Size
Keel-48"x.375# Thruout Single Butt Straps 4.75# Quadruple Riveted 1⅛" Rivs.
6'-0" Moulded Half Breadth
7"x3½"x15# Angle Intermediate Bet Plate & Channel Floors
21"x21"x16#
6"x3½"x11.7# Clips
INTERMEDIATE TANK TOP STIFFENER
Dimensions
Length Over All 600'-0"
" On keel 580'-0"
Breadth Moulded 60'-0"
Depth " 32'-0"
32'-0" Moulded Depth
11'-0"
5'-6"
8'-0"
5'-0"
3"

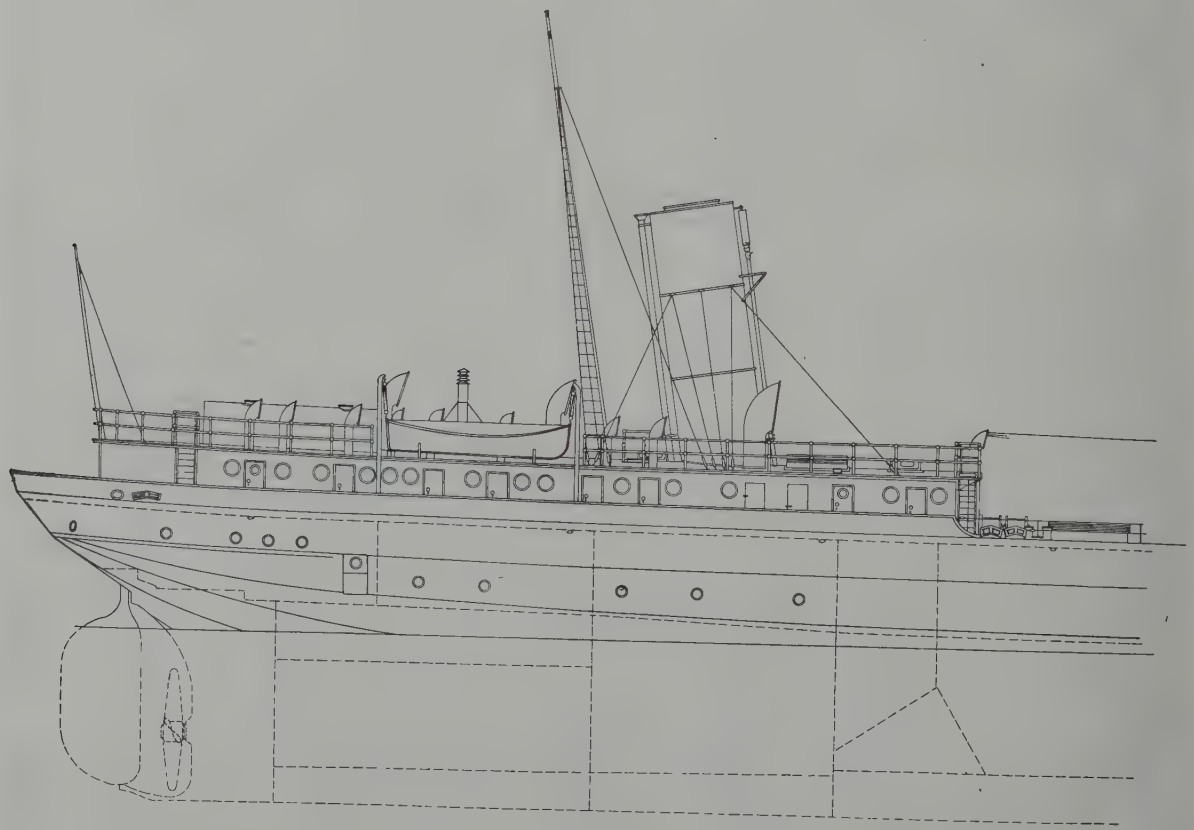
12,300-NET TONS D. W. LAKE BULK FREIGHTER
Great Lakes Engineering Works, Detroit, Mich.

MIDSHIP SECTION

OUTBOARD PROFILE AND SPAR DECK PLAN AFT



SPAR DECK



OUTBOARD PROFILE

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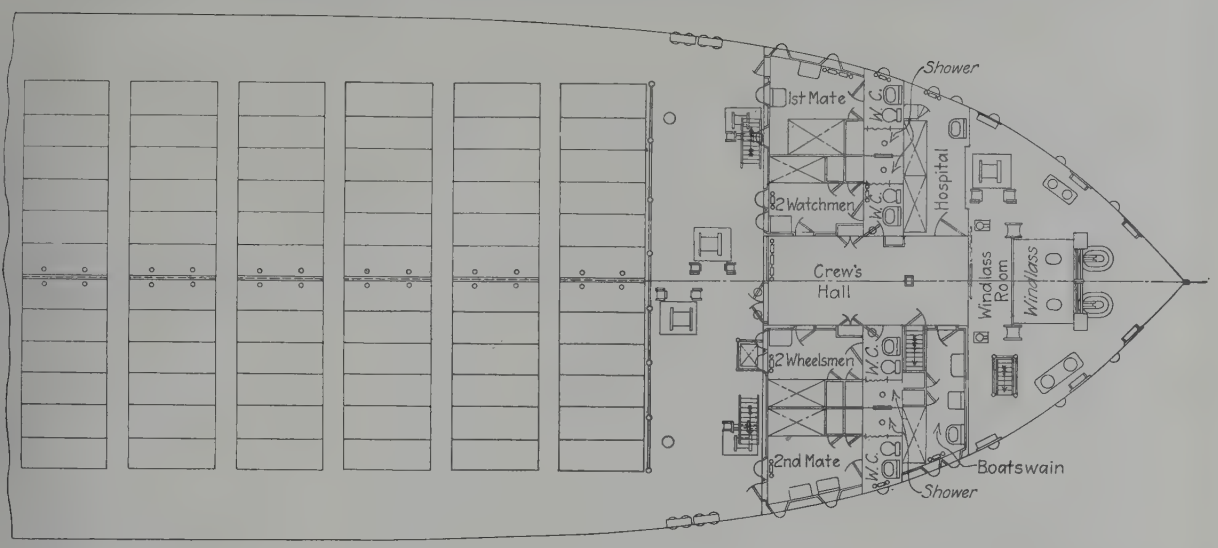
See Opposite Page

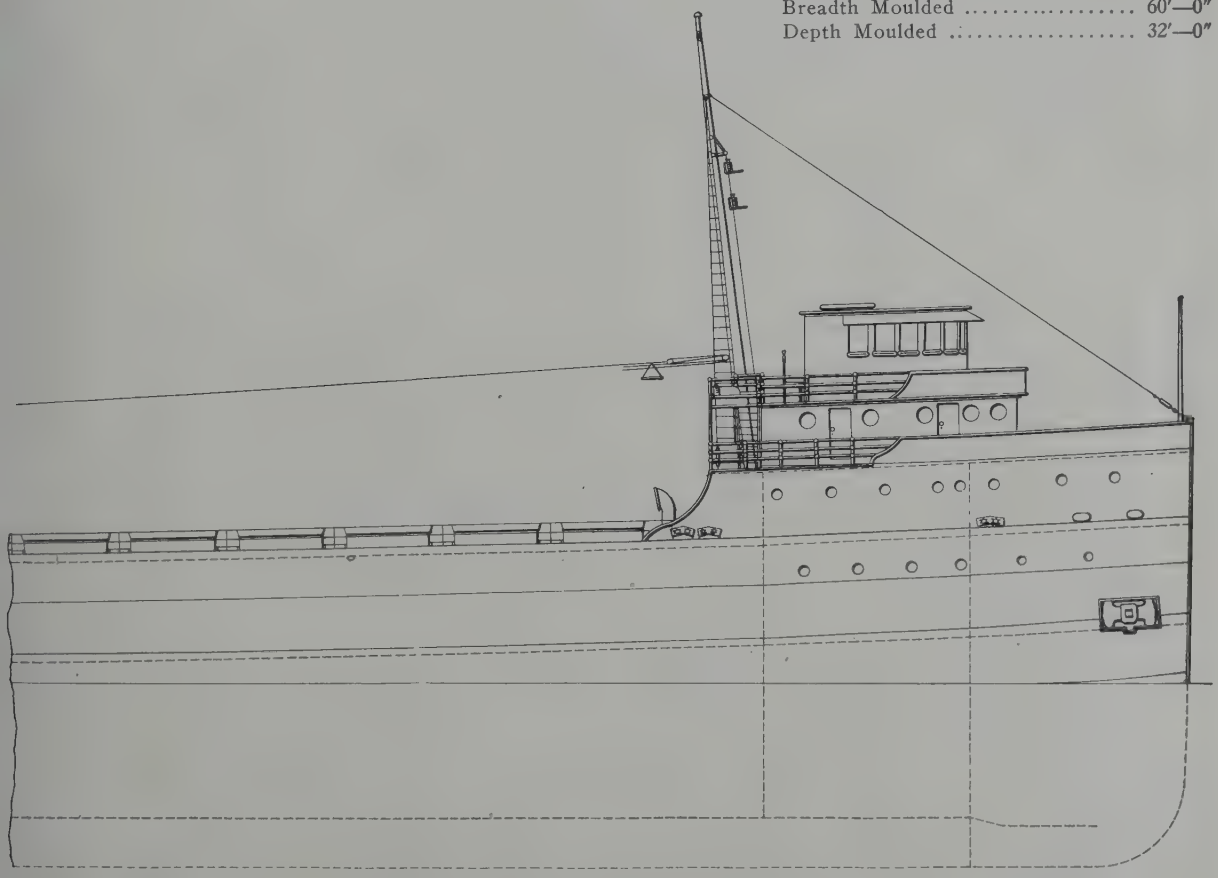
OUTBOARD PROFILE AND SPAR DECK FORWARD



SPAR DECK

Principal Dimensions

Length Over All	600′—0″
Length on Keel	580′—0″
Breadth Moulded	60′—0″
Depth Moulded	32′—0″



OUTBOARD PROFILE

12,300-NET TONS D. W. LAKE BULK FREIGHTER

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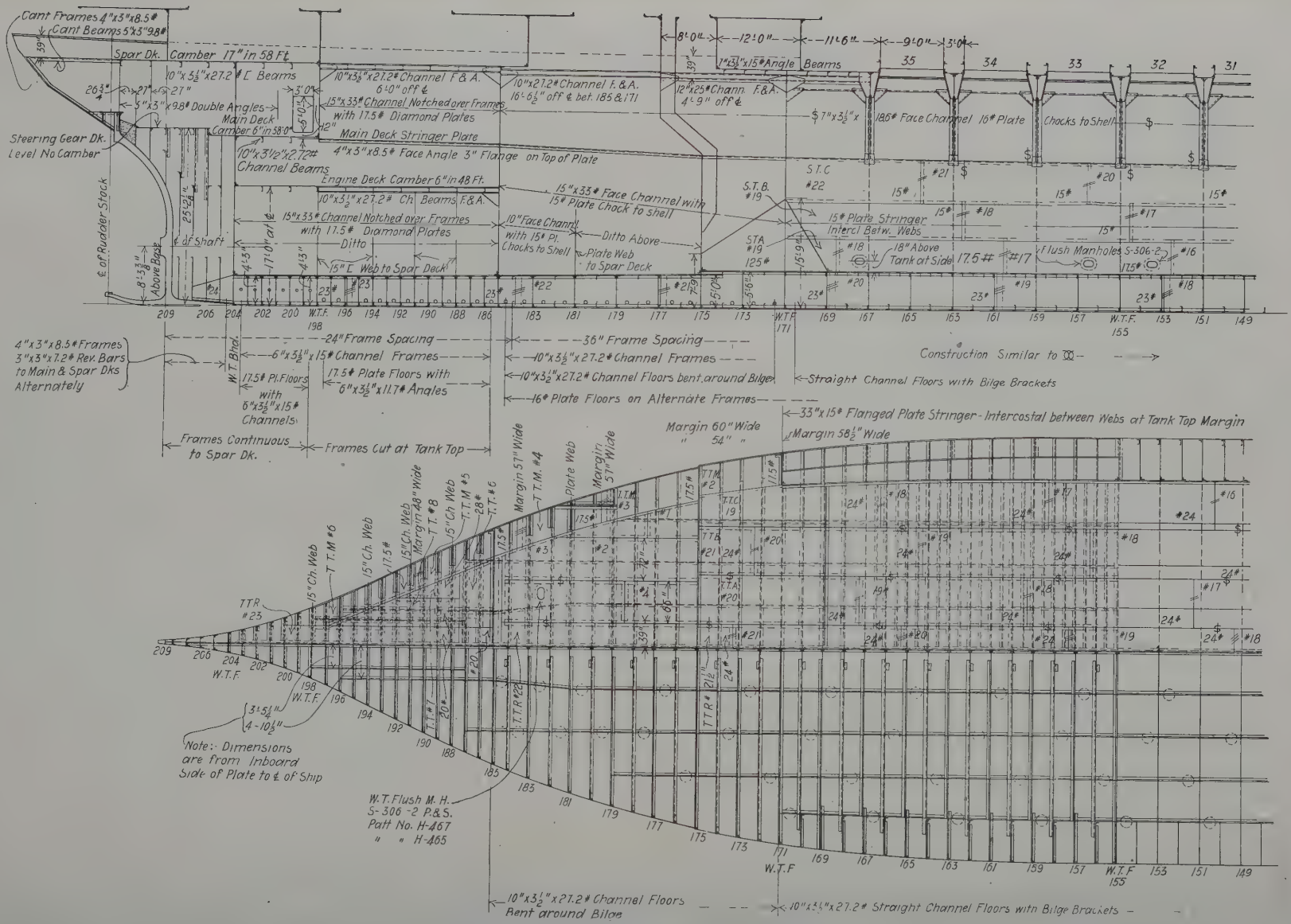
See Opposite Page


Cant Frames 4"x3"x8.5#
Cant Beams 5"x3"x9.8#
Spar Dk. Camber 17" in 58 Ft.
10"x3½"x27.2# C Beams
5"x3"x9.8# Double Angles
Main Deck Camber 6" in 58'0"
Steering Gear Dk. Level No Camber
10"x3½"x27.2# Channel F & A.
6'0" off ℄
15"x33# Channel Notched over Frames with 17.5# Diamond Plates
Main Deck Stringer Plate
4"x3"x8.5# Face Angle 3" Flange on Top of Plate
10"x3½"x27.2# Channel Beams
Engine Deck Camber 6" in 48 Ft.
10"x27.2# Channel F. & A.
16'-6½" off ℄ bet. 185 & 171
12"x25# Chann. F. & A.
4'-9" off ℄
1"x33"x15# Angle Beams
7"x3½"x 186# Face Channel 16# Plate Chocks to Shell
15"x33# Face Channel with 15# Plate Chock to Shell
10" Face Channel with 15# Pl. Chocks to Shell
Ditto Above
Plate Web to Spar Deck
15" ℄ Web to Spar Deck
15# Plate Stringer Intercl Betw. Webs
18" Above Tank at Side 17.5#
Flush Manholes S-306-2
℄ of Rudder Stock
℄ of Shaft
Ditto
15"x33# Channel Notched over Frames with 17.5# Diamond Plates
S.T.B. #19
S.T.C. #22
STA #19 125#
Construction Similar to
4"x3"x8.5# Frames
3"x3"x7.2# Rev. Bars to Main & Spar Dks Alternately
W.T. Bhd.
24" Frame Spacing
36" Frame Spacing
6"x3½"x15# Channel Frames
10"x3½"x27.2# Channel Frames
10"x3½"x27.2# Channel Floors bent around Bilge
Straight Channel Floors with Bilge Brackets
16# Plate Floors on Alternate Frames
17.5# Pl. Floors with 6"x3½"x15# Channels
17.5# Plate Floors with 6"x3½"x11.7# Angles
33"x15# Flanged Plate Stringer - Intercostal between Webs at Tank Top Margin
Frames Continuous to Spar Dk.
Frames Cut at Tank Top
Margin 60" Wide
" 54" "
Margin 58½" Wide
Margin 57" Wide
Plate Web
Margin 57" Wide
Margin 48" Wide
15" Ch. Web
15" Ch. Web
5" Ch. Web
5" Ch. Web
T.T.M. #6
T.T.M. #5
T.T.M. #4
T.T.M. #3
T.T.M. #2
T.T.M. #1
T.T.R. #23
T.T.R. #22
T.T.R. #21
T.T.A. #20
T.T.A. #19
W.T.F.
3'-5¼"
4'-10½"
Note:- Dimensions are from Inboard Side of Plate to ℄ of Ship
W.T. Flush M. H. S-306-2 P.&S. Patt No. H-467
" " H-465
10"x3½"x27.2# Channel Floors Bent around Bilge
10"x3½"x27.2# Straight Channel Floors with Bilge Brackets

12,300-NET TONS D. W. LAKE BULK FREIGHTER

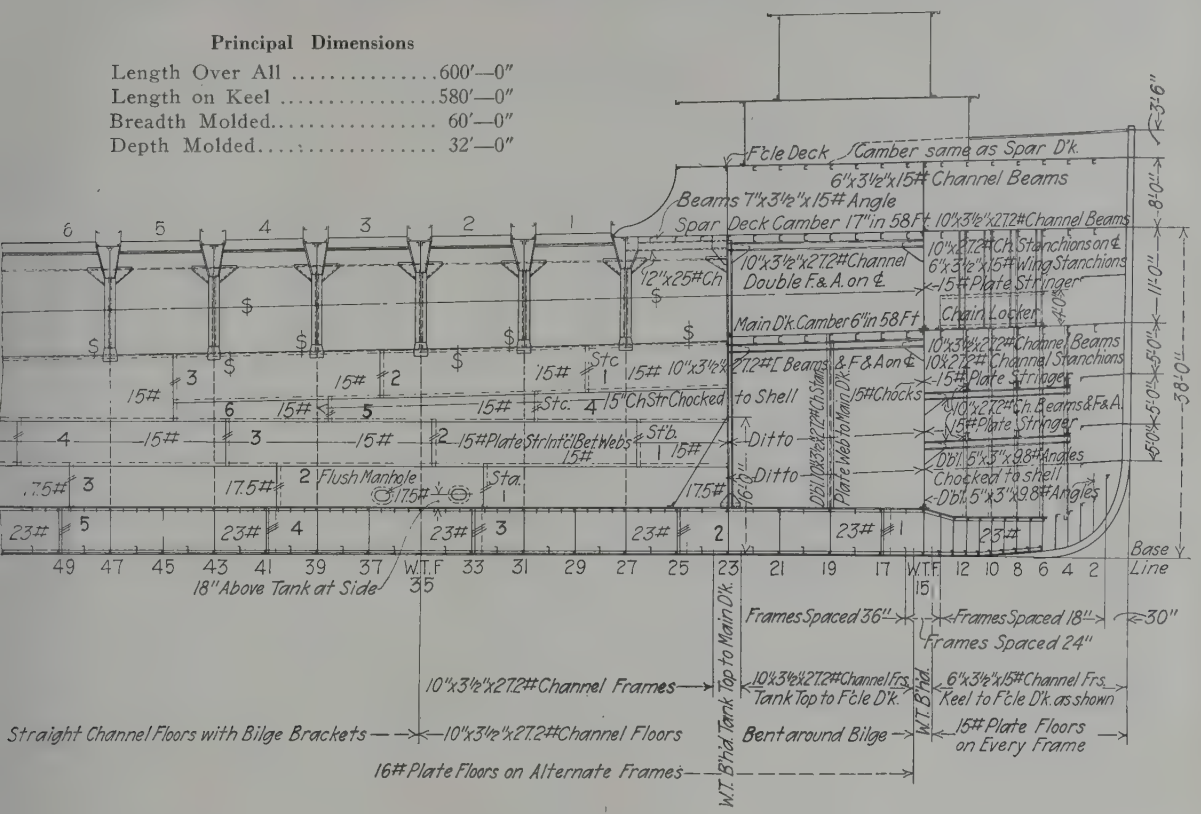
Great Lakes Engineering Works, Detroit, Mich.

See Opposite Page

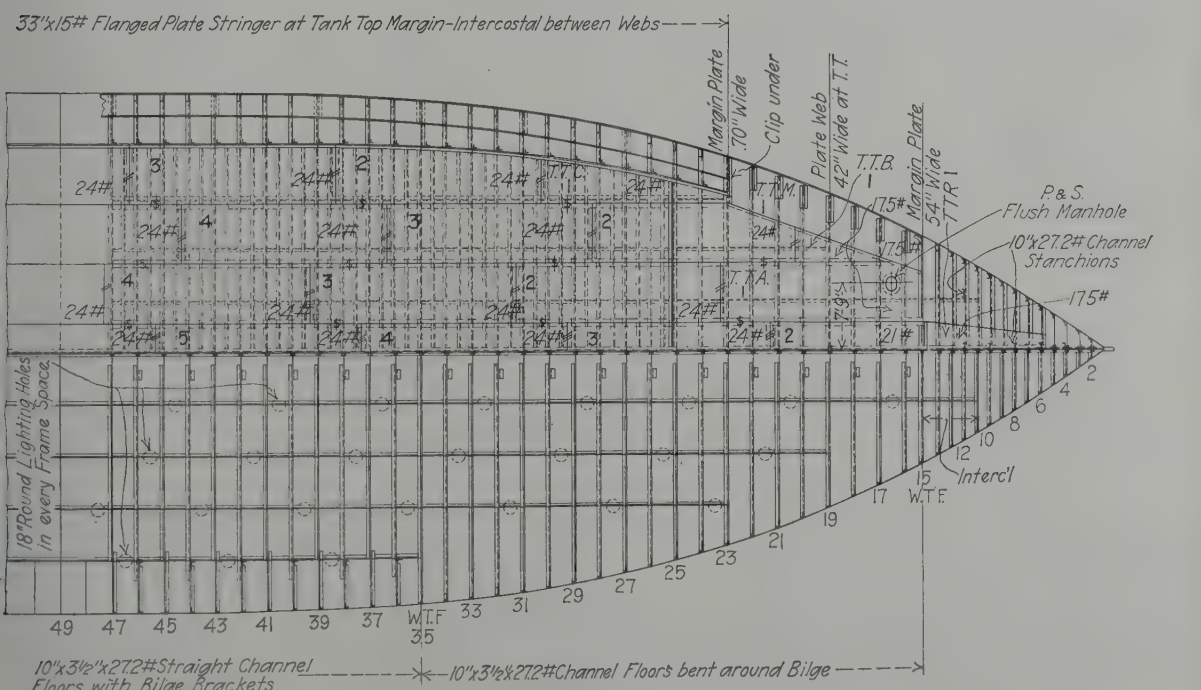
INBOARD PROFILE AND INNER BOTTOM PLATING, FOR'D

Principal Dimensions

Length Over All .....600'—0"
Length on Keel .....580'—0"
Breadth Molded..... 60'—0"
Depth Molded..... 32'—0"


F'cle Deck Camber same as Spar D'k.
6"x3½"x15# Channel Beams
Beams 7"x3½"x15# Angle
Spar Deck Camber 17" in 58 Ft.
10"x3½"x27.2# Channel Beams
10"x27.2# Ch. Stanchions on ℄
6"x3½"x15# Wing Stanchions
15# Plate Stringer
Chain Locker
10"x3½"x27.2# Channel
Double F. & A. on ℄
12"x25# Ch
Main D'k. Camber 6" in 58 Ft.
10"x3½"x27.2# Channel Beams
10"x27.2# Channel Stanchions
15# Plate Stringer
10"x27.2# Ch. Beams & F. & A.
15# Plate Stringer
D'b'l. 5"x3"x.98# Angles
Chocked to shell
D'b'l. 5"x3"x.98# Angles
Flush Manhole
Ditto
Ditto
Base Line
18" Above Tank at Side
Frames Spaced 36"
Frames Spaced 18"
Frames Spaced 24"
10"x3½"x27.2# Channel Frames
10"x3½"x27.2# Channel Frs. Tank Top to F'cle D'k.
6"x3½"x15# Channel Frs. Keel to F'cle D'k. as shown
Straight Channel Floors with Bilge Brackets
10"x3½"x27.2# Channel Floors Bent around Bilge
15# Plate Floors on Every Frame
16# Plate Floors on Alternate Frames
W.T. B'hd. Tank Top to Main D'k.
W.T. B'hd.

←Construction Similar to ⓫ INBOARD PROFILE



TANK TOP PLATING

12,300-NET TONS D. W. LAKE BULK FREIGHTER

Great Lakes Engineering Works, Detroit, Mich.

See Opposite Page

For Boiler Construction
See Opposite Page

Item	U. S. Gov't Rules	Pressure.	Lloyd's Register	Pressure.
Shell plates.	$\frac{62720 \times 1.171875 \times 1.2}{6 \times 81}$	= 182#	$\frac{21.25(18.75 - 2)84.6}{162}$	= 186#
Heads in steam space.	$\frac{175 \times 17.5^2}{17^2}$	= 185#	$\frac{175 \times 17.5^2}{\frac{17^2 + 16^2}{2}}$	= 197#
Girders.	$\frac{825 \times 8.75^2 \times 1.5}{(30.21875 - 7)8 \times 2.6}$	= 188#	$\frac{10660 \times 8.75^2 \times 1.5}{(30 - 7)8 \times 30}$	= 222#
Top of combustion chamber.	$\frac{120 \times 10.5^2}{8^2}$	= 207#	$\frac{100 \times 10.5^2}{\frac{2^2 + 7^2}{2}}$	= 197#
Sides and back of combustion chamber.	$\frac{120 \times 9^2}{6.5^2}$	= 230#	$\frac{100 \times 9^2}{6.5^2}$	= 194#
Tube plate.	$\frac{(4.1875 - 2.784).625 \times 27000}{31.219 \times 4.1875}$	= 181#	$\frac{1750(4.1875 - 2.784)10}{30 \times 4.1875}$	= 196#
Main stays.	$\frac{5.93 \times 9000}{16 \times 17}$	= 196#	$\frac{5.93 \times 10.400}{16 \times 17}$	= 227#
Screw stays in sides and back of combustion chamber.	$\frac{1.024 \times 9000}{6.5^2}$	= 218#	$\frac{1.024 \times 8000}{6.5^2}$	= 194#
Screw stays in top of combustion chamber.	$\frac{1.26 \times 9000}{7 \times 8}$	= 202#	$\frac{1.26 \times 8000}{7 \times 8}$	= 180#
Screw stays in back at verticle edge of combustion chamber.	$\frac{1.52 \times 9000}{\left(\frac{13 + 6.5}{2}\right) \times 6.5}$	= 216#	$\frac{1.52 \times 8000}{\left(\frac{13 + 6.5}{2}\right)6.5}$	= 192#
Screw stays in back at top of combustion chamber.	$\frac{1.52 \times 9000}{\left(\frac{12.5 + 6.5}{2}\right) 6.5}$	= 221#	$\frac{1.52 \times 8000}{\left(\frac{12.5 + 6.5}{2}\right) \times 6.5}$	= 197#
Screw stays in corners of combustion chamber.	$\frac{2.06 \times 9000}{\left(\frac{13 + 6.5}{2}\right) 2}$	= 195#	$\frac{2.06 \times 9000}{\left(\frac{13 + 6.5}{2}\right)\left(\frac{12.5 + 6.5}{2}\right)}$	= 200#
Front head between nests of tubes.			$\frac{\frac{140(12 + 8)^2}{2}}{13.5^2}$	= 196#
Rear head between combustion chamber.			$\frac{\frac{100(10 + 8)^2}{2}}{\frac{13^2 + 6.5^2}{2}}$	= 186#
Stress per square inch in stay tubes in field.			$\frac{(8 \times 8.375 - 7.068 \times 4)180}{1.1888}$	= 5865#
Stress per square inch in stay tubes between nests.			$\frac{(8 \times 10.9375 - 7.0686 \times 3)180}{1.5975}$	= 7470#
Rounded bottom of combustion chamber.	$\frac{900 \times 9^2}{7.25 \times 54.875}$	=183		
Thickness of inner butt strap.			$\frac{3 \times 1.171875(8.5 - 1.3125)}{4(8.5 - 2.625)}$	= 1.08#

Percentage Strength of Joints

Plate: $\frac{(8.5 - 1.3124)100}{8.5} = 84.6\%$

Rivets: $\frac{(4 \times 1.353 \times 1.75 + 1.353)85}{8.5 \times 1.171875} = 92.4\%$

Plate and rivets combined:

$$\frac{100(8.5 - 2 \times 1.3125)}{8.5} + \frac{1.353 \times 85}{8.5 \times 1.17187} = 80.7\%$$

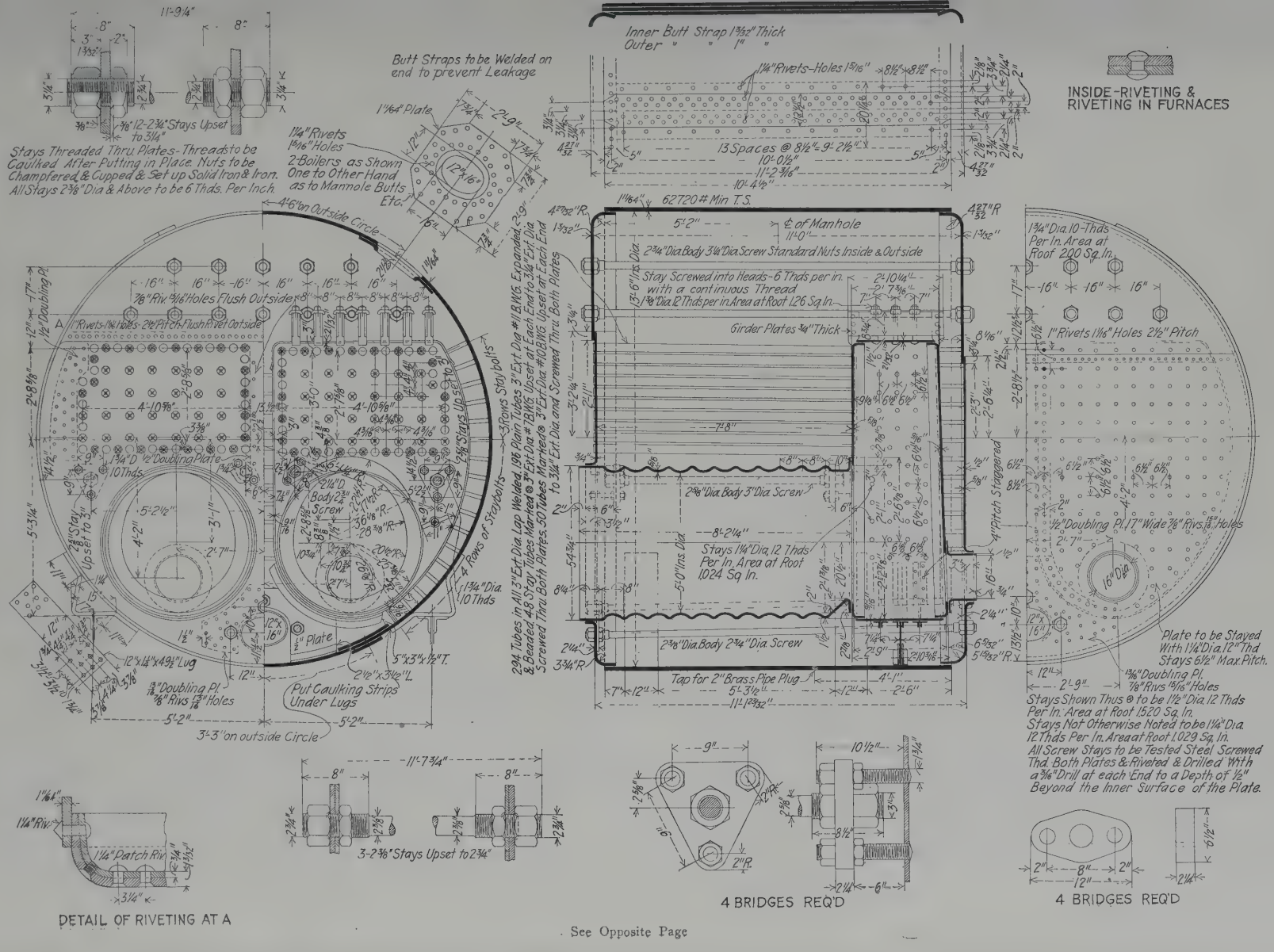
Draft area through tubes: 12.45 square feet.

Ratio. $\frac{\text{Grate Surface}}{\text{Draft area}} \quad \frac{45.75}{12.45} = 3.67$

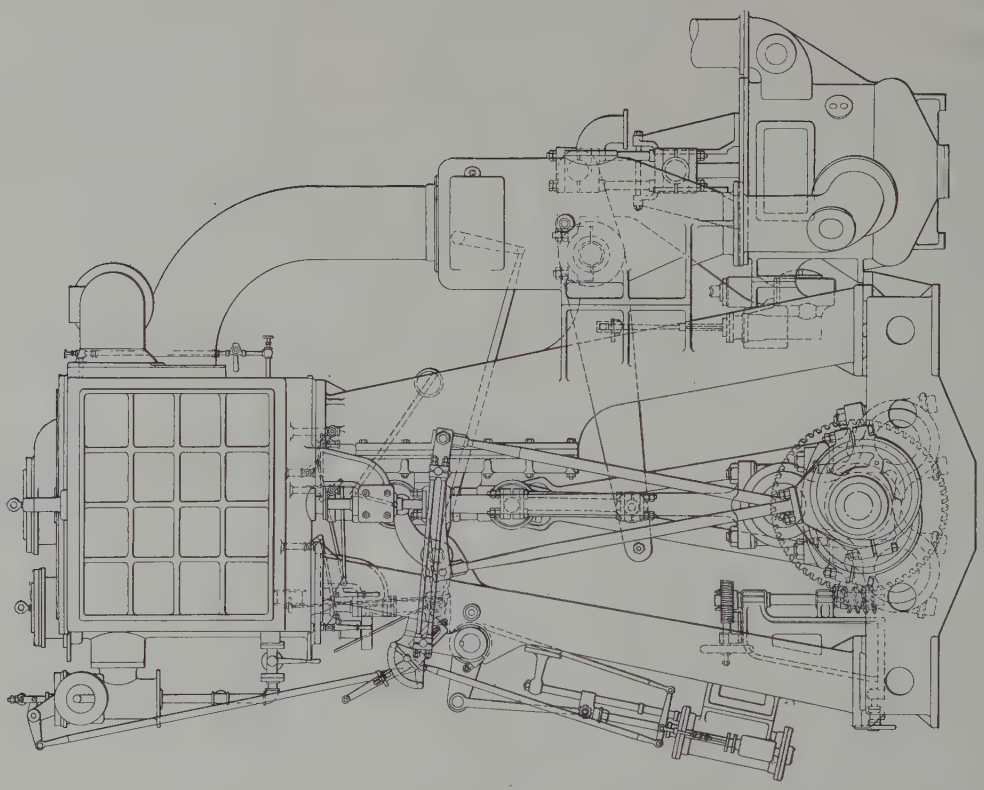
Butt straps to be welded on ends to prevent leakage.

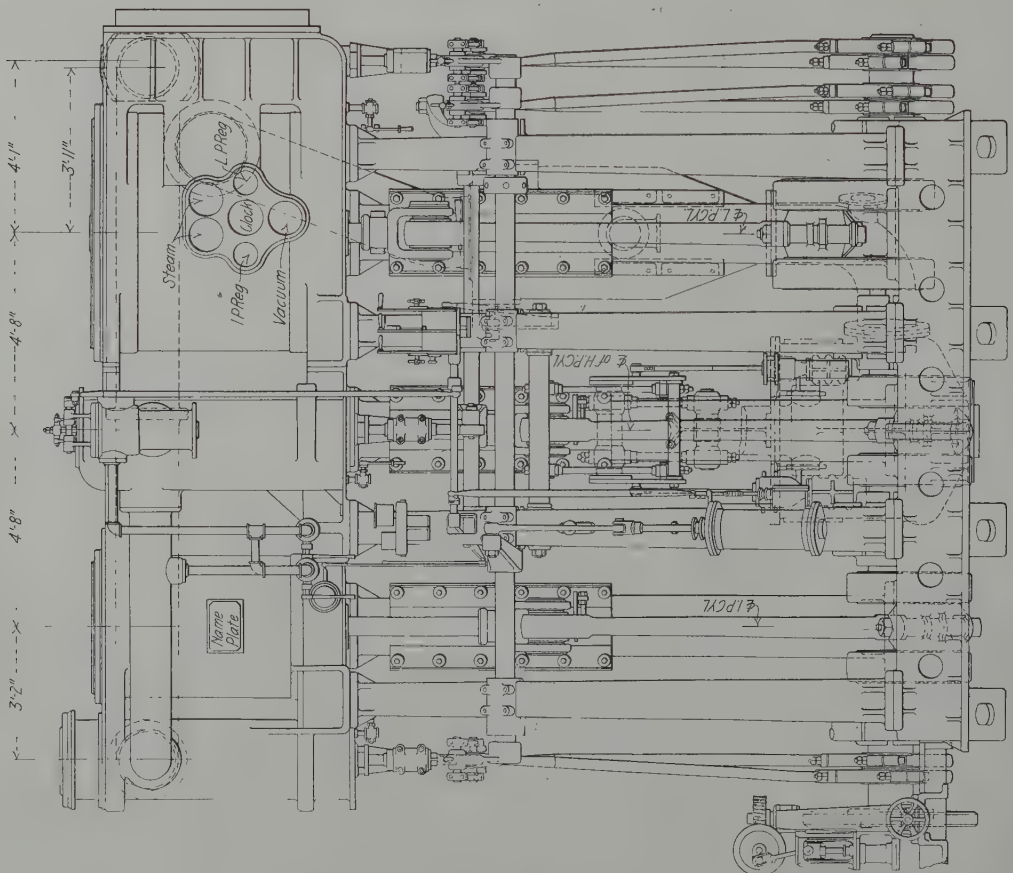
Data for One Boiler

Heating surface of tubes	1770 sq. ft.
Heating surface of combustion chamber	204 sq. ft.
Heating surface of furnaces	113 sq. ft.
Total heating surface	2135 sq. ft.
Grate surface—5'—6" grate bars	45.75
Ratio $\frac{\text{Heating surface}}{\text{Grate surface}}$	46.7

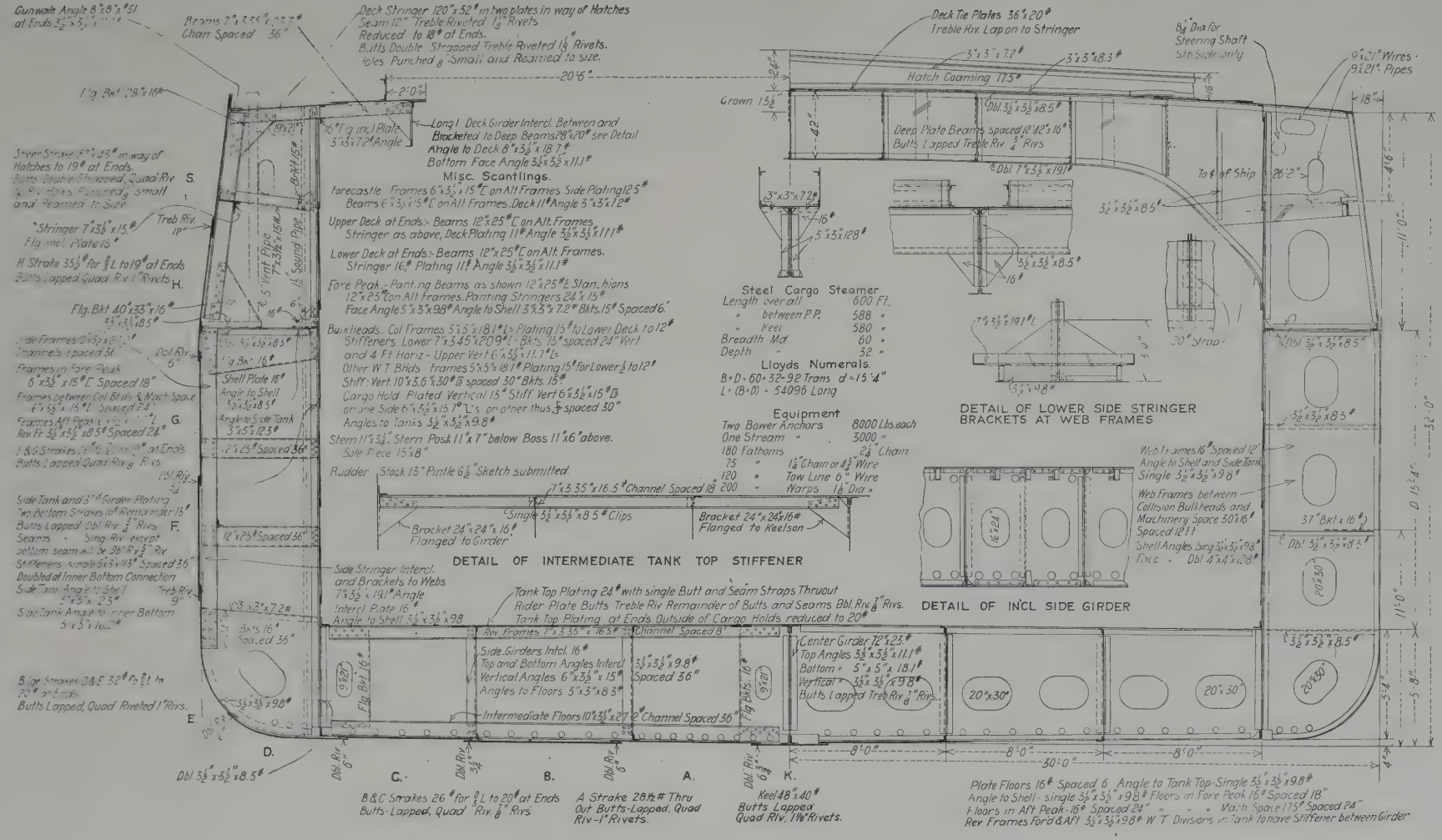

Stays Threaded Thru Plates-Threads to be Caulked After Putting in Place. Nuts to be Chamfered & Cupped & Set up Solid Iron & Iron. All Stays 2⅜" Dia & Above to be 6 Thds. Per Inch.
Butt Straps to be Welded on end to prevent Leakage
Inner Butt Strap 1 3/32" Thick
Outer " " 1" "
INSIDE-RIVETING & RIVETING IN FURNACES
1¼" Rivets 1 5/16" Holes
2 Boilers as Shown One to Other Hand as to Mannole Butts Etc.
13 Spaces @ 8½" = 9'-2½"
10'-0½"
11'-2 3/16"
10'-4½"
62720 # Min T.S.
℄ of Manhole
11"-0"
2¾" Dia Body 3¼" Dia Screw Standard Nuts Inside & Outside
Stay Screwed into Heads-6 Thds per in. with a continuous Thread
⅞" Dia. 12 Thds per in. Area at Root 1.26 Sq. In.
Girder Plates ¾" Thick
1" Rivets 1 1/16" Holes 2½" Pitch
½" Doubling Pl. 17" Wide ⅞" Rivs. 15" Holes
4" Pitch Staggered
6½" Pitch
Plate to be Stayed With 1¼" Dia. 12" Thd Stays 6½" Max. Pitch.
⅜" Doubling Pl. ⅞" Rivs 1 5/16" Holes
Stays Shown Thus ⊗ to be 1½" Dia. 12 Thds Per In. Area at Root 1.520 Sq. In.
Stays Not Otherwise Noted to be 1¼" Dia. 12 Thds Per In. Area at Root 1.029 Sq. In.
All Screw Stays to be Tested Steel Screwed Thd. Both Plates & Riveted & Drilled With a ¾" Drill at each End to a Depth of ½" Beyond the Inner Surface of the Plate.
4'-6" on Outside Circle
3'-3" on outside Circle
⅞" Riv. 1 3/16 Holes Flush Outside
1" Rivets 1 1/16" Holes 2½" Pitch Flush Rivet Outside
3 Rows Stay Bolts
4 Rows of Stay Bolts
2¾" Dia. 10 Thds
Put Caulking Strips Under Lugs
12" x 1¼" x 49½" Lug
5" x 3" x ½" T.
2½" x 3½" L
294 Tubes in All 3" Ext. Dia. Lap Welded, 198 Plain Tubes 3" Ext. Dia. # 11 B.W.G. Expanded & Beaded 48 Stay Tubes Marked ⊗ 3" Ext. Dia. # 13 B.W.G. Upset at Each End to 3¼" Ext. Dia Screwed Thru Both Plates. 50 Tubes Marked ⊙ 3" Ext. Dia. # 10 B.W.G. Upset at Each End to 3¼" Ext. Dia and Screwed Thru Both Plates
Stays 1¼" Dia. 12 Thds Per In. Area at Root 1.024 Sq. In.
2⅜" Dia. Body 3" Dia. Screw
2⅜" Dia. Body 2¾" Dia. Screw
Tap for 2" Brass Pipe Plug
Stays Upset to 3"
Stays Upset to 2¾"
1¼" Patch Riv.
1⅛" Riv.
DETAIL OF RIVETING AT A
3-2⅜" Stays Upset to 2¾"
4 BRIDGES REQ'D
4 BRIDGES REQ'D

See Opposite Page





24½" x 40" x 65" x 42" STROKE
Great Lakes Engineering Co., Detroit, Mich.


Misc. Scantlings.
Steel Cargo Steamer
Length over all 600 Ft.
" between P.P. 588 "
" Keel 580 "
Breadth Mld 60 "
Depth " 32 "
Lloyds Numerals.
B+D=60+32=92 Trans d=15'4"
L+(B+D)=54096 Long
Equipment
Two Bower Anchors 8000 Lbs. each
One Stream " 3000 "
180 Fathoms 2¾" Chain
75 " 1¼" Chain or 4¾" Wire
120 " Tow Line 6" Wire
200 " Warps 1⅛" Dia "
DETAIL OF INTERMEDIATE TANK TOP STIFFENER
DETAIL OF LOWER SIDE STRINGER BRACKETS AT WEB FRAMES
DETAIL OF INCL SIDE GIRDER
Plate Floors 16# Spaced 6', Angle to Tank Top-Single 3½"x3½"x9.8#
Angle to Shell - single 5½"x3½"x9.8# Floors in Fore Peak 16# Spaced 18"
Floors in Aft Peak-16# Spaced 24" " " " Math Space 115# Spaced 24"
Rev Frames Fore & Aft 5½"x3½"x9.8# W.T. Divisions in Tank to have Stiffener between Girder
B&C Strakes 26# for ⅝ L to 20# at Ends
Butts-Lapped, Quad Riv. ⅞" Rivs.
A Strake 28½# Thru
Out Butts-Lapped, Quad
Riv-1" Rivets.
Keel 48"x40#
Butts Lapped
Quad Riv. 1⅛" Rivets.

12,120-NET TONS D. W. LAKE BULK FREIGHTER, "HORACE S. WILKINSON"

The Toledo Shipbuilding Co., Toledo, Ohio

12.120-NET TONS D. W. LAKE BULK FREIGHTER, "HORACE S. WILKINSON"

For Arrangement Plan
See Plate XII opposite Page 392

LIST OF STEAM VALVES

Pc. No.	No. of Pcs.	Name	Mat'l	Remarks
1	3	3″ Globe fl'g'd ex. h'vy	C.I.	Aux. st. at boilers.
2	1	3″ Globe fl'g'd ex. h'vy	C.I.	H. P. line aft.
3	1	2½″ Reduce fl'g'd ex. h'vy	C.I.	L. P. line to dynamos.
4	2	2½″ Globe fl'g'd ex. h'vy	C.I.	L. P. line to dynamos.
5	1	3″ Reduce fl'g'd ex. h'vy	C.I.	L. P. line for'd to winches and windlass.
6	2	3″ Globe fl'g'd ex. h'vy	C.I.	L. P. line for'd to winches and windlass.
7	1	2″ Reduce fl'g'd ex. h'vy	Brass	L. P. line to steer. eng.
8	2	2″ Globe fl'g'd ex. h'vy	Brass	L. P. line to steer. eng.
9	1	3″ Reduce fl'g'd ex. h'vy	C.I.	L. P. line to ballast engines.
10	2	3″ Globe fl'g'd ex. h'vy	C.I.	L. P. line to ballast engines.
11	1	2″ Reduce fl'g'd ex. h'vy	Brass	L. P. line to ballast and sanitary pumps and revers. eng.
12	2	2″ Globe fl'g'd ex. h'vy	Brass	L. P. line to ballast and san. pumps and revers. eng.
13	2	2″ Ang. scr'd ex. h'vy	Brass	St. at 15 K. W. dynamos.
14	1	1¼″ Ang. scr'd ex. h'vy	Brass	St. at 7½ K. W. dynamos.
15	2	2″ Globe scr'd ex. h'vy	Brass	St. at injectors.
16	1	2″ Globe scr'd ex. h'vy	Brass	St. at fire pump.
17	1	1″ Globe scr'd ex. h'vy	Brass	St. at mate's pump.
18	1	1½″ Globe scr'd ex. h'vy	Brass	St. at feed pump.
19	1	1″ Globe scr'd ex. h'vy	Brass	St. at turning eng.
20	1	1″ Globe scr'd ex. h'vy	Brass	St. at revers. eng.
21	1	1″ Globe scr'd ex. h'vy	Brass	St. at san. pump.
22	1	2½″ Globe scr'd ex. h'vy	C.I.	St. at independent ballast pump.
23	1	1½″ Globe scr'd ex. h'vy	Brass	St. at fan eng.
24	2	3″ Globe fl'g'd ex. h'vy	C.I.	St. at ballast engs.
25	2	1″ Globe scr'd ex. h'vy	Brass	St. to hose line.
26	2	2½″ Ang. fl'g'd ex. h'vy	C.I.	St. to whistle.
27	1	1½″ Globe scr'd ex. h'vy	Brass	St. to fire exting. line.
28	6	1½″ Globe scr'd ex. h'vy	Brass	St. at fire exting. manifold.
29	1	1″ Reduce scr'd ex. h'vy	Brass	St. to heating line aft 100# to 10.#
30	2	1″ Globe scr'd ex. h'vy	Brass	St. to heating line aft.
31	1	1″ Reduce scr'd ex. h'vy	Brass	St. to heating line for'd 100# to 10.#
32	2	1″ Globe scr'd ex. h'vy	Brass	St. to heating line for'd.
33	5	2″ Globe scr'd ex. h'vy	Brass	St. to flue blowers (smoke bx.)

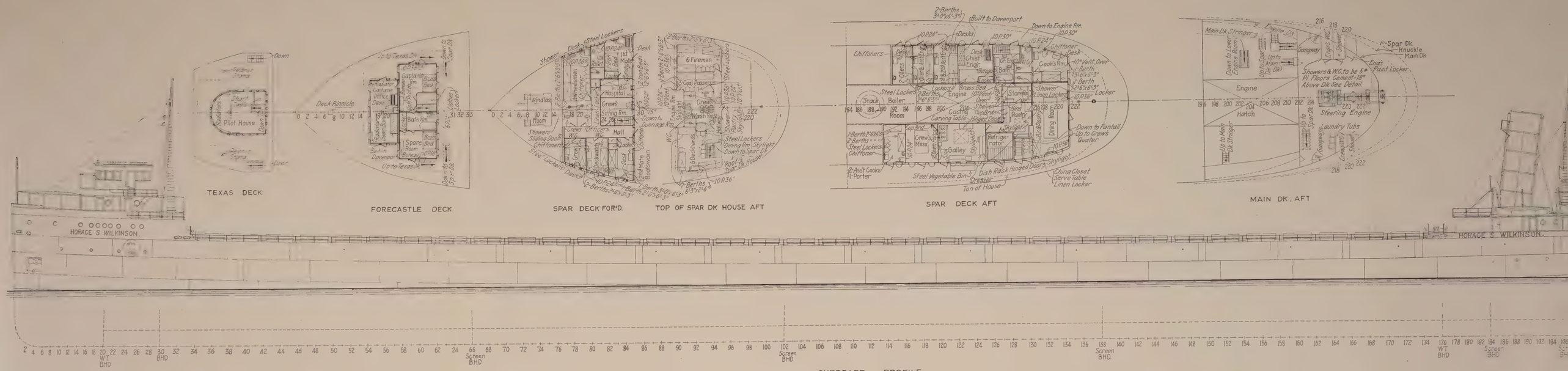
LIST OF STEAM VALVES—Continued

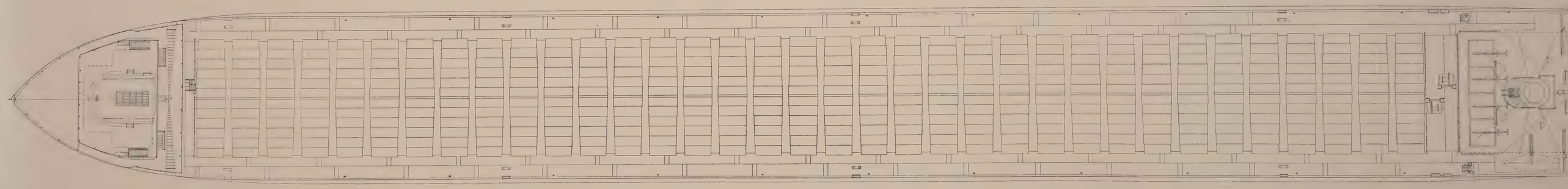
Pc. No.	No. of Pcs.	Name	Mat'l	Remarks
34	7	2″ Ang. scr'd ex. h'vy	Brass	St. at deck winches.
35	4	1½″ Ang. scr'd ex. h'vy	Brass	St. at hatch winches.
36	1	2″ Globe scr'd ex. h'vy	Brass	St. at steer. eng.
37	3	4″ Ang. fl'g'd ex. h'vy	C.S.	Safety valves, duplex.
38	1	3″ Globe fl'g'd ex. h'vy	C.I.	St. at windlass.
39	2	1½″ Globe scr'd ex. h'vy	Brass	St. at syphons.
40	3	5″ Ang. fl'g'd ex. h'vy	C.I.	Main st. stop valves.
41	2	2½″ Globe fl'g'd ex. h'vy	C.I.	St. to whistle (in pipe line).
42	1	3″ Globe fl'g'd ex. h'vy	C.I.	Main st. to injectors (main line).
43	1	2″ Globe fl'g'd ex. h'vy	Brass	Main st. line to flue blowers.
0	2	4″ Globe fl'g'd ex. h'vy	C.I.	Port and starb'd. cut out valves aux. steam.

LIST OF EXHAUST VALVES

Pc. No.	No. of Pcs.	Name	Mat'l	Remarks
44	1	3″ Gate fl'g'd st'd.....	C.I.	Exh. from ballast pump.
45	1	2″ Gate scr'd st'd.....	Brass	Exh. from fan eng.
46	1	1½″ Gate scr'd st'd...	Brass	Exh. from rever. eng.
47	1	2½″ Gate fl'g'd st'd...	C.I.	Exh. from steer. eng.
48	1	3″ Gate fl'g'd st'd.....	C.I.	Exh. from windlass.
49	2	2½″ Ang. scr'd st'd...	C.I.	Exh. from 15 K. W. dynamos.
50	1	1½″ Ang. scr'd st'd...	Brass	Exh. from 7½ K. W. dynamos.
51	1	2″ Gate scr'd st'd.....	Brass	Exh. from feed pump.
52	1	1¼″ Gate scr'd st'd...	Brass	Exh. from san. pump.
53	1	1½″ Gate scr'd st'd...	Brass	Exh. from mates pump.
54	7	2½″ Ang. scr'd st'd...	C.I.	Exh. from deck winches.
55	4	2″ Ang. scr'd st'd.....	Brass	Exh. from hatch winches.
56	2	3½″ Gate fl'g'd st'd...	C.I.	Exh. from ballast engines.
57	1	6″ Gate fl'g'd st'd.....	C.I.	Exh. at heater inlet.
58	1	1½″ Gate scr'd st'd...	Brass	Exh. from turning engine.
59	1	3″ Gate fl'g'd st'd.....	C.I.	Exh. from fire pump.
60	1	5″ fl'g'd st'd	C.I.	Back pres. valve, vertical.
61	1	3″ Ang. fl'g'd st'd.....	C.I.	Exh. from for'd line.
62	1	2″ Ang. scr'd st'd.....	Brass	Heater drain (feed water).
63	1	2″ Ang. scr'd st'd.....	Brass	Water catch drain overboard.
69	1	1½″ Globe scr'd ex. h'vy	Brass	St. to stack blower.

(Continued on Next Page)

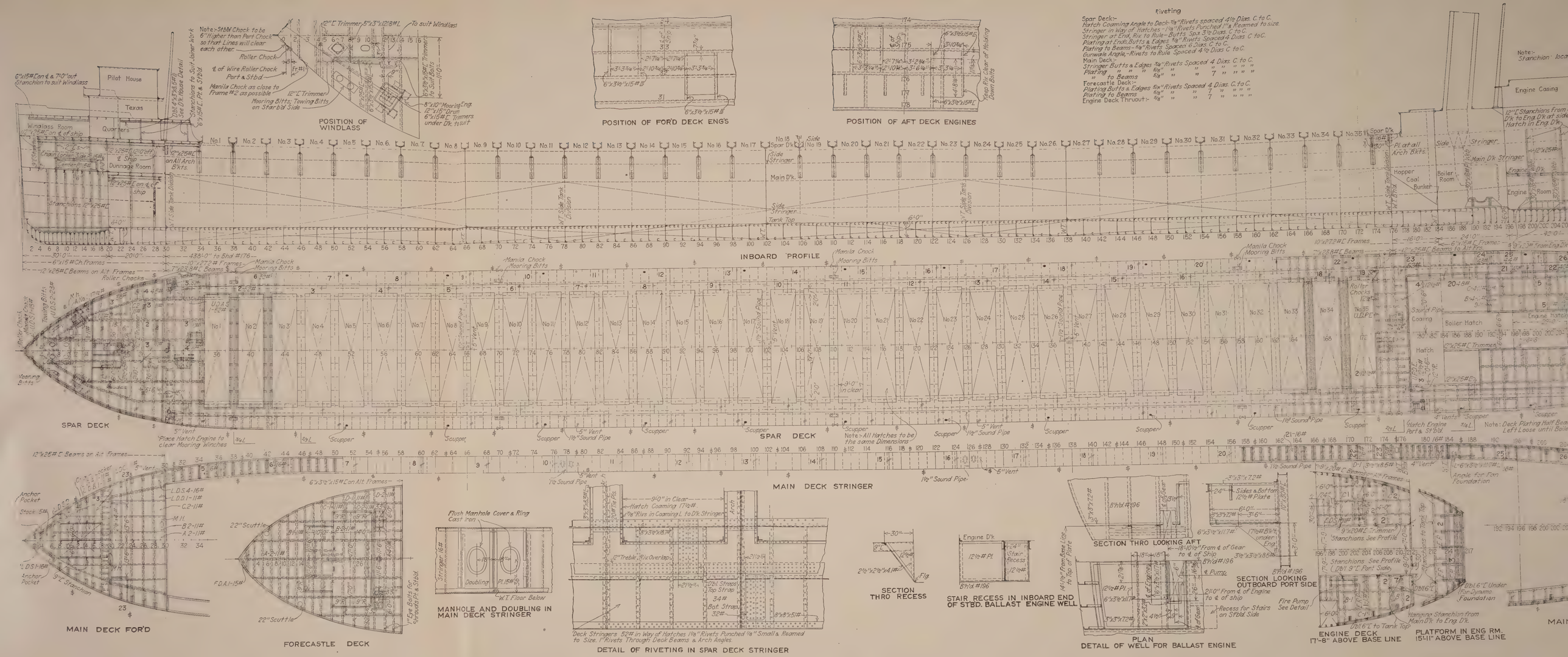




Principal Dimensions

L. O. A.	600'—0"
L. B. P.	588'—0"
L. Keel	580'—0"
Breadth, M'l'd	60'—0"
Depth, M'l'd	32'—0"

OUTBOARD PROFILE AND SPAR DECK
12,120-NET TONS D. W. LAKE BULK FREIGHTER "HORACE S. WILKINSON"
The Toledo Shipbuilding Co., Toledo, Ohio


Riveting
Spar Deck:-
Hatch Coaming Angle to Deck-7/8" Rivets spaced 4½ Diam. C. to C.
Stringer in Way of Hatches - 1 1/16" Rivets Punched 1"s Reamed to size.
Stringer at End, Riv. to Rule - Butts, Spar, 3/4 Diam. C. to C.
Plating at Ends, Butts & Edges 7/8" Rivets Spaced 4 Diam. C. to C.
Plating to Beams - 7/8" Rivets Spaced 6 Diam. C. to C.
Gunwale Angle, - Rivets to Rule Spaced 4½ Diam. C. to C.
Main Deck:-
Stringer Butts & Edges 3/4" Rivets Spaced 4 Diam. C. to C.
Plating " " " 5/8" " " " " "
" to Beams 5/8" " " 7 " " "
Forecastle Deck:-
Plating Butts & Edges 5/8" Rivets Spaced 4 Diam. C. to C.
Plating to Beams 5/8" " " 7 " " "
Engine Deck Thruout:- 5/8" " " 7 " " "
POSITION OF WINDLASS
POSITION OF FOR'D DECK ENG'S
POSITION OF AFT DECK ENGINES
INBOARD PROFILE
SPAR DECK
SPAR DECK
MAIN DECK STRINGER
MAIN DECK FOR'D
FORECASTLE DECK
MANHOLE AND DOUBLING IN MAIN DECK STRINGER
DETAIL OF RIVETING IN SPAR DECK STRINGER
SECTION THRO RECESS
STAIR RECESS IN INBOARD END OF STBD. BALLAST ENGINE WELL
SECTION THRO LOOKING AFT
SECTION LOOKING OUTBOARD PORT SIDE
PLAN
DETAIL OF WELL FOR BALLAST ENGINE
ENGINE DECK
17'-8" ABOVE BASE LINE
PLATFORM IN ENG RM.
15'-11" ABOVE BASE LINE

INBOARD PROFILE AND DECK PLANS

12,120-NET TONS D. W. LAKE BULK FREIGHTER, "HORACE S. WILKINSON"

The Toledo Shipbuilding Co., Toledo, Ohio

12,120-NET TONS D. W. LAKE BULK FREIGHTER, "HORACE S. WILKINSON"

For Arrangement Plan
See Plate XII opposite Page 392

LIST OF SUCTION VALVES

Pc. No.	No. Pcs.	Name	Mat'l	Remarks
70	2	2" Gate scr'd. St'd....	Brass	Injector suction from sea.
71	1	7" Ang. flg'd. St'd....	C.I.	Ballast system suct. from channel plate.
72	1	2½" Ang. scr'd. St'd..	C.I.	San. pump suct. from sea.
73	1	2½" Ang. scr'd. St'd...	C.I.	San. pump suct. from aft peak tank.
74	1	2½" Ang. scr'd. St'd...	C.I.	Cooler pump suct. from sea.
75	1	2½" Ang. scr'd. St'd...	C.I.	Cooler pump suct. from aft. peak tank.
76	1	4" Ang. fl'g'd. St'd....	C.I.	Feed pump suct. from sea.
77	1	4" Ang fl'g'd. St'd....	C.I.	Feed pump suct. from hot well.
78	1	4" Ang. fl'g'd. St'd...	C.I.	Feed and cooler pump suct. at stool.
79	1	4" Ang. fl'g'd. St'd....	C.I.	Injectors—mates—fire pump suct. at stool.
80	1	4" Manifold		Fire pump suct. from sea.
81	1	4" Manifold		Fire pump suct from bilge.
82	1	4" Manifold		Fire pump suct. from hot well.
83	1	2½" Gate fl'g'd. St'd..	C.I.	Sanitary pump suct. at stool.
84	1	2½" Check scr'd. St'd..	C.I.	Deck pump suct. from sea.
85	1	2½" Ang. scr'd. St'd..	C.I.	Mate's pump suct. from sea.
86	1	6" Ang. fl'g'd. St'd....	C.I.	Main injection to condenser.
87	1	6" Ang. fl'g'd. St'd....	C.I.	Main injection from for'd. sea cock.
88	1	4" Check fl'g'd. St'd....	C.I.	Independent ballast pump suct. from bilge—screw down check.

LIST OF DISCHARGE VALVES

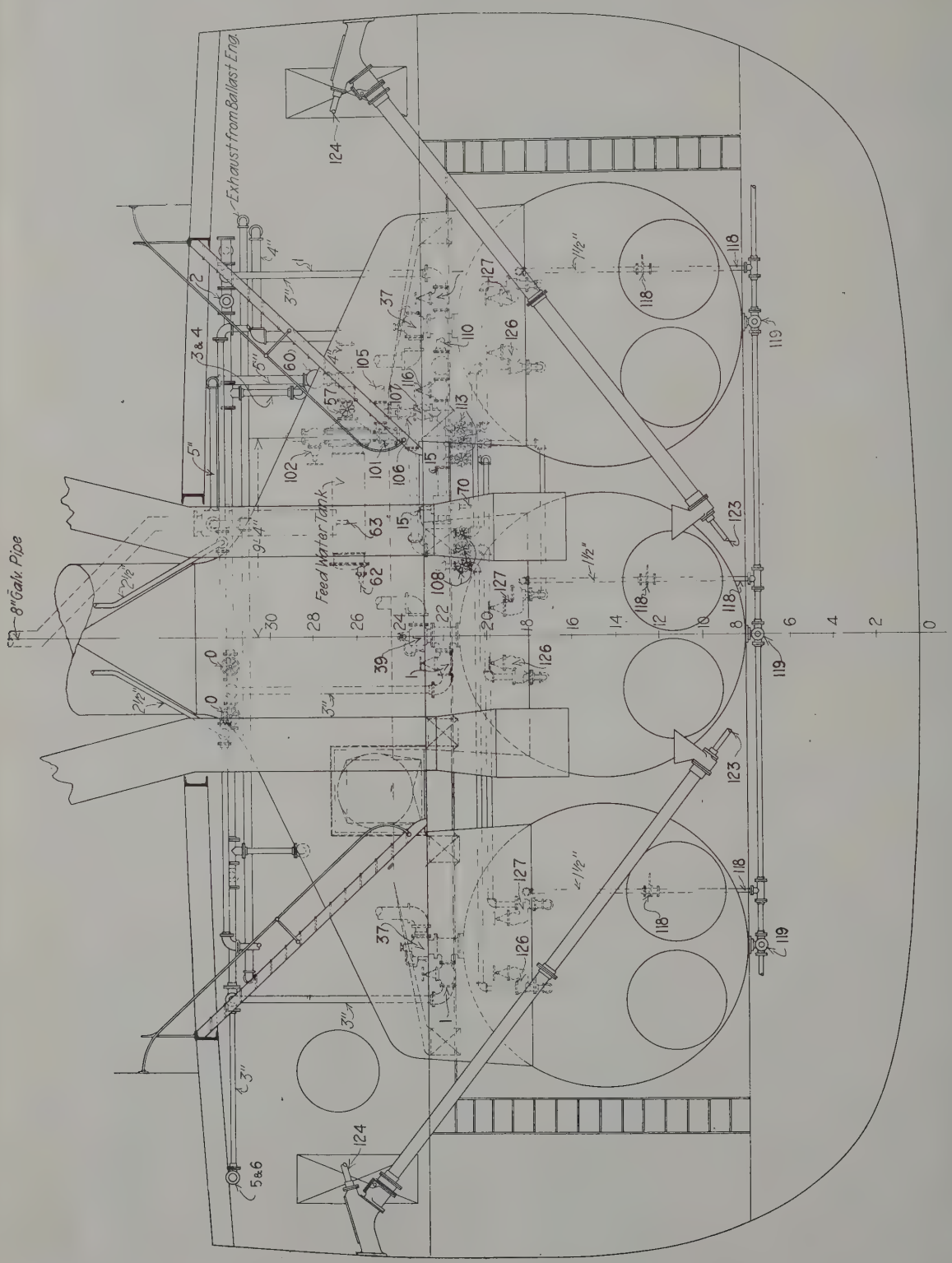
Pc. No.	No. Pcs.	Name	Mat'l	Remarks
101	1	3" Ang. fl'g'd. ex. hvy.	C.I.	Feed line at heater inlet—combination.
102	1	3" Globe fl'g'd. ex. h'vy.	C.I.	Feed line at heater outlet.
103	1	3" Gate fl'g'd. ex. h'vy.	C.I.	Feed pump discharge to heater at pump.
104	1	3" Check fl'g'd. ex. h'vy.	C.I.	Feed pump discharge to heater at pump.
105	1	3" Gate fl'g'd. ex. h'vy.	C.I.	Feed pump discharge to heater (main line).
106	1	3" Check fl'g'd. ex. h'vy.	C.I.	Manifold discharge to heater.
107	1	3" Globe fl'g'd. ex. h'vy.	C.I.	Manifold discharge to heater.
108	3	2" Globe scr'd. ex. h'vy.	Brass	Main feed line regulating valves.
109	2	3" Globe fl'g'd. ex. h'vy.	C.I.	Fire pump discharge to manifold.

LIST OF DISCHARGE VALVES—Continued

Pc. No.	No. Pcs.	Name	Mat'l	Remarks
110	1	2½" Globe fl'g'd ex. h'vy.	C.I.	Manifold discharge overboard.
111	1	2" Gate scr'd. ex. h'vy.	Brass	Manifold discharge to condenser and cooling system.
113	3	2" Globe scr'd. ex. h'vy.	Brass	Manifold discharge to boilers.
114	1	2" Gate scr'd. ex. h'vy.	Brass	Manifold discharge to hose.
115	2	2" Gate scr'd. ex. h'vy.	Brass	Injector discharge to manifold.
116	1	3" Gate fl'g'd. ex. h'vy.	C.I.	Manifold dividing valve.
117	1	2" Globe scr'd. ex. h'vy.	Brass	Cooler pump discharge to cooling system.
118	3	1½" Thru fl'g'd. ex..... h'vy.	Brass	Surface blow off.
119	3	2½" Thru fl'g'd. ex. h'vy.	C.I.	Bottom blow off.
120	1	2" Angle scr'd. ex. h'vy.	Brass	Boiler drain.
121	9	1½" Angle scr'd. med..	Brass	Hose line on deck.
122	1	3" Angle fl'g'd. ex. h'vy.	C.I.	Fire pump discharge to ash guns.
123	2	2½" Thru fl'g'd. ex. h'vy.	C.I.	Bottom discharge to ash guns—quick opening valves.
124	2	2" Thru fl'g'd. ex. h'vy.	C.I.	Top discharge to ash guns—quick opening valves.
125	6	1½" Ang. scr'd. ex. h'vy.	Brass	Top and bottom connection for water column.
126	3	2"		Main feed at boilers.
127	3	2"		Aux. feed at boilers.
128	1	2" Gate scr'd. st'd.....	Brass	Boiler blow off (overboard discharge).

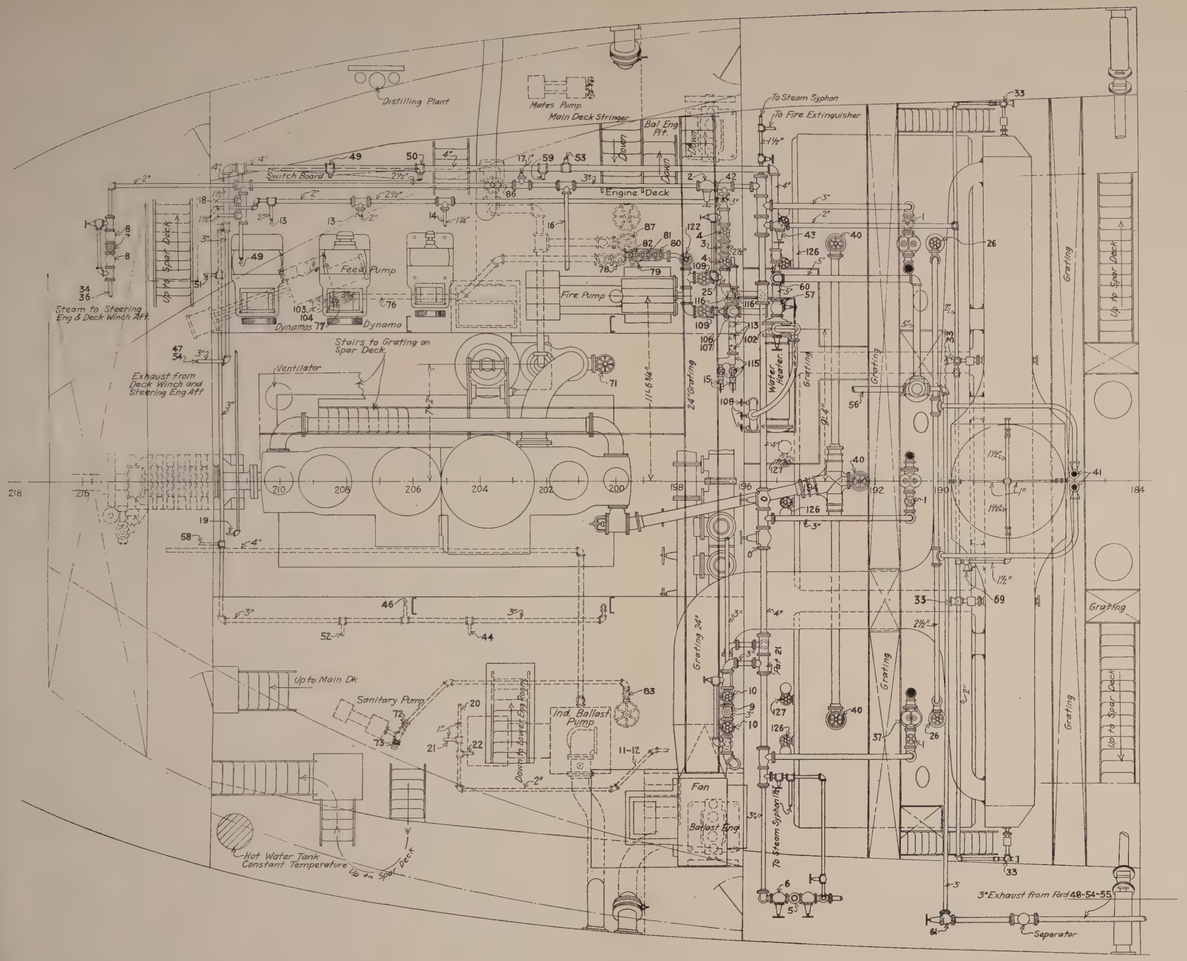
LIST OF AUXILIARIES

No.	Description	Size
1	Dynamo, 115 volts.....	7½ K. W.
2	Dynamo, 115 volts.....	15 K. W.
1	Fan, direct connected to 6 x 6 engine....	#7—36" dia.
1	Ballast pump horizontal—duplex—piston.	12x18x18
1	Sanitary pump horizontal—duplex—piston	5½x3¾x5
1	Feed pump horizontal—duplex—plunger.	8x5x12
1	Mate's pump horizontal—duplex—piston.	6x4x6
1	Fire pump horizontal—duplex—plunger..	14x7½x12
2	Pumping engines for ballast system.....	8x8x8
1	Steering engine for screw.....	10x8
14	Pumps composing ballast system—7 stbd. —7 port.....	16x12
1	Direct connected bilge pump.....	5½x10
1	Direct connected cooler pump.....	4⅞x10
1	Direct connected air pump.....	40x13¼
1	Turning engine.....	6x6
1	Reverse engine.....	12x18
1	Feed water heater horizontal.....	#10 L.
7	Deck winches.....	8x10
4	Hatch winches.....	6x5
1	No 11 steam capstan windlass — spur geared—reverse valve.....	10x14

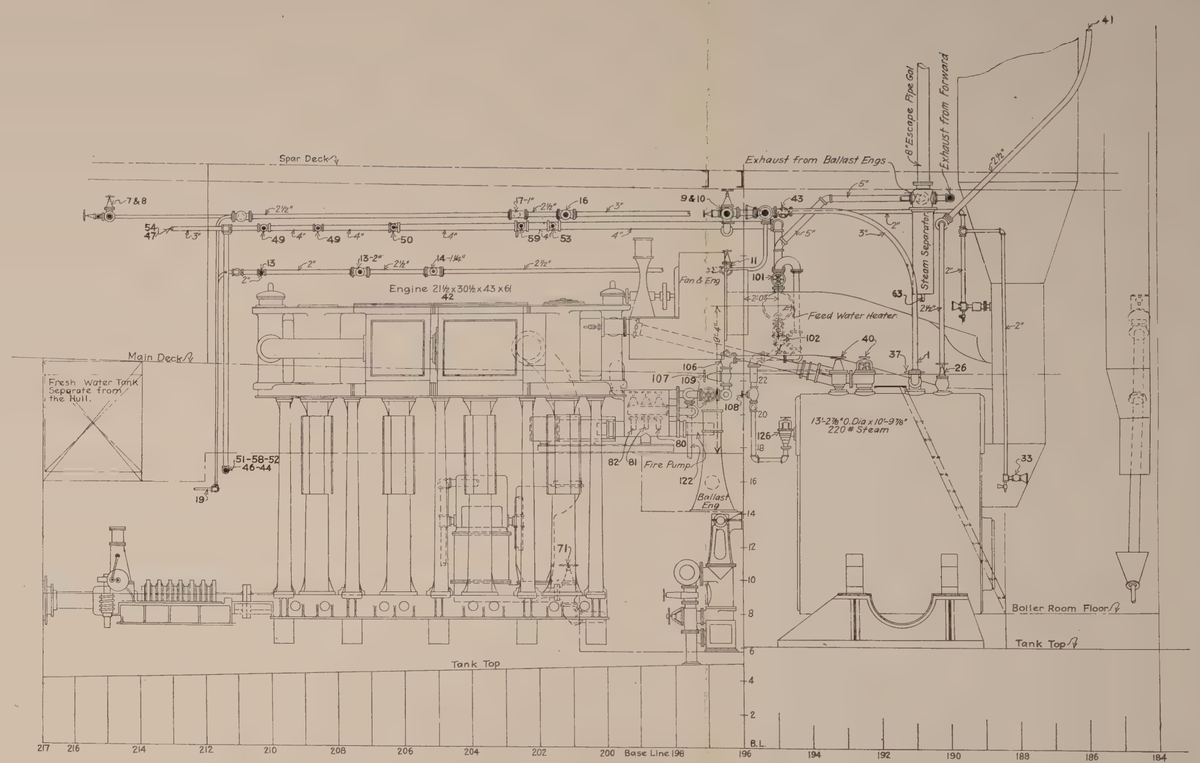


SECTION AT FRAME #184 LOOKING AFT

12,120-NET TONS D. W. LAKE BULK FREIGHTER "HORACE S. WILKINSON"
The Toledo Shipbuilding Co., Toledo, Ohio



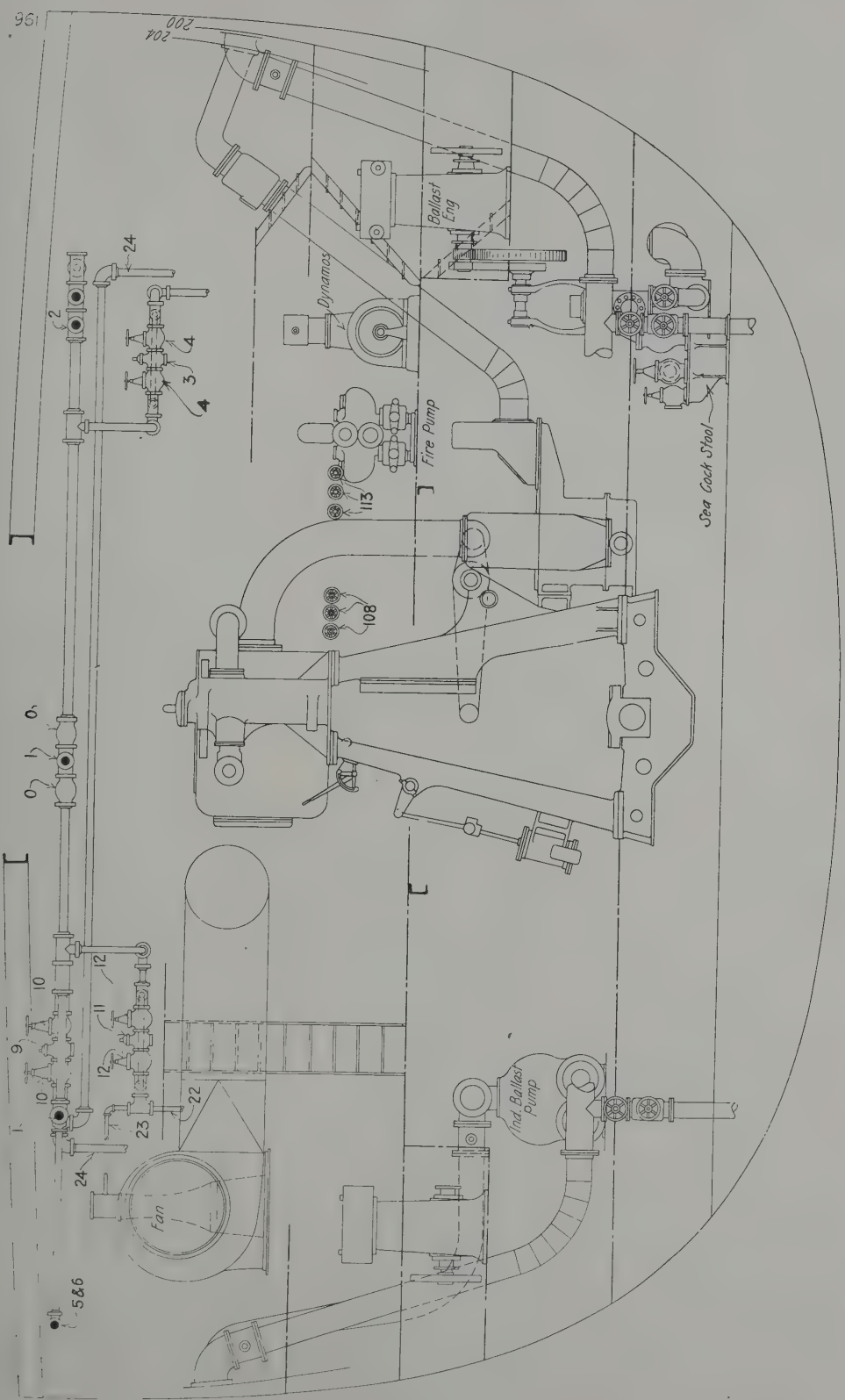
PLAN VIEW



ELEVATION

ARRANGEMENT OF MACHINERY AND PIPING
12,120-NET TONS D. W. LAKE BULK FREIGHTER, "HORACE S. WILKINSON"
The Toledo Shipbuilding Co., Toledo, Ohio.

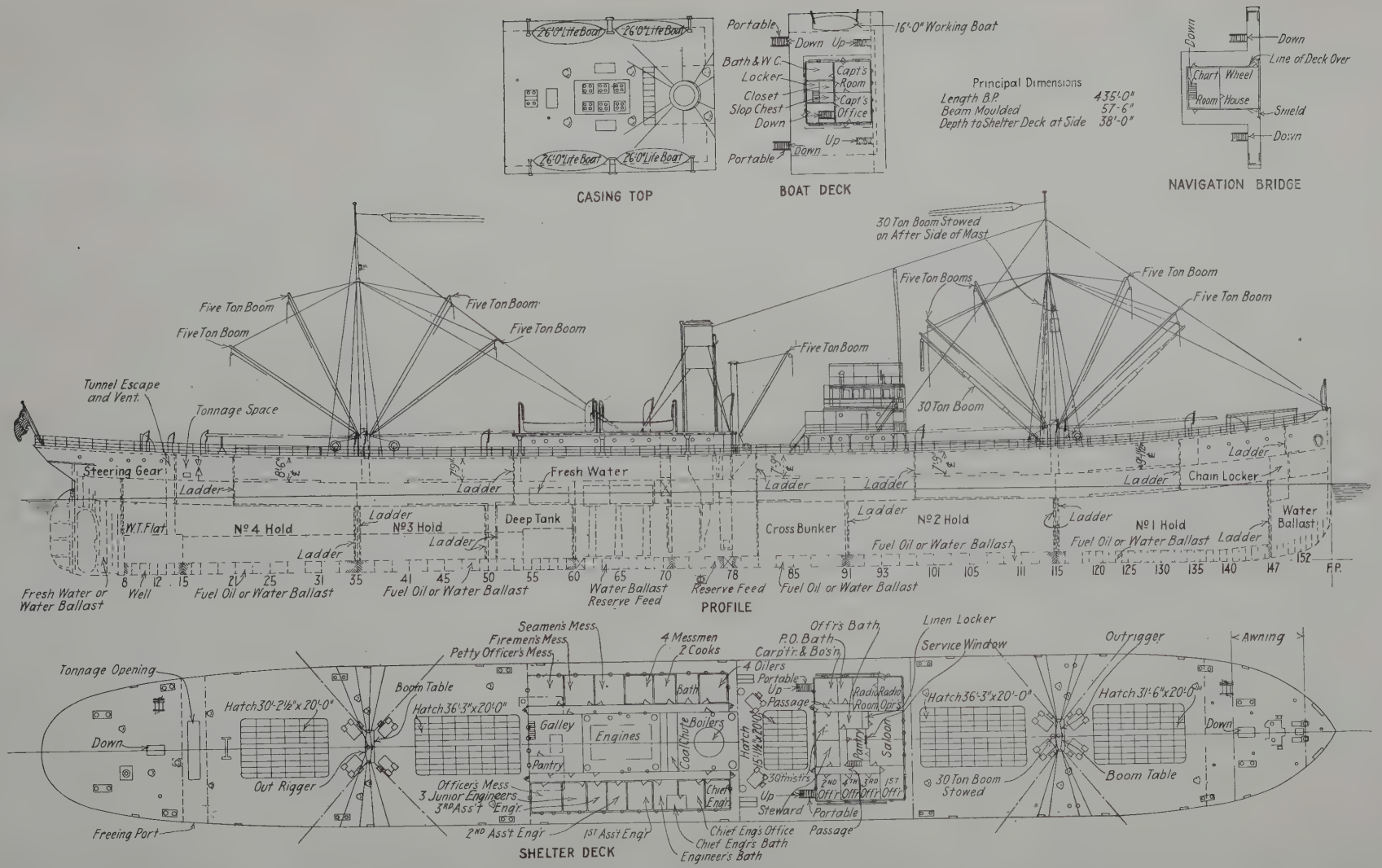
PLATE XII



SECTION AT FRAME #196 LOOKING AFT

12,120-NET TONS D. W. LAKE BULK FREIGHTER, "HORACE S. WILKINSON"

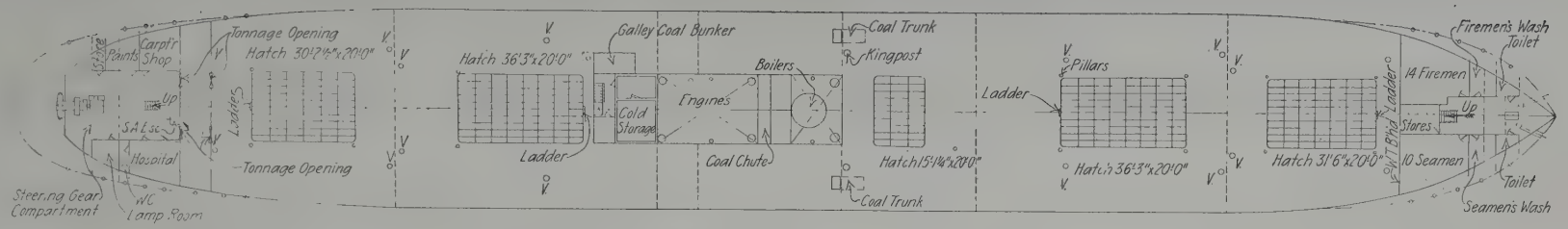
The Toledo Shipbuilding Co., Toledo, Ohio



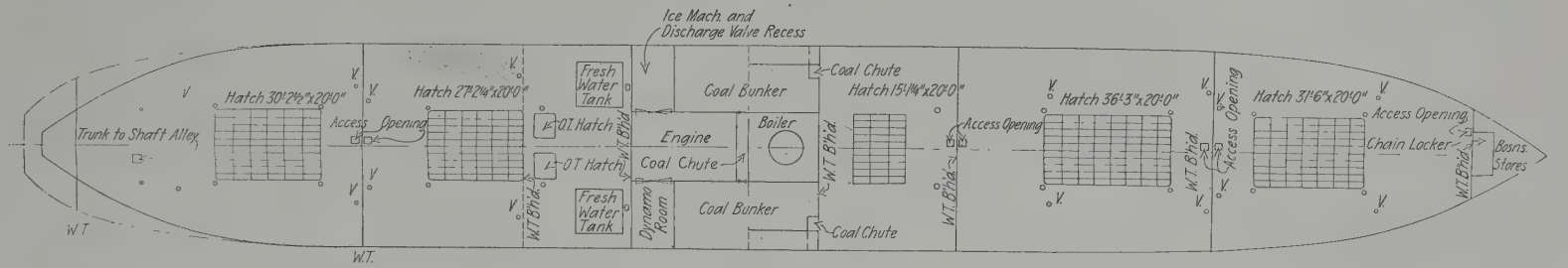
12,000-TON D. W. FREIGHTER

Sun Shipbuilding Co., Chester, Pa.

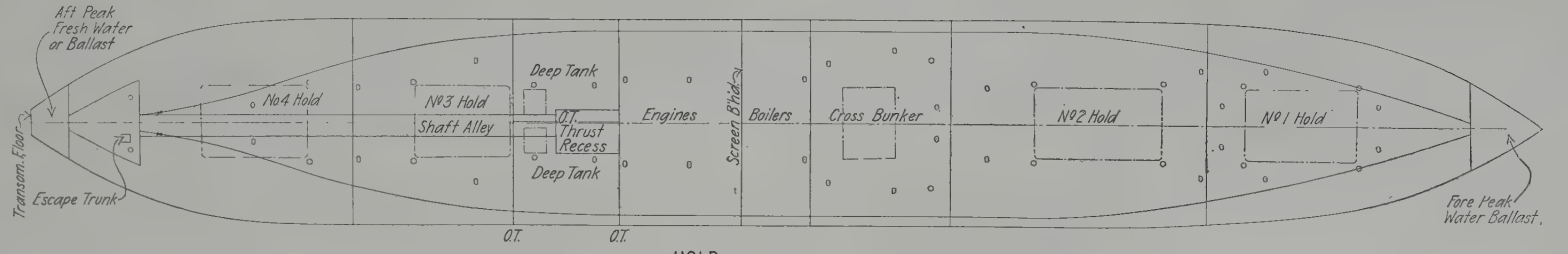
See Opposite Page



UPPER DECK



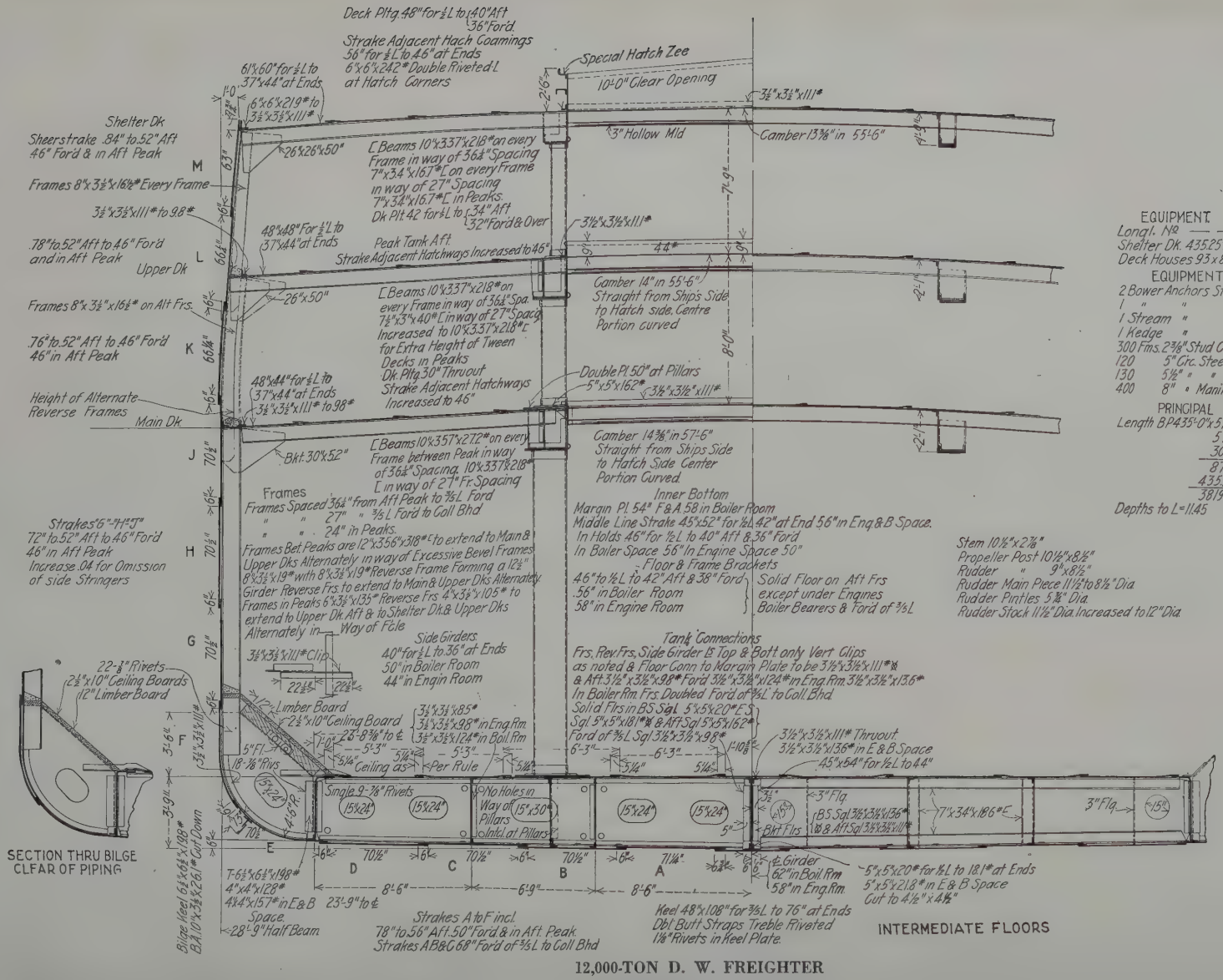
MAIN DECK



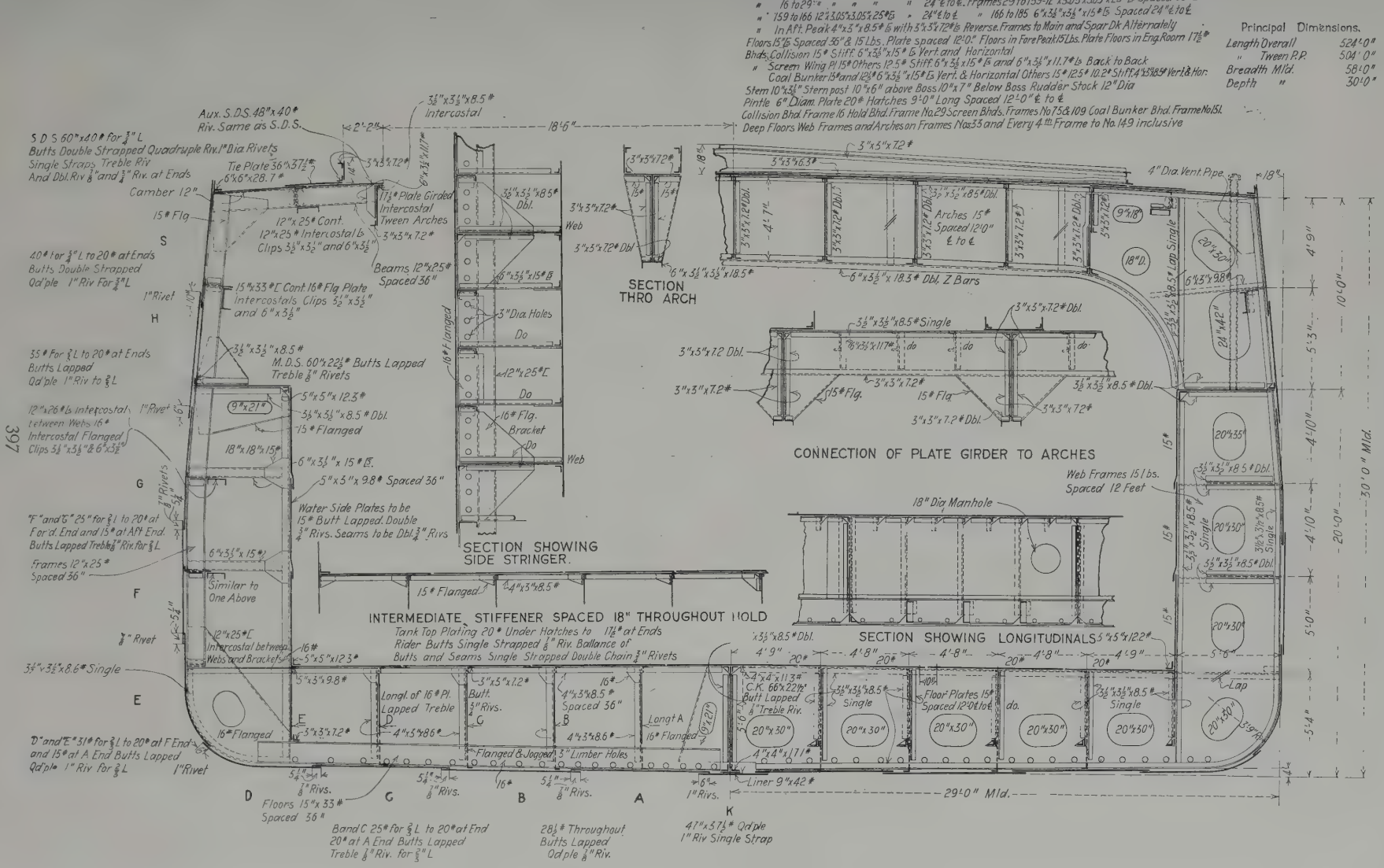
HOLD

12,000-TON D. W. FREIGHTER
Sun Shipbuilding Co., Chester, Pa.

See Opposite Page


Deck Plt'g 48" for ½L to 140' Aft 36" For'd.
Strake Adjacent Hach Coamings 56" for ½L to 46" at Ends 6"x6"x24.2# Double Riveted L at Hatch Corners
Special Hatch Zee
10'-0" Clear Opening
3" Hollow Mld
Camber 13⅜" in 55'-6"
Shelter Dk
Sheerstrake .84" to 52" Aft 46" For'd & in Aft Peak
Frames 8"x3½"x16½# Every Frame
.78" to 52" Aft to 46" For'd and in Aft Peak
Upper Dk
Frames 8"x3½"x16½# on Alt Frs.
.76" to 52" Aft to 46" For'd 46" in Aft Peak
Height of Alternate Reverse Frames
Main Dk.
Bkt. 30"x52"
Strakes "G" "H" "J" 72" to 52" Aft to 46" For'd 46" in Aft Peak Increase .04 for Omission of side Stringers
Frames
Frames Spaced 36½" from Aft Peak to ⅜L For'd
" " 27" " ⅜L For'd to Coll Bhd
" " 24" in Peaks.
Frames Bet. Peaks are 12"x356"x318#
Upper Dks Alternately in way of Excessive Bevel Frames
8"x3½"x19# with 8"x3½"x19# Reverse Frame Forming a 12½"
Girder Reverse Frs to extend to Main & Upper Dks Alternately
Frames in Peaks 6"x3½"x135# Reverse Frs 4"x3½"x105# to extend to Upper Dk Aft & to Shelter Dk & Upper Dks Alternately in Way of Fc'le
Side Girders
40" for ½L to 36" at Ends
50" in Boiler Room
44" in Engin Room
Tank Connections
Frs, Rev. Frs, Side Girder Lʙ Top & Bott only Vert Clips as noted & Floor Conn to Margin Plate to be 3½"x3½"x111#
& Aft 3½"x3½"x98# Ford 3½"x3½"x124# in Eng. Rm 3½"x3½"x136#
In Boiler Rm Frs Doubled Ford of ⅜L to Coll. Bhd
Solid Flrs in B.S. Sgl 5"x5"x20# E.S.
Sgl 5"x5"x18.1# & Aft Sgl 5"x5"x15.2#
Ford of ⅜L Sgl 3½"x3½"x98#
Inner Bottom
Margin Pl. 54" F & A 58 in Boiler Room
Middle Line Strake 45"x52" for ½L 42" at End 56" in Eng. & B. Space.
In Holds 46" for ½L to 40" Aft & 36" Ford
In Boiler Space 56" In Engine Space 50"
Floor & Frame Brackets
46" to ½L to 42" Aft & 38" Ford } Solid Floor on Aft Frs
56" in Boiler Room } except under Engines
58" in Engine Room } Boiler Bearers & Ford of ⅜L
Stem 10½"x2⅞"
Propeller Post 10½"x8½"
Rudder " 9"x8½"
Rudder Main Piece 11½" to 8½" Dia.
Rudder Pintles 5⅞" Dia.
Rudder Stock 11½" Dia. Increased to 12" Dia.
EQUIPMENT
Long'l. № — — — — — — 38193
Shelter Dk. 435.25'x7.75'x.75 — — — 2535
Deck Houses 93'x8'x5 — — — — — 372
EQUIPMENT № — — — — 41100
2 Bower Anchors Stockless — — — 8120 Lbs
1 " " " — — — — 6944 "
1 Stream " " — — — — 2870 "
1 Kedge " " — — — — 1260 "
300 Fms. 2⅜" Stud Chain Cable
120 5" Gr. Steel Wire Hawser
130 5½" " " " Towline
400 8" " Manila Hawsers & Warps
PRINCIPAL DIMENSIONS
Length B.P 435'-0"x57'-6"x38'-0" Mld to Shelter Dk
575
30.25
87.75 = 1st. №
435.25 Length
38193-18 = Long'l №
Depths to L = 11.45
Keel 48"x108" for ⅜L to 76" at Ends
Dbl. Butt Straps Treble Riveted
1⅛" Rivets in Keel Plate.
INTERMEDIATE FLOORS
SECTION THRU BILGE CLEAR OF PIPING

12,000-TON D. W. FREIGHTER
Sun Shipbuilding Co., Chester, Pa.


Scantlings
Frames #0 to #16-6"x3½"x3½"x15# Lbs Spaced 18" ℄ to ℄
" 16 to 29 " " " " " 24" ℄ to ℄ Frames 29 to 159-12"x3.05"x3.05"x25# Lbs Spaced 36" ℄ to ℄
" 159 to 166 12"x3.05"x3.05"x25# Lbs " 24" ℄ to ℄ " 166 to 185 6"x3½"x3½"x15# Lbs Spaced 24" ℄ to ℄
" In Aft Peak 4"x3"x8.5# Lbs with 3"x3"x7.2# Lbs Reverse. Frames to Main and Spar Dk Alternately
Floors 15# Lbs Spaced 36" & 15 Lbs. Plate spaced 12'0". Floors in Fore Peak 15 Lbs. Plate Floors in Eng. Room 17½#
Bhds: Collision 15# Stiff 6"x3½"x15# Lbs Vert and Horizontal
" Screen Wing Pl 15# Others 12.5# Stiff. 6"x3½"x15# Lbs and 6"x3½"x11.7# Lbs Back to Back
Coal Bunker 15# and 12½# 6"x3½"x15# Lbs Vert. & Horizontal Others 15# 12.5# 10.2# Stiff. A 4"x3"x8.5# Vert & Hor.
Stem 10"x3½" Stern post 10"x6" above Boss 10"x7" Below Boss Rudder Stock 12" Dia
Pintle 6" Diam. Plate 20# Hatches 9'0" Long Spaced 12'0" ℄ to ℄
Collision Bhd. Frame 16 Hold Bhd. Frame No. 29 Screen Bhds. Frames No. 75 & 109 Coal Bunker Bhd. Frame No. 151
Deep Floors Web Frames and Arches on Frames Nos. 33 and Every 4th Frame to No. 149 inclusive

Principal Dimensions.
Length Overall 524'0"
" Tween P.P. 504'0"
Breadth Mld. 58'0"
Depth " 30'0"

SECTION THRO ARCH
SECTION SHOWING SIDE STRINGER.
CONNECTION OF PLATE GIRDER TO ARCHES
INTERMEDIATE STIFFENER SPACED 18" THROUGHOUT HOLD
SECTION SHOWING LONGITUDINALS
Aux. S.D.S. 48"x40# Riv. Same as S.D.S.
S D S 60"x40# for ⅞" L Butts Double Strapped Quadruple Riv. 1" Dia Rivets Single Straps Treble Riv And Dbl. Riv ⅞" and ¾" Riv. at Ends
Camber 12"
15# Flg.
40# for ¾" L to 20# at Ends Butts Double Strapped Qd'ple 1" Riv For ¾" L
35# For ⅝ L to 20# at Ends Butts Lapped Qd'ple 1" Riv to ⅝ L
12"x26# Intercostal between Webs 16# Intercostal Flanged Clips 3½"x3½" & 6"x3½"
"F" and "G" 25" for ⅝ L to 20# at F or'd. End and 15# at Aft End. Butts Lapped Treble ⅞" Riv. for ⅝ L
Frames 12"x25# Spaced 36"
Similar to One Above
⅞" Rivet
3½"x3½"x8.6# Single
"D" and "E" 31# for ⅝ L to 20# at F End and 15# at A End Butts Lapped Qd'ple 1" Riv for ⅝ L
1" Rivet
Tie Plate 36"x37½#
6"x6"x28.7#
17½# Plate Girded Intercostal Tween Arches
12"x25# Cont. 12"x25# Intercostal Ls Clips 3½"x3½" and 6"x3½"
Beams 12"x25# Spaced 36"
15"x33#℄ Cont. 16# Flg Plate Intercostals Clips 5½"x5½" and 6"x3½"
M.D.S. 60"x22½# Butts Lapped Treble ⅞" Rivets
5"x5"x12.3#
3½"x3½"x8.5# Dbl.
15# Flanged
18"x18"x15#
6"x3½"x15#
5"x5"x9.8# Spaced 36"
Water Side Plates to be 15# Butt Lapped. Double ¾" Rivs. Seams to be Dbl. ¾" Rivs
6"x3½"x15#
16# Flanged
Floors 15"x33# Spaced 36"
Band C 25# for ⅝ L to 20# at End 20# at A End Butts Lapped Treble ⅞" Riv. for ⅝" L
3½"x3½"x8.5# Intercostal
3"x3"x7.2#
3½"x3½"x8.5# Dbl.
3"x3"x7.2# Dbl.
6"x3½"x15#
3"Dia Holes
Do
16# Flg. Bracket
Web
3"x3"x7.2# Dbl.
6"x3½"x18.5#
3"x5"x7.2#
5"x3"x6.3#
4" Dia. Vent. Pipe
3½"x3½"x8.5# Dbl.
6"x3½"x18.3# Dbl. Z Bars
Arches 15# Spaced 12'0" ℄ to ℄
3½"x3½"x8.5# Single
3"x3"x7.2# Dbl.
15# Flg.
3"x3"x7.2#
3½"x3½"x8.5# Dbl.
3"x3"x7.2# Dbl.
3"x3"x7.2#
Web Frames 151 lbs. Spaced 12 Feet
18" Dia Manhole
3½"x3½"x8.5# Single
3½"x3½"x8.5# Dbl.
5"x5"x12.2#
4'9" 4'8" 4'8" 4'8" 4'9"
20"x30"
20"x35"
20"x42"
3"x4"x11.3# C.K. 66°22½" Butt Lapped ⅞" Treble Riv.
4"x4"x11.7#
Floor Plates 15# Spaced 12'0" ℄ to ℄
Lap
Liner 9"x42#
Longl. of 16# Pl. Lapped Treble
Butt ¾" Rivs.
Longt A
4"x3"x8.6#
Flanged & Jogged
5" Limber Holes
⅞" Rivs.
1" Rivs.
Floors
Throughout Butts Lapped Qd'ple ⅞" Riv.
4.7"x3.7½" Qd'ple 1" Riv Single Strap
29'0" Mld.
30'0" Mld.
A
B
C
D
E
F
G
H
K
S
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9,860-NET TONS D. W. LAKE BULK FREIGHTER, "NORWAY"
The Toledo Shipbuilding Co., Toledo, Ohio.

MIDSHIP SECTION

9,860-NET TONS D. W. LAKE BULK FREIGHTER, "NORWAY"

For Arrangement Plan
See Pages 400 and 401

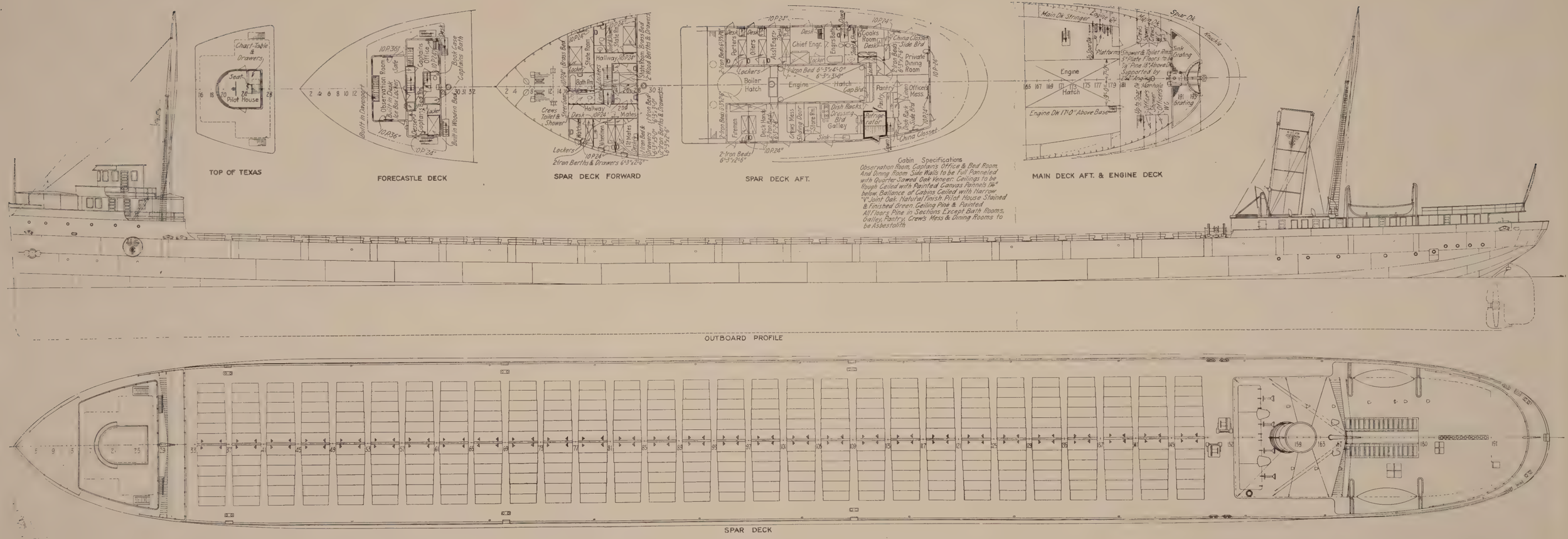
LIST OF VALVES FOR ONE SHIP

Pc. No.	No. of Pcs.	Name	Mat'l	Remarks
1	3	3" Globe valve, fl'g'd ex. h'vy.	C.I.	Aux. st. at boil'rs.
2	1	3" Globe valve, fl'g'd ex. h'vy.	C.I.	Aux. st. (h. p. line aft).
3	2	3" Globe valve, fl'g'd ex. h'vy.	C.I.	Aux. st. (l. p. line aft).
4	1	3" Red. valve, fl'g'd ex. h'vy..	C.I.	Aux. st. (l. p. line aft) 210 lbs. to 100 lbs.
5	1	3" Red. valve, fl'g'd ex. h'vy..	C.I.	Aux. st. (l. p. line for'd) 210 lbs. to 100 lbs.
6	2	3" Globe valve, fl'g'd ex. h'vy.	C.I.	Aux. st. (l. p. line for'd).
7	2	1" Globe valve, scr'd ex. h'vy.	Brass	Aux. st. to hose line.
8	1	3" Globe valve, fl'g'd ex. h'vy.	C.I.	Aux. st. to whistle.
9	1	3" Globe valve, fl'g'd ex. h'vy balanced valve	Brass	Aux. st. to whistle (regulating).
10	1	1½" Globe valve, scr'd ex. h'vy.	Brass	Aux. st. to fire ext. line.
11	6	1½" Globe valve, scr'd ex. h'vy.	Brass	Aux. st. to fire ext. manifold.
12	2	1" Globe valve, scr'd ex. h'vy.	Brass	Aux. st. to radiators.
13	1	1" Red. valve, scr'd ex. h'vy..	Brass	Aux. st. to radiators, 100 lbs. to 10 lbs.
14	1	1½" Globe valve, scr'd ex. h'vy.	Brass	Aux. st. to fan engine.
15	1	2" Globe valve, scr'd ex. h'vy.	Brass	Aux. st. to steer. eng.
16	1	3" Globe valve, fl'g'd ex. h'vy.	C.I.	Aux. st. to windlass (for'd).
17	1	2½" Globe valve, fl'g'd ex. h'vy.	C.I.	Aux. st. to ballast pump.
18	1	1" Globe valve, scr'd ex. h'vy..	Brass	Aux. st. to reverse eng.
19	1	1½" Globe valve, scr'd ex. h'vy.	Brass	Aux. st. to fire pump.
20	2	2" Globe valve, scr'd ex. h'vy..	Brass	Aux. st. to injectors.
21	2	2½" Globe valve, fl'g'd ex. h'vy.	C.I.	Aux. st. to dynamo line.
22	1	2½" Red. valve, fl'g'd ex. h'vy.	C.I.	Aux. st. to dynamo line, 210 lbs. to 100 lbs.
23	2	1½" Globe valve, scr'd ex. h'vy.	Brass	Aux. st. to dynamo eng's.
24	2	1½" Globe valve, scr'd ex. h'vy.	Brass	Aux. st. to syphons.
25	1	1" Red. valve, scr'd ex. h'vy...	Brass	Aux. st. to heating line for'd, 100 lbs. to 10 lbs.
26	1	1" Globe valve, scr'd ex. h'vy..	Brass	Aux. st. to heating line for'd.
27	7	1½" Globe valve, scr'd ex. h'vy.	Brass	Aux. st. to flue blowers.
28	1	¾" Globe valve, scr'd ex. h'vy.	Brass	Aux. st. to san. pump.
29	1	1" Globe valve, scr'd ex. h'vy..	Brass	Aux. st. to mate's pump.
30	6	2" Angle valve, scr'd ex. h'vy..	Brass	Aux. st. to deck eng's.

LIST OF VALVES FOR ONE SHIP—Continued

Pc. No.	No. of Pcs.	Name	Mat'l	Remarks
31	2	3" Globe valve, fl'g'd ex. h'vy..	C.I.	Aux. st. to ballast eng's
32	1	3" Globe valve, fl'g'd ex. h'vy..	C.I.	Aux. st. to ballast eng's. line.
33	1	1" Globe valve, scr'd ex. h'vy..	Brass	Aux. st. to turning eng.
34	1	3" Globe valve, fl'g'd ex. h'vy..	C.I.	Aux. st. to connect. h. and l. pressure lines.
35	3	5" Angle valve, fl'g'd ex. h'vy..	C.I.	Main st. stop valves.
36	3	5" Angle valve, fl'g'd ex. h'vy..	C.I.	Safety valves, pop.
37	1	2½" Globe valve, fl'g'd ex. h'vy.	C.I.	Aux. st. at feed pump.
40		Exhaust		
41	1	3" Gate valve, fl'g'd st'd.....	C.I.	Exh. from ballast pump.
42	1	2" Gate valve, scr'd st'd.....	Brass	Exh. from fan eng.
43	1	1½" Gate valve, scr'd st'd....	Brass	Exh. from reverse eng.
44	1	2" Gate valve, scr'd st'd.....	Brass	Exh. from steer. eng.
45	1	3" Gate valve, fl'g'd st'd.....	C.I.	Exh. from windlass eng.
46	2	2" Gate valve, scr'd st'd.....	Brass	Exh. from dynamo eng.
47	1	2" Gate valve, scr'd st'd.....	Brass	Exh. from fire pump.
48	1	4" Angle valve, fl'g'd st'd.....	C.I.	Exh. at heater (outlet).
49	1	4" Angle valve, scr'd st'd.....	C.I	Exh. at heater (outlet).
50	1	4" Combination valve.....		Exh. at heater (inlet).
51	1	3" Gate valve, fl'g'd st'd.....	C.I.	Exh. from for'd.
52	1	2" Angle valve, scr'd st'd.....	Brass	Water catch drain overboard.
53	1	1¼" Gate valve, scr'd st'd....	Brass	Heater drain.
54	1	1¼" Gate valve, scr'd st'd....	Brass	Exh. from san. pump.
55	1	1½" Gate valve, scr'd st'd....	Brass	Exh. from mate's pump.
56	6	2½" Angle valve, fl'g'd st'd...	C.I.	Exh. from deck eng's.
56	2	3" Gate valve, fl'g'd st'd.....	C.I.	Exh. from ballast eng's.
57	1	1½" Gate valve, scr'd std'....	Brass	Exh. from turning eng.
58	1	3" Check valve, fl'g'd st'd.....	C.I.	Exh. from st'b'd side and for'd.
59	1	3" Gate valve, fl'g'd st'd.....	C.I.	Exh. from feed pump.
60	1	3" Gate valve, fl'g'd st'd.....	Brass	Exh. from overboard.
65		Suction		
66	2	2" Gate valve, scr'd st'd.....	Brass	Injector suction from sea.
67	1	7" Gate valve, fl'g'd st'd.....	C.I.	Ballast pump suction channel plate.
68	1	2½" Angle valve, scr'd st'd...	Brass	San. pump suction from sea.

(Continued on Next Page)



Principal Dimensions

Length, Over All	524'—0"
Length B. P.	504'—0"
Breadth Molded	58'—0"
Depth Molded	30'—0"

OUTBOARD PROFILE AND DECK ARRANGEMENT
9,860-NET TONS D. W. LAKE BULK FREIGHTER, "NORWAY"
The Toledo Shipbuilding Co., Toledo, Ohio

PLATE XIII

9,860-NET TONS D. W. LAKE BULK FREIGHTER, "NORWAY"

For Arrangement Plan
See Pages 400 and 401

LIST OF VALVES FOR ONE SHIP—Continued

Pc. No.	No. of Pcs.	Name	Mat'l	Remarks
69	1	2½" Angle valve, scr'd st'd...	Brass	San. pump suction from aft peak tank.
70	1	2½" Angle valve, scr'd st'd...	Brass	Cooler pump suction from sea.
71	1	2½" Angle valve, scr'd st'd...	Brass	Cooler pump suction from aft peak tank.
72	1	4" Angle valve, fl'g'd st'd.....	C.I.	Feed pump suction from sea.
73	1	4" Angle valve, fl'g'd st'd.....	C.I.	Feed pump suction from hot well.
74	1	5" Globe valve, fl'g'd st'd.....	C.I.	Feed and cooler pump suction (at stool).
75	1	4" Globe valve, fl'g'd st'd.....	C.I.	Injector — mate's and fire pump suction (at stool).
76	1	4" Globe valve, fl'g'd st'd.....	C.I.	Fire pump suction from sea.
77	1	4" Globe valve, fl'g'd st'd.....	C.I.	Fire pump suction from hot well (in manifold.)
78	1	4" Globe valve, fl'g'd st'd.....	C.I.	Fire pump suction from bilge (in manifold.)
79	1	2½" Globe valve, fl'g'd st'd...	C.I.	San. pump suction (at stool).
80	1	2½" Check valve, scr'd st'd...	C.I.	Deck pump suction from sea.
81	1	2½" Angle valve, scr'd st'd...	C.I.	Mate's pump suction from sea.
82	1	3" Angle valve, scr'd st'd.....	C.I.	Mate's pump suction from hot well.
83	1	6" Angle valve, fl'g'd st'd.....	C.I.	Main injector to condenser.
84	1	6" Globe valve, fl'g'd st'd.....	C.I.	Main injector from for'd sea cock.
94		Discharge		
95	1	3" Combination valve.....		Feed line at heater (inlet).
96	1	3" Globe valve, fl'g'd ex. h'vy.	C.I.	Feed line at heater (outlet).
97	2	3" Gate valve, fl'g'd ex. h'vy..	C.I.	Feed pump discharge to heater at pump.
98	1	3" Check valve, fl'g'd ex. h'vy.	C.I.	Feed pump discharge to heater at pump.
99	1	3" Gate valve, fl'g'd ex. h'vy..	C.I.	Feed pump discharge to heater (main line).
100	1	3" Check valve, fl'g'd ex. h'vy.	C.I.	Manifold discharge to heater.
101	1	3" Globe valve, fl'g'd ex. h'vy.	C.I.	Manifold discharge to heater.
102	3	2" Globe valve, scr'd ex. h'vy.	Brass	Main line (feed reg'lating valves)
103	2	3" Globe valve, fl'g'd ex. h'vy.	C.I.	Fire pump discharge to manifold.
104	1	2½" Globe valve, fl'g'd ex. h'vy.	C.I.	Manifold discharge overboard.
105	1	2" Gate valve, scr'd ex. h'vy...	Brass	Manifold discharge to cond. and cool. system.

LIST OF VALVES FOR ONE SHIP—Continued

Pc. No.	No. of Pcs.	Name	Mat'l	Remarks
106	1	3" Globe valve, fl'g'd ex. h'vy..	C.I.	Manifold discharge to heater.
107	3	2" Globe valve, scr'd ex. h'vy.	Brass	Manifold discharge to boilers.
108	1	2" Gate valve, scr'd ex. h'vy..	Brass	Manifold discharge to hose.
109	2	2" Gate valve, scr'd ex. h'vy..	Brass	Injector discharge to manifold.
110	1	3" Gate valve, fl'g'd ex. h'vy..	C.I.	Manifold dividing valve.
111	1	2" Globe valve, scr'd ex. h'vy.	C.I.	Cooler pump discharge to cooling system.
112	3	1½" Globe valve, scr'd ex. h'vy.	Brass	Surface blow off.
113	3	2" Angle valve, fl'g'd ex. h'vy.	C.I.	Bottom blow off.
114	3	2" Angle valve, scr'd ex. h'vy.	Brass	Boiler drain.
115	9	1½" Angle valve, scr'd medium	Brass	Hose line on deck.
116	1	3" Globe valve, fl'g'd ex. h'vy.	C.I.	Fire pump discharge to ash guns.
117	2	2½" Gate valve, scr'd st'd.....	Brass	Bottom discharge to ash guns quick opening lever.
118	2	2" Gate valve, scr'd st'd.....	Brass	Top discharge to ash guns quick opening lever.
119	6	1½" Angle valve, scr'd ex. h'vy.	C.I.	Top and bottom connection for water columns.
120	3	2" Combination stop & ch'k val.		Main feed at boilers.
121	3	2" Combination stop & ch'k val.		Auxiliary feed at boilers.
122	1	2" Gate valve, scr'd st'd.....	Brass	Boiler blower overboard discharge.

INDEPENDENT PUMPS

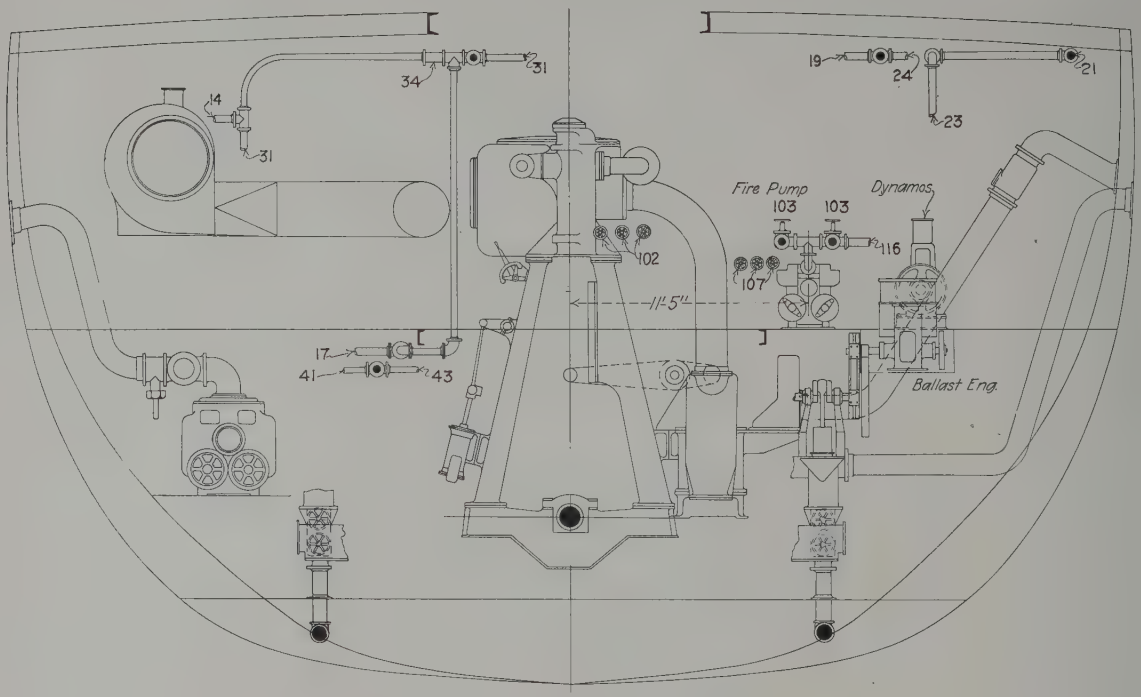
No.	Description	Size
1	Duplex piston ballast pump.....	12"x18"x18"
1	Special duplex piston mate's pump.....	6"x4"x6"
1	Special duplex piston san. pump.....	5½"x4¾"x5"
1	Single outside plunger feed pump.....	12"x7"x12"
1	Duplex fire pump.....	12"x6"x10"
2	Engines for ballast system.....	7"x7"x6"

DEPENDENT PUMPS

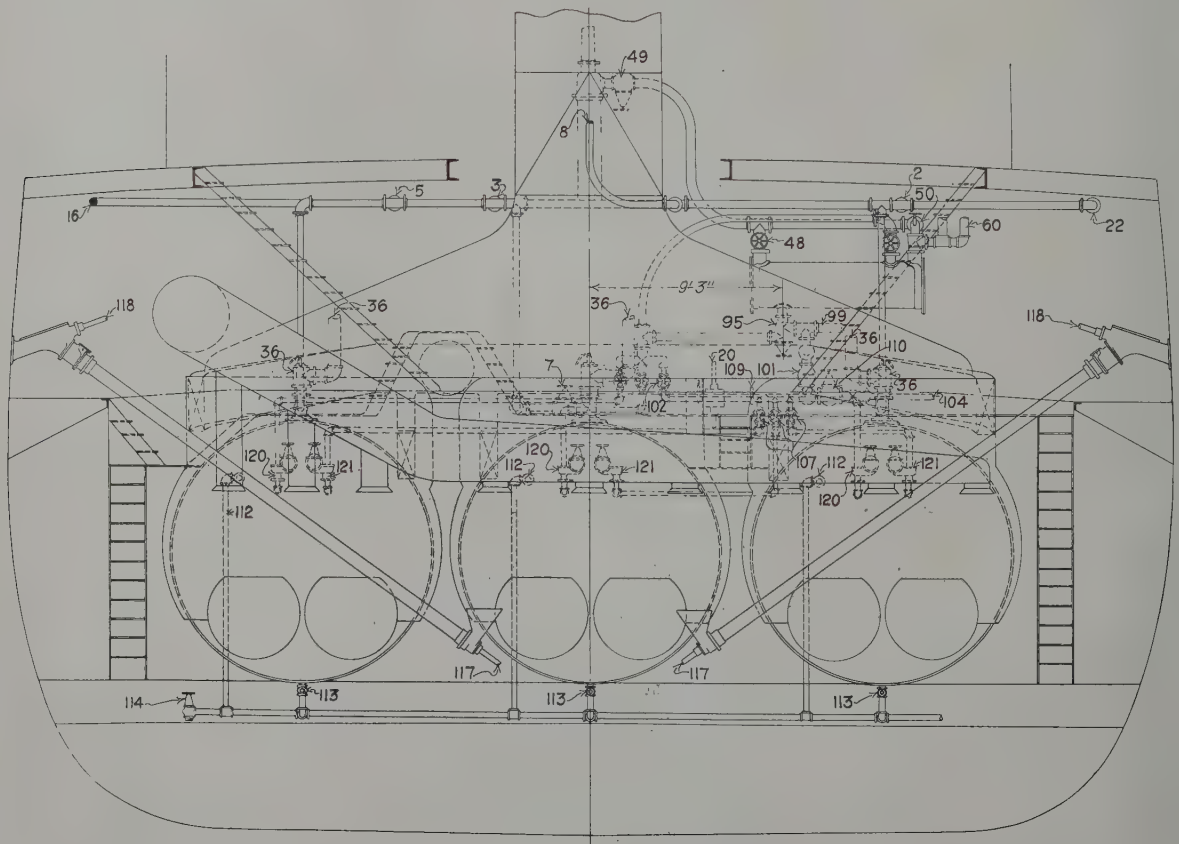
1	Direct connected air pump.....	34"x14"
1	Direct connected bilge pump.....	5½"x11"
1	Direct connected cooler pump.....	3¾"x11"

AUXILIARIES

1	Turning engine single.....	6"x6"
1	Steering engine.....	8"x8"
2	10 K. W. generators.....	6½"x5" Eng.
6	Deck engines.....	8"x10"
1	Windlass	12"x12" Eng.
1	Fan	6'x6" Eng.

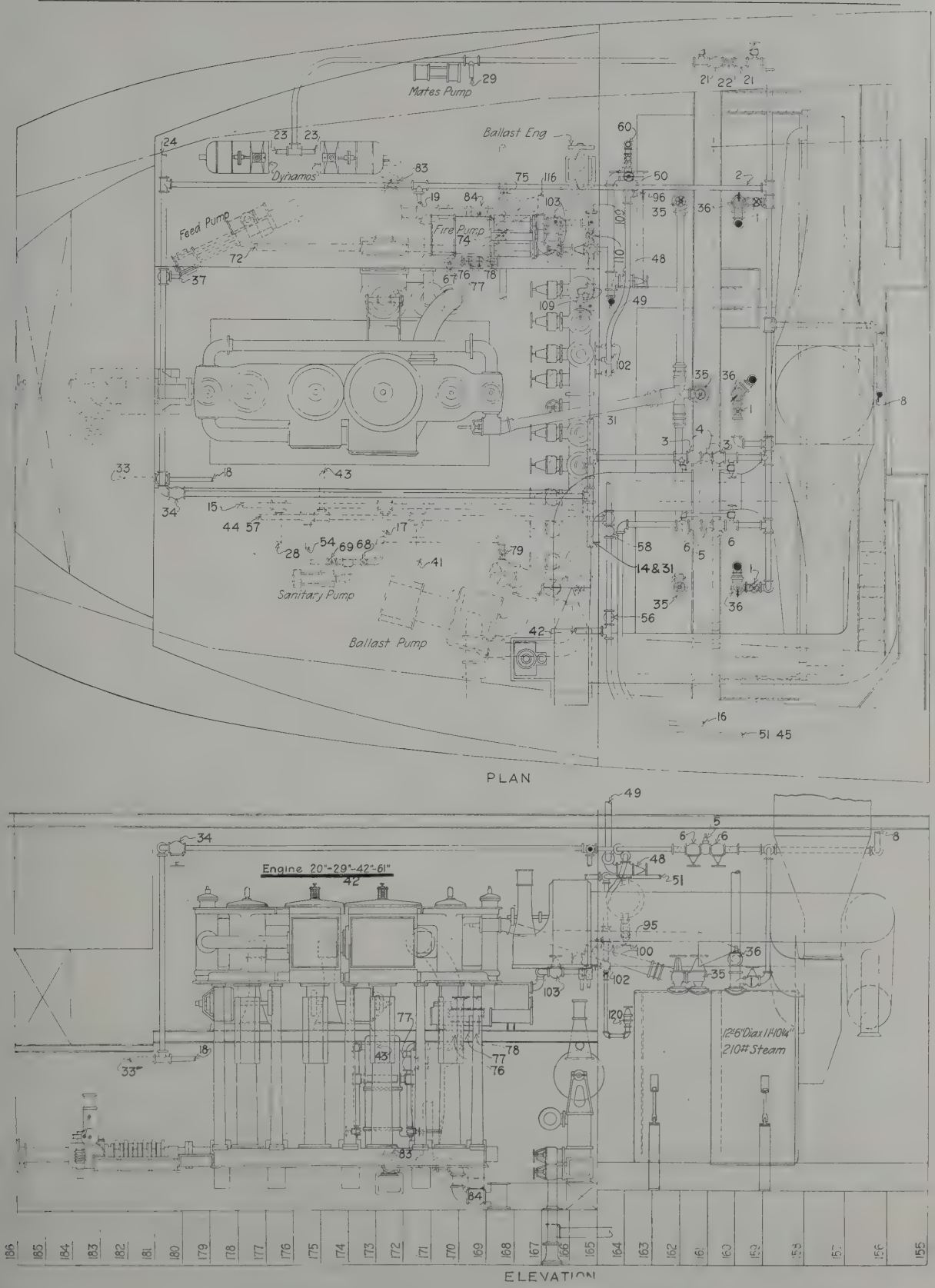


LOOKING AFT FRAME #165



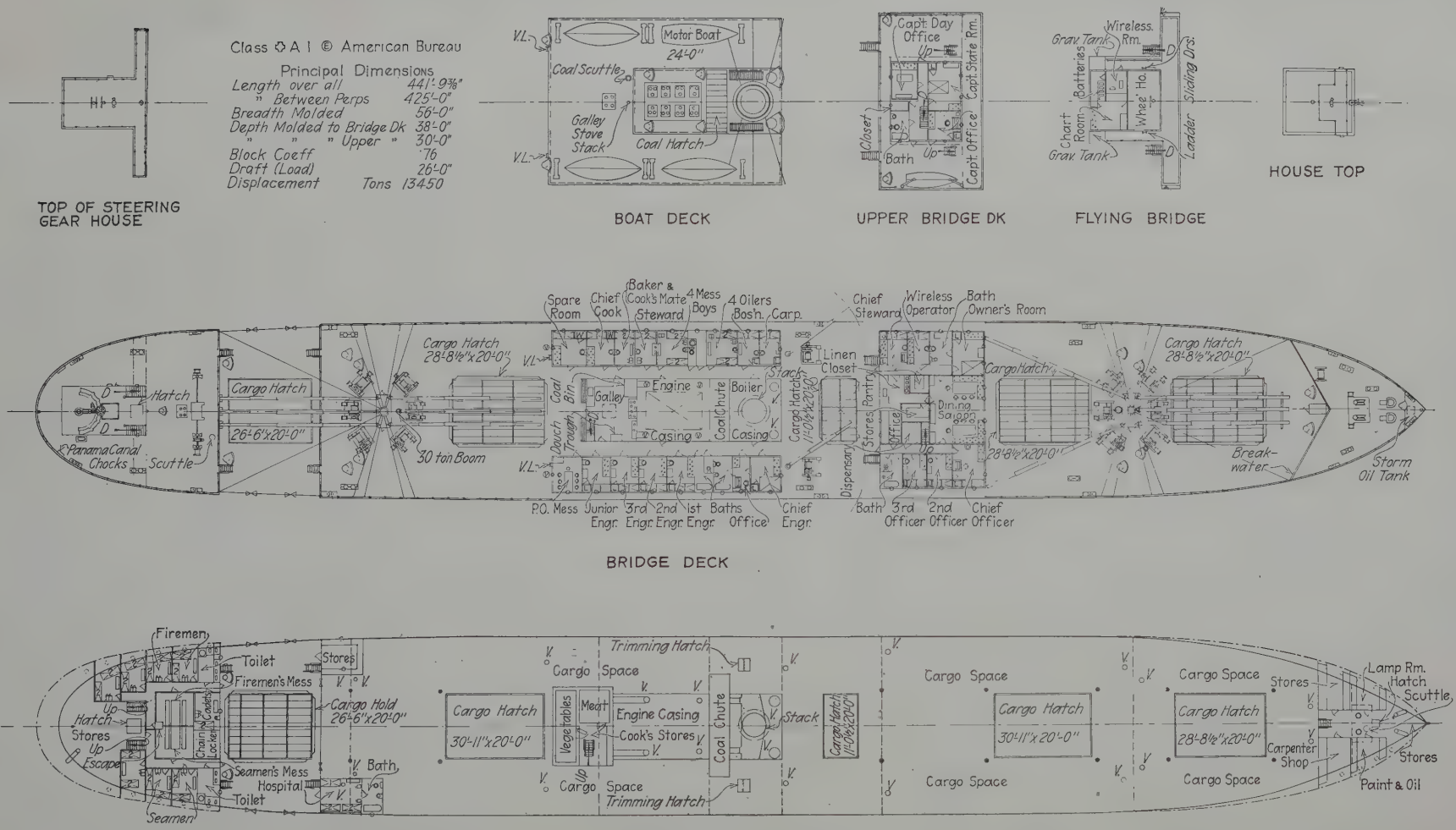
LOOKING AFT FRAME #155

9,860-NET TONS D. W. LAKE BULK FREIGHTER, "NORWAY"
The Toledo Shipbuilding Co., Toledo, Ohio.



9,860-NET TONS D. W. LAKE BULK FREIGHTER, "NORWAY"

The Toledo Shipbuilding Co., Toledo, Ohio.

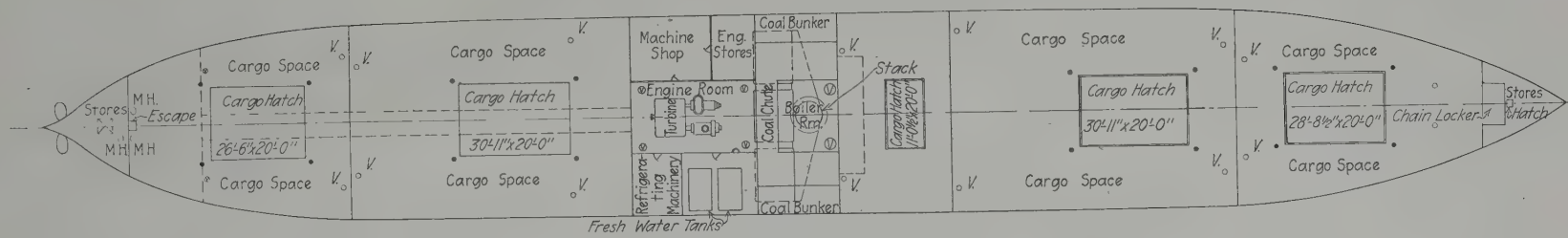


9,650-TON D. W. GENERAL CARGO VESSEL
Federal Shipbuilding Co., Kearney, N. J.

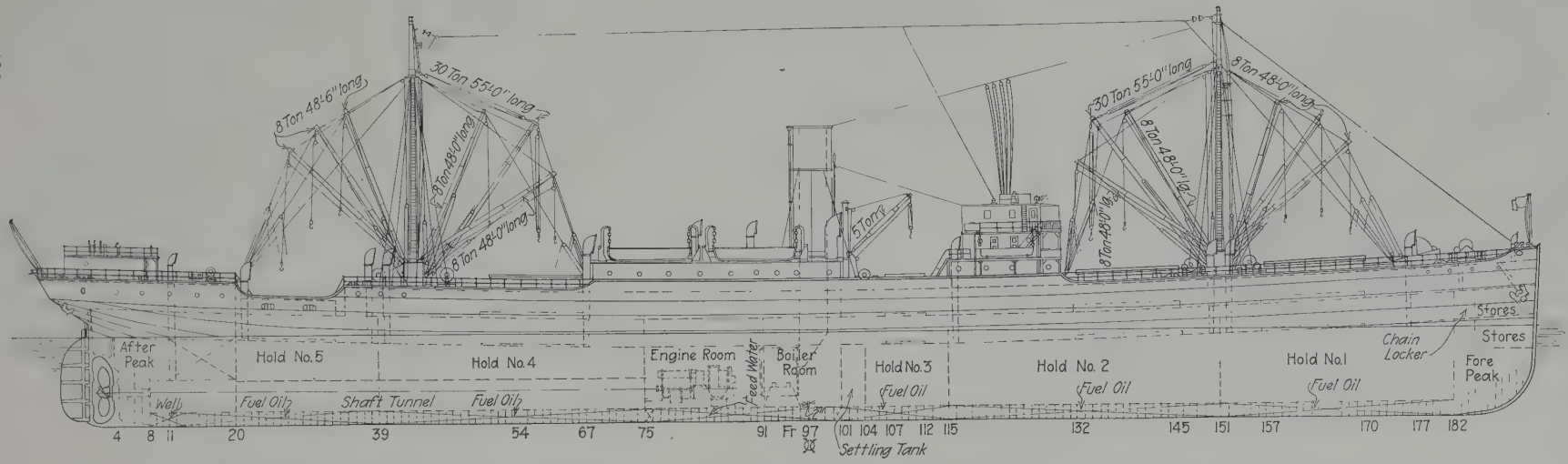
See Opposite Page

Principal Dimensions

Length, O. A.	441′—9⅜″
Length B. P.	425′—0″
Breadth M'l'd	56′—0″
Depth M'l'd to Bridge Dk.	38′—0″
Depth M'l'd to Upper Dk.	30′—0″
Block Coeff.	.76
Draft (Load)	26′—0″
Displacement	Tons, 13,450



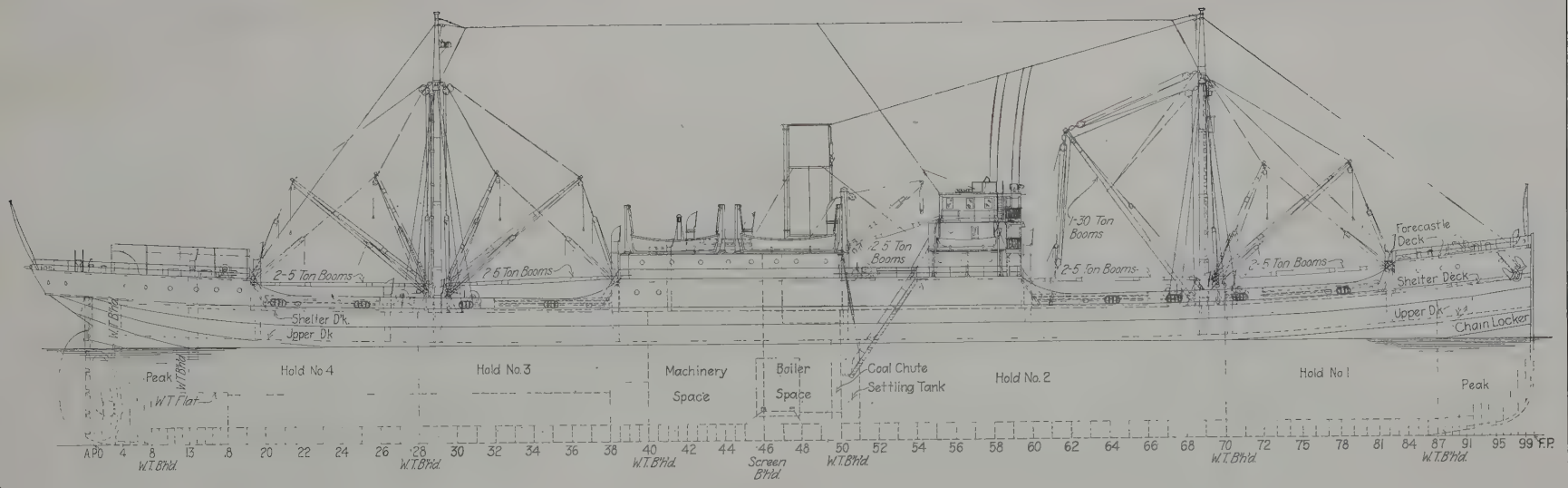
MAIN DECK



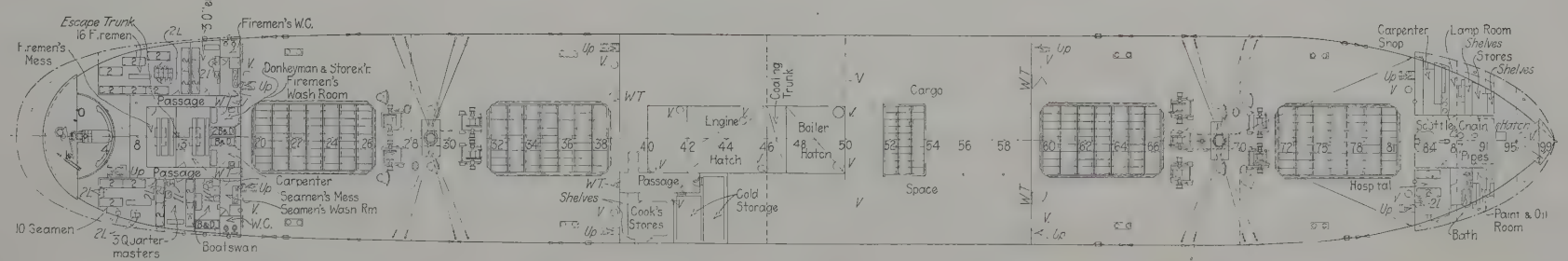
OUTBOARD PROFILE

9,650-TON D. W. GENERAL CARGO VESSEL
Federal Shipbuilding Co., Kearney, N. J.

See Opposite Page



PROFILE

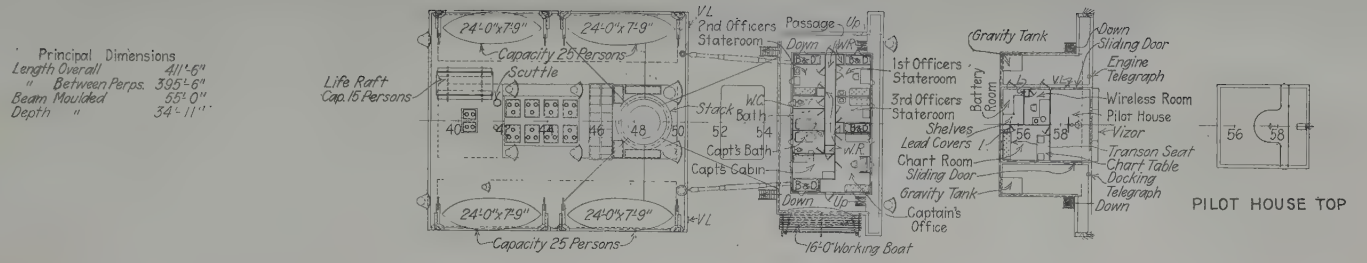


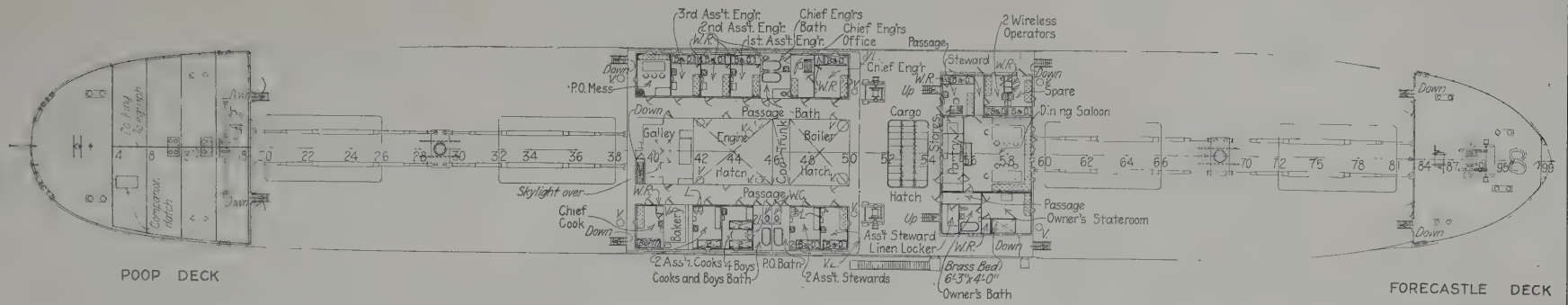
SHELTER DECK

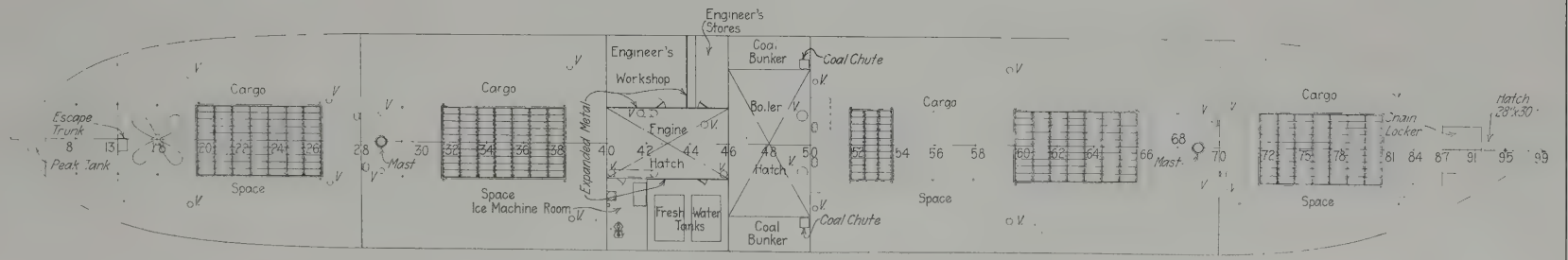
9,600-TON D. W. GENERAL CARGO VESSEL

Federal Shipbuilding Co., Kearney, N. J.

See Opposite Page







9,600-TON D. W. GENERAL CARGO VESSEL

Federal Shipbuilding Co., Kearney, N. J.

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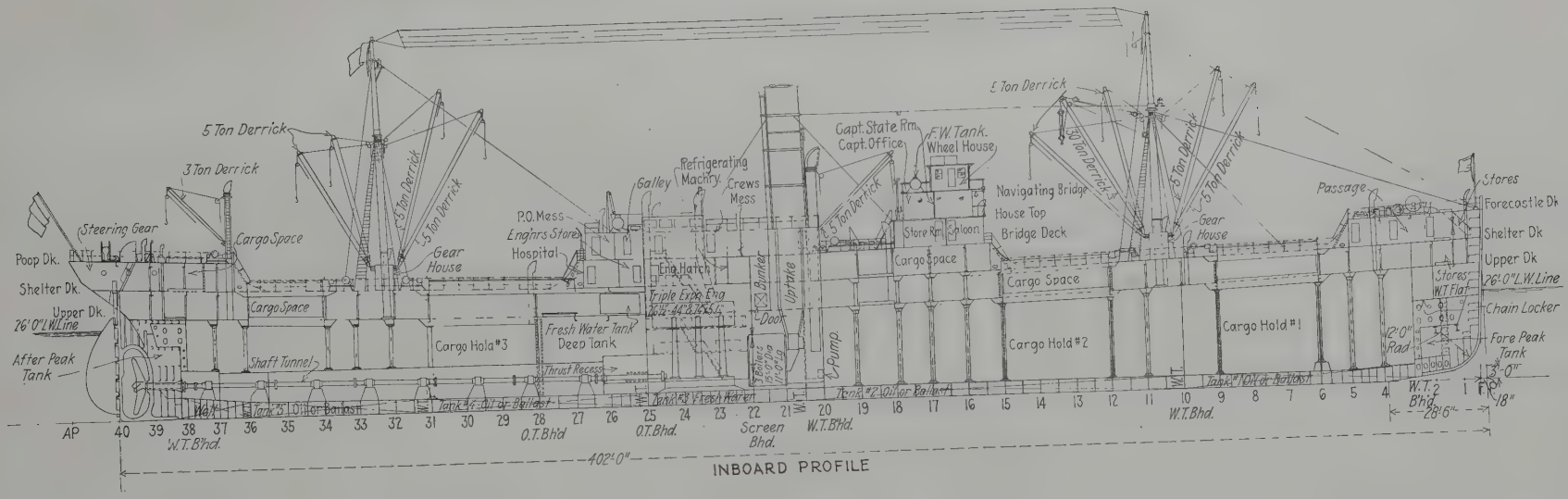

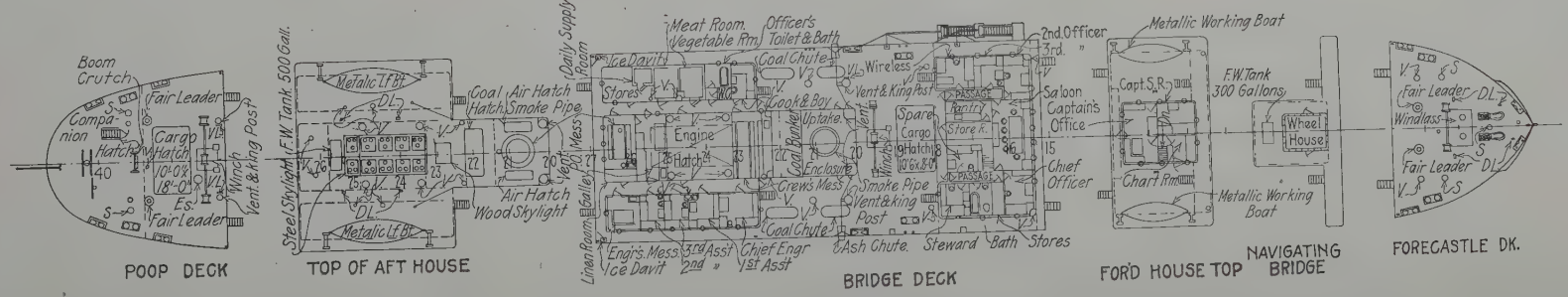

9,500-TON D. W. FREIGHTER

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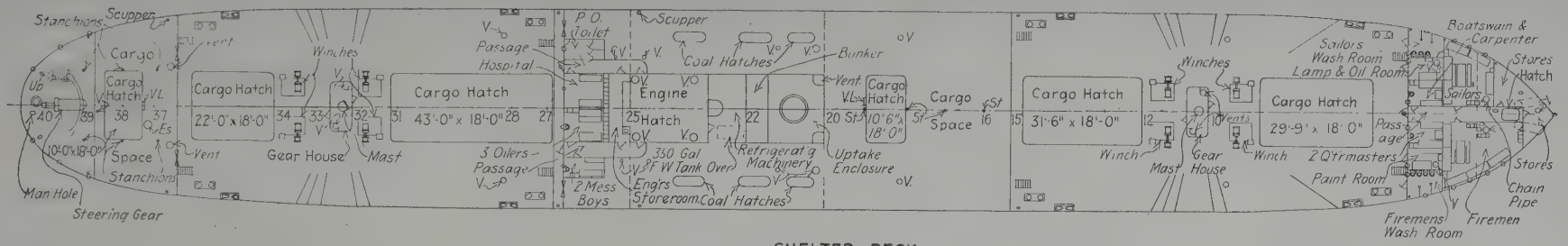
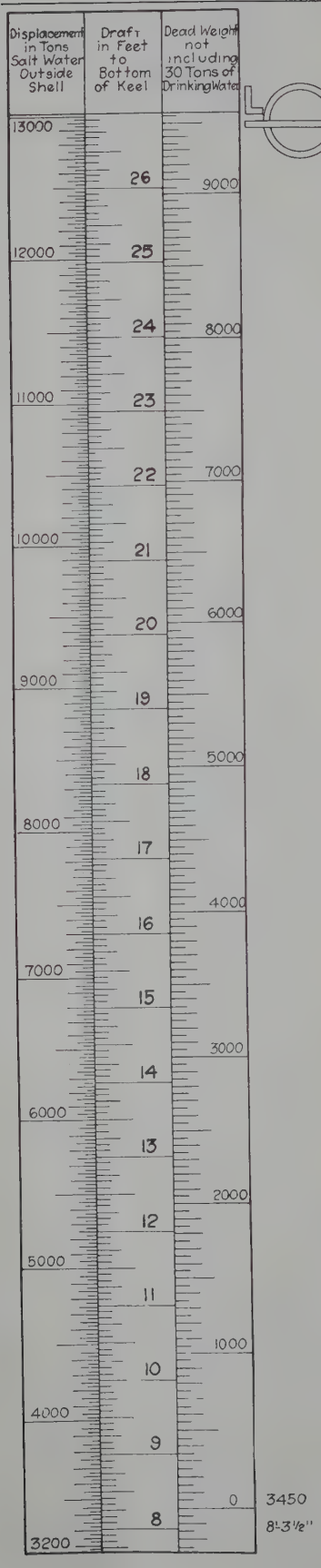


9,500-TON D. W. FREIGHTER

See Opposite Page.

CAPACITY DIAGRAM



DATA

Length B. P.	402′—0″
Length O. A.	416′—0″
Breadth	54′—0″
Depth, upper deck	25′—6″
Depth, shelter deck	33′—9″
Engine	26½″x44″x74″—54″
Boilers	3-15′ 0″ dia.x11′ 0″ long
Furnaces	9-44″ inside dia.
Heating surface	8,118 sq. ft.
Propeller	17′ 0″ dia., 17′ 6″ pitch
Wireless	2 K.W. Marconi
Electric operators	2-10 K.W.
Refrig. machinery	1-2 ton
Winches,	8-7″x10″, 1-7″x10″ extension heads, 1-9″x10″ extension heads

CAPACITY OF PEAK TANKS

Location	Cubic Feet	Fresh Water Tons	Salt Water Tons	Gallons
Fore peak	3,775	105	108	28,241
After peak	2,187	61	63	16,358
Totals	5,962	166	171	44,599

CAPACITY OF TANKS IN INNER BOTTOM

Location	Cubic Feet Port	Cubic Feet St'b'd	Fresh Water Tons Port	Fresh Water Tons St'b'd	Salt Water Tons Port	Salt Water Tons St'b'd	Gallons Port	Gallons St'b'd	Barrels 42 Gallons per Bbl. Port	Barrels 42 Gallons per Bbl. St'b'd
No. 1 tank bet. bhds. 3 and 10	2,490	2,490	...	...	72	72	18,626	18,626	444	444
No. 2 tank bet. bhds. 10 and 20½	7,707	7,696	...	...	221	220	57,659	57,575	1,373	1,371
No. 3 tank bet. bhds. 20½ and 25	3,573	3,573	99	99	...	...	26,724	26,724	...	...
No. 4 tank bet. bhds. 25 and 31	4,225	4,225	...	...	121	121	31,601	31,601	753	753
No. 5 tank bet. bhds. 31 and 36	1,469	1,469	...	...	42	42	10,985	10,985	262	262
Well bet. bhds. 36 and 38½	244	244	...	...	7	7	1,825	1,825	...	...
Totals—One side	19,708	19,697	99	99	463	462	147,420	147,336	2,832	2,830
Totals—Both sides	39,405		198		925		294,756		5,662	
Totals, peak and I. B. tanks	45,367		364		1,096		339,355		.....	

CAPACITY OF DEEP TANKS

Heights in Feet Above Inner Bot.	Cubic Feet Port	Cubic Feet St'b'd	Gallons Port	Gallons St'b'd	Barrels Port	Barrels St'b'd	Tons Salt Water Port	Tons Salt Water St'b'd
1	985	938	7,369	7,012	176	167	29	27
2	1,752	1,657	13,104	12,396	312	296	50	47
3	2,534	2,392	18,957	17,895	452	426	73	68
4	3,313	3,124	24,783	23,369	591	557	95	89
5	4,099	3,863	30,664	28,897	731	688	117	110
6	4,879	4,603	36,497	34,432	869	820	140	132
7	5,668	5,344	42,398	39,971	1,010	952	162	153
8	6,463	6,091	48,345	45,562	1,152	1,085	185	174
9	7,270	6,866	54,382	51,359	1,295	1,223	207	196
10	8,082	7,649	60,459	57,218	1,440	1,363	231	219
11	8,929	8,493	66,797	63,536	1,591	1,513	255	243
12	9,790	9,354	73,835	69,972	1,744	1,666	279	267
13	10,645	10,208	79,635	76,363	1,895	1,819	304	292
14	11,505	11,067	86,064	82,790	2,050	1,972	329	316
15	12,362	11,924	92,476	89,201	2,202	2,124	353	341
16	13,220	12,781	98,894	93,611	2,355	2,277	378	365
17	14,080	13,641	105,328	102,043	2,508	2,430	402	390
18	14,935	14,496	111,728	108,440	2,661	2,582	426	414
19	15,795	15,355	118,156	114,867	2,814	2,735	451	439
20	16,653	16,212	124,576	121,281	2,967	2,888	476	463
21	17,503	17,062	130,934	127,639	3,118	3,040	500	488
22	18,352	17,911	139,286	133,990	3,269	3,191	525	512
Full	19,039	18,599	142,428	139,141	3,392	3,313	544	531

CARGO CAPACITIES

Location	Grain Cu. Ft.	Bales Cu. Ft.
Hold No. 1	75,166	70,018
Hold No. 2	131,426	125,397
Deep tank (port)	18,684	16,619
Deep tank (starboard)	17,245	15,825
Hold No. 3	92,550	85,425
Between decks over No. 1 and No. 2 hold	71,424	68,230
Between decks over machinery space	14,660	12,883
Between decks over No. 3 hold	56,982	53,065
Bridge space	34,906	33,675
Poop space	7,380	6,929
After peak	.....	1,045
Totals	520,423	491,111

CAPACITY OF BUNKERS

Location	Cubic Feet Port	Cubic Feet St'b'd	Tons At 43 Cubic Feet Per Ton Port	Tons At 43 Cubic Feet Per Ton St'b'd
Wing bunkers, Fr. 20 to 25, upper to shelter dk.	7,330	7,330	171	171
Athwartship bunker, upper deck to bridge deck house-top	3,123		73	
Totals	17,783		415	

9,500-TON D. W. FREIGHTER

MIDSHIP SECTION

EQUIPMENT

ANCHORS

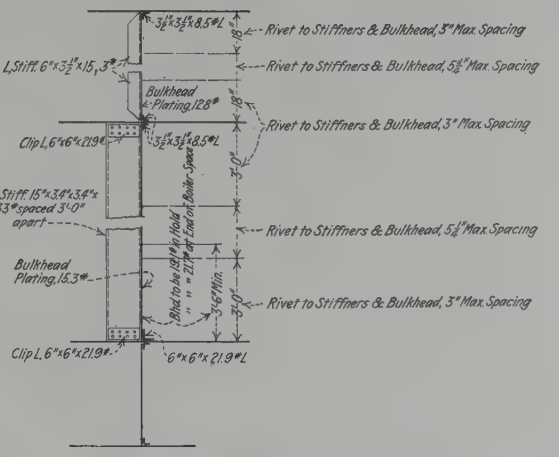
3-Bower Anchors-Stockless 63$\frac{3}{8}$ Cwts(of 112#)each
1-Stream Anchor-Exclusive of Stock 17$\frac{1}{2}$ Cwts(of 112#)
1-Kedge Anchor-Exclusive of Stock 7$\frac{1}{2}$ Cwts(of 112#)

CHAIN CABLES, HAWSERS, ETC.

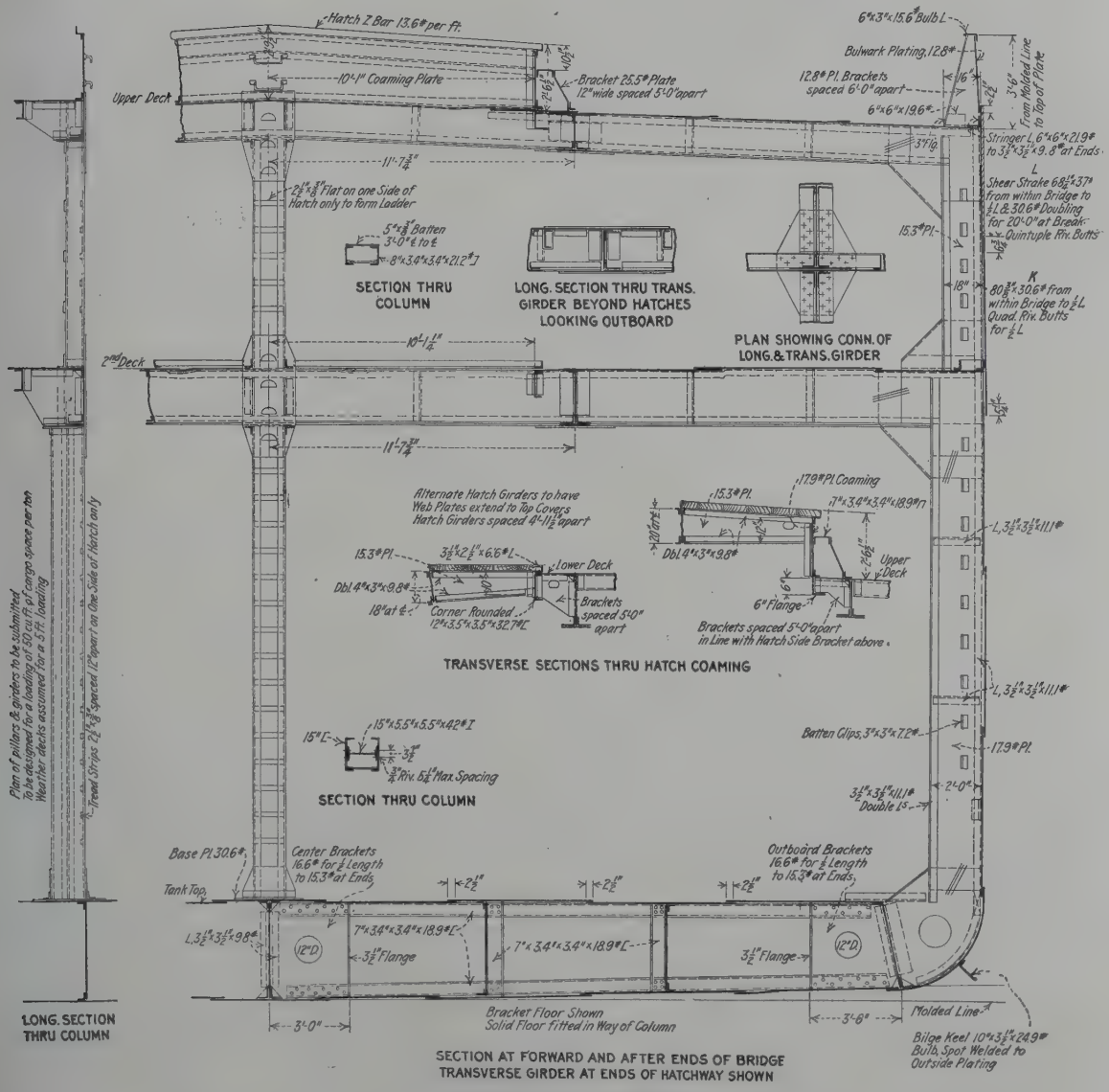
270 Fathoms Stud Link Chain 2$\frac{1}{4}$" Min. Wt. 68.2 Cwts(of 112#)
90 Fathoms Stud Link Chain 1$\frac{3}{4}$" Min. Wt. 72 Cwts(of 112#)
Or 90 Fathoms 4$\frac{3}{8}$" Steel Wire Breaking Strength = 47 Tons
Hawsers and Warps, 2 of 8" and 2 of 7" x 90 Fathoms Hemp
Towline 120 Fathoms 5" Steel Wire

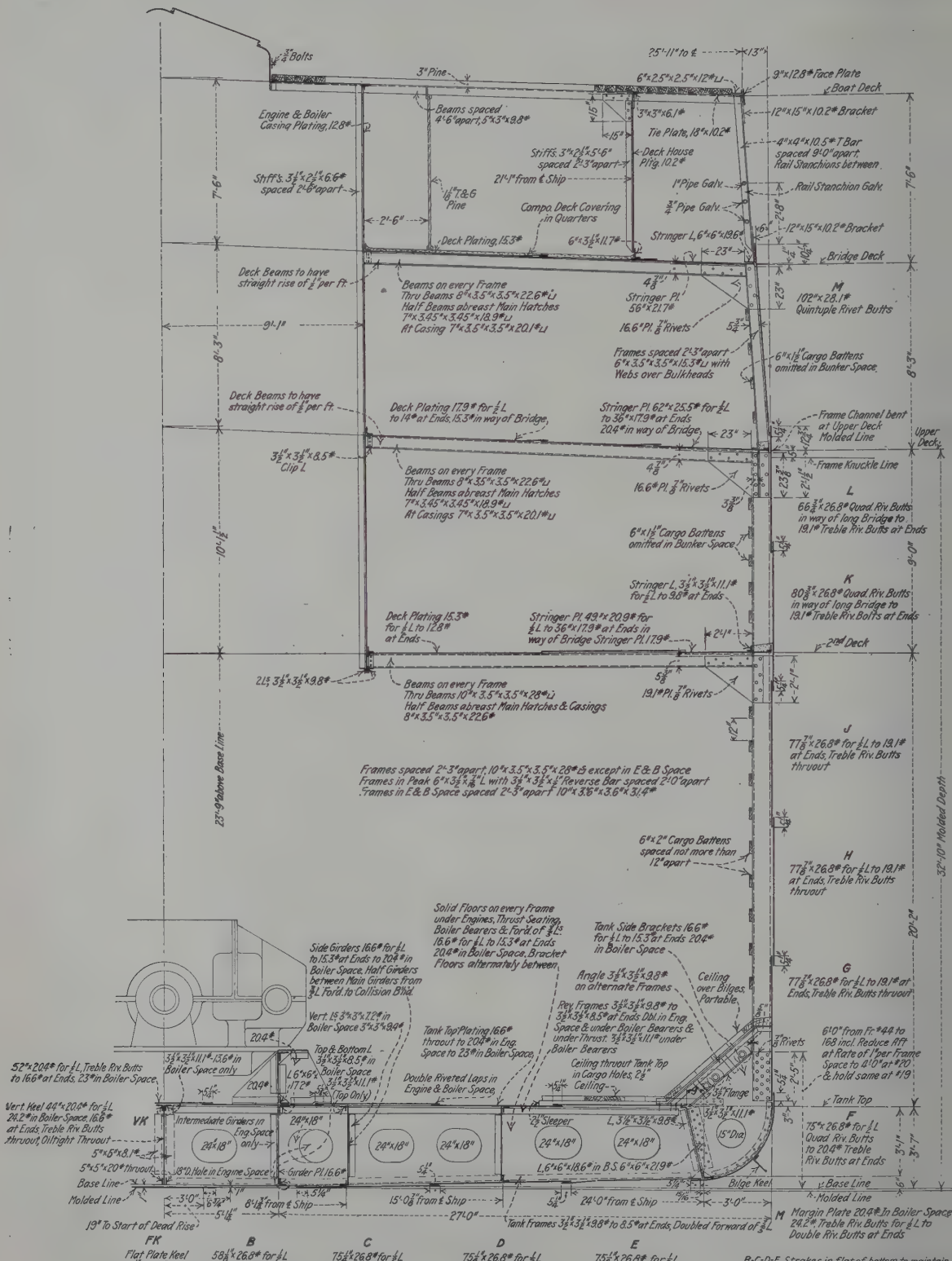
DIMENSIONS

401'-0" x 54'-0" x 32'-10" M/d. to Upper Deck
Length of Bridge = 123'-9"
Length of Poop = 35'-9"
Length of Forecastle = 44'-3"


3½"x3½"x8.5#L
Rivet to Stiffners & Bulkhead, 3" Max. Spacing
L Stiff. 6"x3½"x15.3#
Rivet to Stiffners & Bulkhead, 5⅛" Max. Spacing
Bulkhead Plating, 12.8#
Rivet to Stiffners & Bulkhead, 3" Max. Spacing
Clip L. 6"x6"x21.9#
U Stiff. 15"x3.6"x3.4"x 33.# spaced 3'-0" apart
Rivet to Stiffners & Bulkhead, 5⅛" Max. Spacing
Bulkhead Plating, 15.3#
Rivet to Stiffners & Bulkhead, 3" Max. Spacing
6"x6"x21.9#L

LONGITUDINAL SECTION THRU BULKHEADS


Hatch 7 Bar 13.6# per ft.
Upper Deck
10'-1" Coaming Plate
Bracket 25.5# Plate 12" wide spaced 5'-0" apart
11'-7⅞"
2½"x⅜" Flat on one Side of Hatch only to form Ladder
5"x⅜" Batten 3'-0" ℄ to ℄
8"x3.4"x3.4"x21.2#J
SECTION THRU COLUMN
LONG. SECTION THRU TRANS. GIRDER BEYOND HATCHES LOOKING OUTBOARD
PLAN SHOWING CONN. OF LONG. & TRANS. GIRDER
2nd Deck
10'-1½"
11'-7⅞"
Alternate Hatch Girders to have Web Plates extend to Top Covers
Hatch Girders spaced 4'-11½" apart
15.3#Pl.
3½"x2½"x6.6#L
Lower Deck
Dbl. 4"x3"x9.8#
18" at ℄
Corner Rounded 12"x3.5"x3.5"x32.7#L
Brackets spaced 5'-0" apart
17.9#Pl. Coaming
7"x3.4"x3.4"x18.9#I
Dbl. 4"x3"x9.8#
Upper Deck
6" Flange
Brackets spaced 5'-0" apart in Line with Hatch Side Bracket above.
TRANSVERSE SECTIONS THRU HATCH COAMING
Plan of pillars & girders to be submitted to be designed for a loading of 50 cu. ft. of cargo space per ton
Weather decks assumed for a 3 ft. loading
Tread Strips 2½"x⅜" spaced 12" apart on One Side of Hatch only
15"I
15"x5.5"x5.5"x42#I
⅜" Riv. 5⅛" Max. Spacing
SECTION THRU COLUMN
Batten Clips, 3"x3"x7.2#
17.9#Pl.
3½"x3½"x11.1# Double 15
2'-0"
Base Pl. 30.6#
Center Brackets 16.6# for ½ Length to 15.3# at Ends
Outboard Brackets 16.6# for ½ Length to 15.3# at Ends
Tank Top
2½"
L. 3½"x3½"x9.8#
7"x3.4"x3.4"x18.9#I
3½" Flange
(12" D)
Bracket Floor Shown
Solid Floor fitted in Way of Column
3'-0"
3'-6"
Molded Line
Bilge Keel 10"x3½"x24.9# Bulb. Spot Welded to Outside Plating
LONG. SECTION THRU COLUMN
SECTION AT FORWARD AND AFTER ENDS OF BRIDGE
TRANSVERSE GIRDER AT ENDS OF HATCHWAY SHOWN
6"x3"x15.6# Bulb L.
Bulwark Plating, 12.8#
12.8# Pl. Brackets spaced 6'-0" apart
6"x6"x19.6#
From Molded Line to Top of Plate
3'-6"
Stringer L. 6"x6"x21.9# to 3½"x3½"x9.8# at Ends
L
Sheer Strake 68⅛"x37# from within Bridge to ½ L & 30.6# Doubling for 20'-0" at Break. Quintuple Riv. Butts
15.3#Pl.
K
80⅜"x30.6# from within Bridge to ½ L Quad. Riv. Butts for ½ L

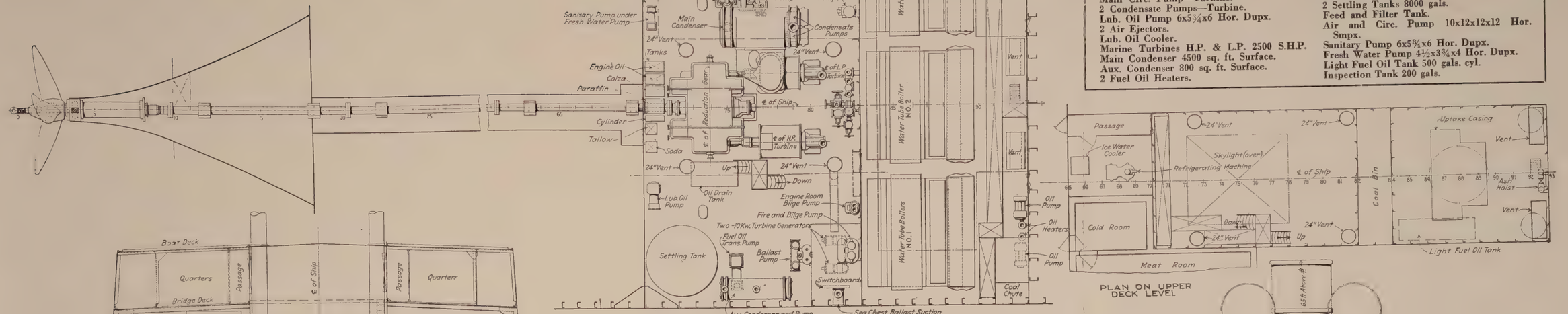

Engine & Boiler Casing Plating, 12.8#
Beams spaced 4'-6" apart, 5"x3"x9.8#
Stiffs. 3"x2½"x5'-6" spaced 2'-3" apart
Stiffs. 3½"x2½"x6.6# spaced 2'-6" apart
21'-1" from ℄ Ship
1⅛" T.&G. Pine
Compo. Deck Covering in Quarters
Deck Plating, 15.3#
6"x3½"x11.7#
Stringer L, 6"x6"x18.6#
3" Pine
6"x2.5"x2.5"x12.8# L
3"x3"x6.1#
Tie Plate, 18"x10.2#
Deck House Plfg. 10.2#
1" Pipe Galv.
¾" Pipe Galv.
9"x12.8# Face Plate
Boat Deck
12"x15"x10.2# Bracket
4"x4"x10.5# T Bar spaced 9'-0" apart. Rail Stanchions between.
Rail Stanchion Galv.
12"x15"x10.2# Bracket
Bridge Deck
Deck Beams to have straight rise of ½" per ft.
Beams on every Frame Thru Beams 8"x3.5"x22.6# L Half Beams abreast Main Hatches 7"x3.45"x3.45"x18.9# L At Casing 7"x3.5"x3.5"x20.1# L
Stringer Pl. 56"x21.7#
16.6# Pl. ⅞" Rivets
Frames spaced 2'-3" apart 6"x3.5"x3.5"x15.3# L with Webs over Bulkheads
6"x1½" Cargo Battens omitted in Bunker Space
M
102"x28.1# Quintuple Rivet Butts
Deck Beams to have straight rise of ½" per ft.
Deck Plating 17.9# for ½L to 14# at Ends, 15.3# in way of Bridge,
Stringer Pl. 62"x25.5# for ½L to 36"x17.9# at Ends 20.4# in way of Bridge,
Frame Channel bent at Upper Deck Molded Line
Upper Deck
3½"x3½"x8.5# Clip L
Beams on every Frame Thru Beams 8"x3.5"x22.6# L Half Beams abreast Main Hatches 7"x3.45"x3.45"x18.9# L At Casings 7"x3.5"x3.5"x20.1# L
16.6# Pl. ⅞" Rivets
Frame Knuckle Line
L
66⅜" x 26.8# Quad. Riv. Butts in way of long Bridge to 19.1# Treble Riv. Butts at Ends
6"x1½" Cargo Battens omitted in Bunker Space
Stringer L, 3½"x3½"x11.1# for ½L to 9.8# at Ends
K
80⅜" x 26.8# Quad. Riv. Butts in way of long Bridge to 19.1# Treble Riv. Butts at Ends
Deck Plating 15.3# for ½L to 12.8# at Ends
Stringer Pl. 49"x20.9# for ½L to 36"x17.9# at Ends in way of Bridge Stringer Pl. 17.9#
2nd Deck
21½" 3½"x3½"x9.8#
Beams on every Frame Thru Beams 10"x3.5"x3.5"x28.4# L Half Beams abreast Main Hatches & Casings 8"x3.5"x3.5"x22.6#
19.1# Pl. ⅞" Rivets
J
77⅞" x 26.8# for ½L to 19.1# at Ends, Treble Riv. Butts thruout
Frames spaced 2'-3" apart, 10"x3.5"x3.5"x28.4# L except in E & B Space
Frames in Peak 6"x3½"x⅞" L with 3½"x3½"x½" Reverse Bar spaced 2'-0" apart
Frames in E & B Space spaced 2'-3" apart 10"x3.6"x3.6"x31.4#
23'-9" above Base Line
6"x2" Cargo Battens spaced not more than 12" apart
H
77⅞" x 26.8# for ½L to 19.1# at Ends, Treble Riv. Butts thruout
Solid Floors on every Frame under Engines, Thrust Seating, Boiler Bearers & Ford. of ½Ls 16.6# for ½L to 15.3# at Ends 20.4# in Boiler Space, Bracket Floors alternately between
Tank Side Brackets 16.6# for ½L to 15.3# at Ends 20.4# in Boiler Space
Side Girders 16.6# for ½L to 15.3# at Ends to 20.4# in Boiler Space, Half Girders between Main Girders from ¾L Ford. to Collision Bhd.
Angle 3½"x3½"x9.8# on alternate Frames
Ceiling over Bilges, Portable
Rev. Frames 3½"x3½"x9.8# to 5½"x3½"x8.5# at Ends Dbl. in Eng. Space & under Boiler Bearers & under Thrust. 5½"x3½"x11.1# under Boiler Bearers
Vert. 15"x3"x3"x12.2# in Boiler Space 3'-3"x9.4#
20.4#
Tank Top Plating 16.6# thruout to 20.4# in Eng. Space to 23.8# in Boiler Space,
Top & Bottom L 5½"x3½"x8.5# in Boiler Space only
L 6"x6"x 17.2# Boiler Space
5½"x3½"x11.1# (Top Only)
Double Riveted Laps in Engine & Boiler Space,
Ceiling thruout Tank Top in Cargo Holes, 2"
Tank Top
G
77⅞" x 26.8# for ½L to 19.1# at Ends, Treble Riv. Butts thruout
⅞" Rivets
6'-10" from Fr. #44 to 168 incl. Reduce Aft at Rate of 1" per Frame Space to 4'-0" at #20 & hold same at #19
52"x20.4# for ½L Treble Riv. Butts to 16.6# at Ends, 23"in Boiler Space.
3½"x3½"x11.1#-13.6# in Boiler Space only
20.4#
5½"x3½"x11.1#
Vert. Keel 44"x20.6# for ½L 24.2# in Boiler Space, 16.8# at Ends, Treble Riv. Butts thruout, Oil tight Thruout
VK
Intermediate Girders in Eng. Space only
24"x18"
Girder Pl. 16.6#
5"x5"x8.1#
5"x5"x20# thruout
18" D. Hole in Engine Space
Base Line
Molded Line
3'-0"
6'-1⅝" from ℄ Ship
15'-0⅞" from ℄ Ship
24'-0" from ℄ Ship
3'-0"
27'-0"
19° To Start of Dead Rise
Tank Frames 3½"x3½"x9.8# to 8.5# at Ends, Doubled Forward of ¾L
Margin Plate 20.4# In Boiler Space 24.2# Treble Riv. Butts for ½L to Double Riv. Butts at Ends
Bilge Keel
Base Line
Molded Line
F
75"x 26.8# for ½L Quad. Riv. Butts to 20.4# Treble Riv. Butts at Ends
32'-10" Molded Depth
20'-2"
FK
Flat Plate Keel 51⅛"x40.8# for ½L Quad. Riv. Butts to 29'-3" at Ends
B
58⅜"x 26.8# for ½L Quad. Riv. Butts to 20.4# Treble Riv. Butts at Ends
C
75¼"x 26.8# for ½L Quad. Riv. Butts to 20.4# Treble Riv. Butts at Ends
D
75¼"x 26.8# for ½L Quad. Riv. Butts to 20.4# Treble Riv. Butts at Ends
E
75¼"x 26.8# for ½L Quad. Riv. Butts to 20.4# Treble Riv. Butts at Ends
B-C-D-E Strakes in flat of bottom to maintain midship thickness to collision bhd. Strake connected to stern frame to be same thickness as midship. Propeller boss plate 30.6#

SECTION THRU ENGINE ROOM—SOLID FLOOR SHOWN

9,000-TON D. W. FREIGHTER

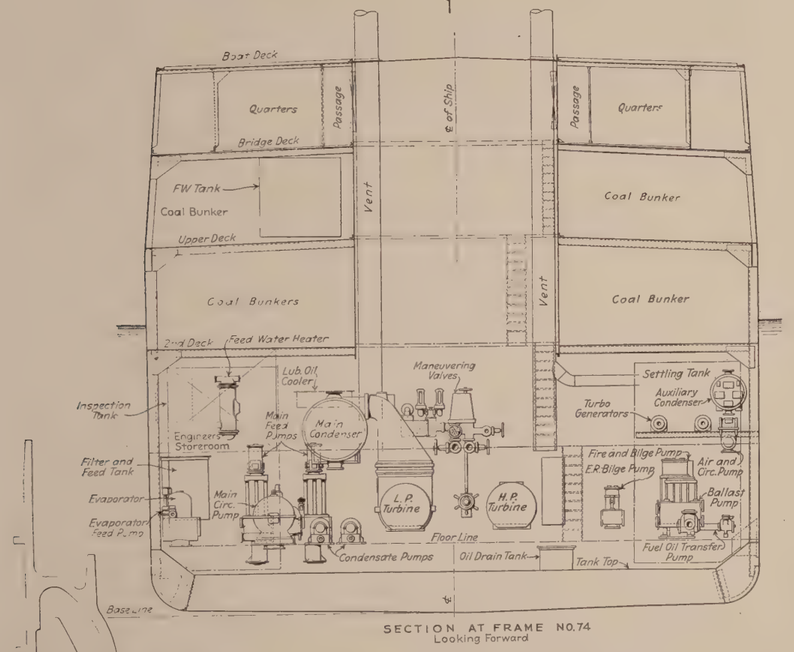
LIST OF MACHINERY—TURBINE INSTALLATION

2 Feed Pumps 12x8x24 Vert. Smpx.
Eng. Room Bilge Pump 6x5¾x6 Vert. Dupx.
Ballast Pump 10x12x12 Vert. Dupx.
Fire & Bilge Pump 10x8x12 Vert. Dupx.
Fuel Oil Trans. Pump 7½x7½x10 Hor. Dupx.
Evap. Feed Pump 4½x4x4 Vert. Dupx.
2 Fuel Oil Service Pumps 5¼x3½x5 Hor. Dupx.
Main Circ. Pump—Turbine.
2 Condensate Pumps—Turbine.
Lub. Oil Pump 6x5¾x6 Hor. Dupx.
2 Air Ejectors.
Lub. Oil Cooler.
Marine Turbines H.P. & L.P. 2500 S.H.P.
Main Condenser 4500 sq. ft. Surface.
Aux. Condenser 800 sq. ft. Surface.
2 Fuel Oil Heaters.
Feed Water Heater.
Ash Hoist.
2 Generators 10 K.W. Turbo.
Evaporator.
2 Induced Draft Fans, 90 in. dia.
3 Marine Boilers 3025 sq. ft. Heat Sur.
Refrigerating Machine Ammonia.
Oil Storage Tank.
Oil Filter Tank.
Oil Drain Tank.
2 Settling Tanks 8000 gals.
Feed and Filter Tank.
Air and Circ. Pump 10x12x12x12 Hor. Smpx.
Sanitary Pump 6x5¾x6 Hor. Dupx.
Fresh Water Pump 4½x3¾x4 Hor. Dupx.
Light Fuel Oil Tank 500 gals. cyl.
Inspection Tank 200 gals.

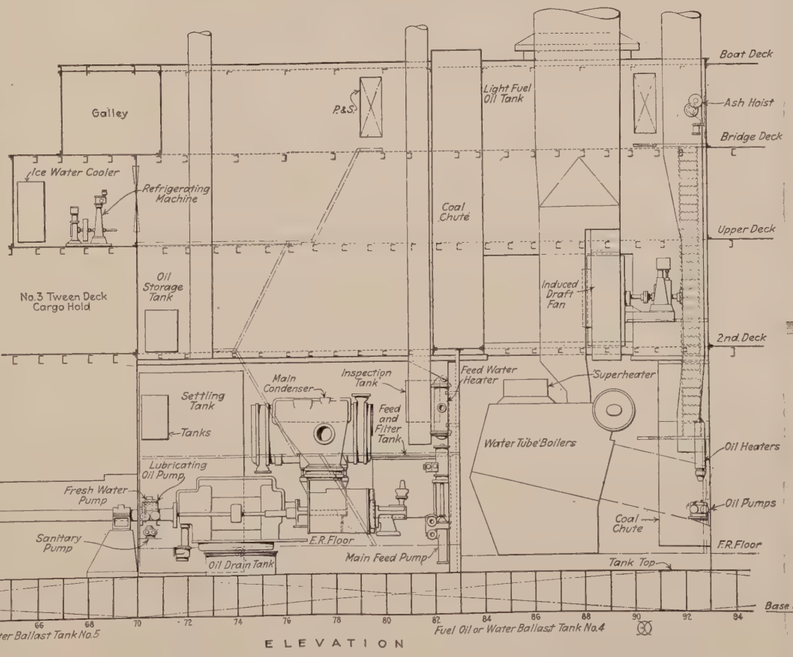


PLAN
Below Second Deck

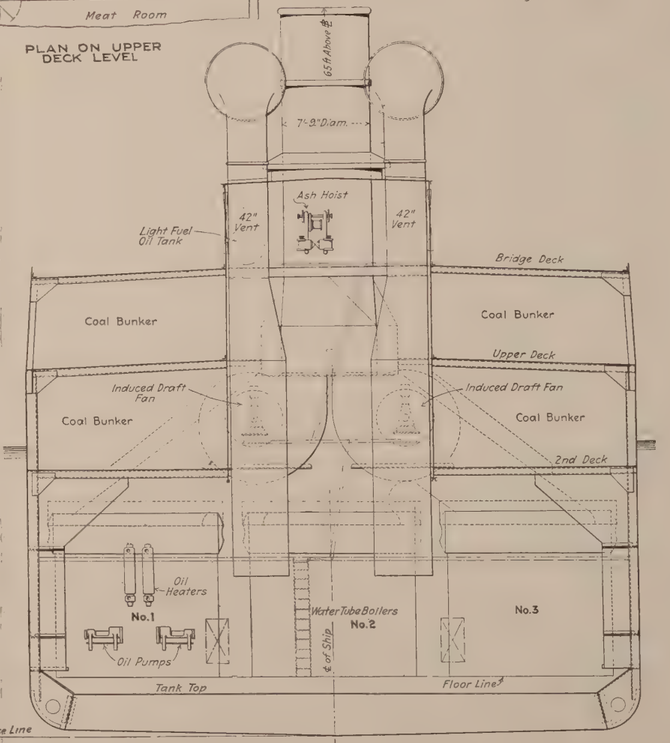
PLAN ON UPPER DECK LEVEL



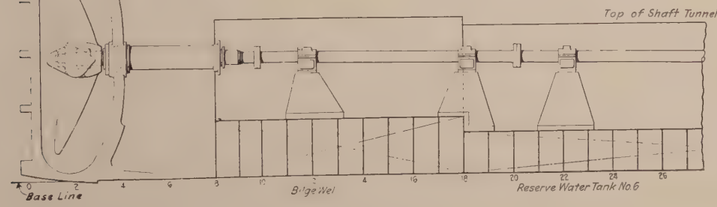
SECTION AT FRAME NO.74
Looking Forward



ELEVATION



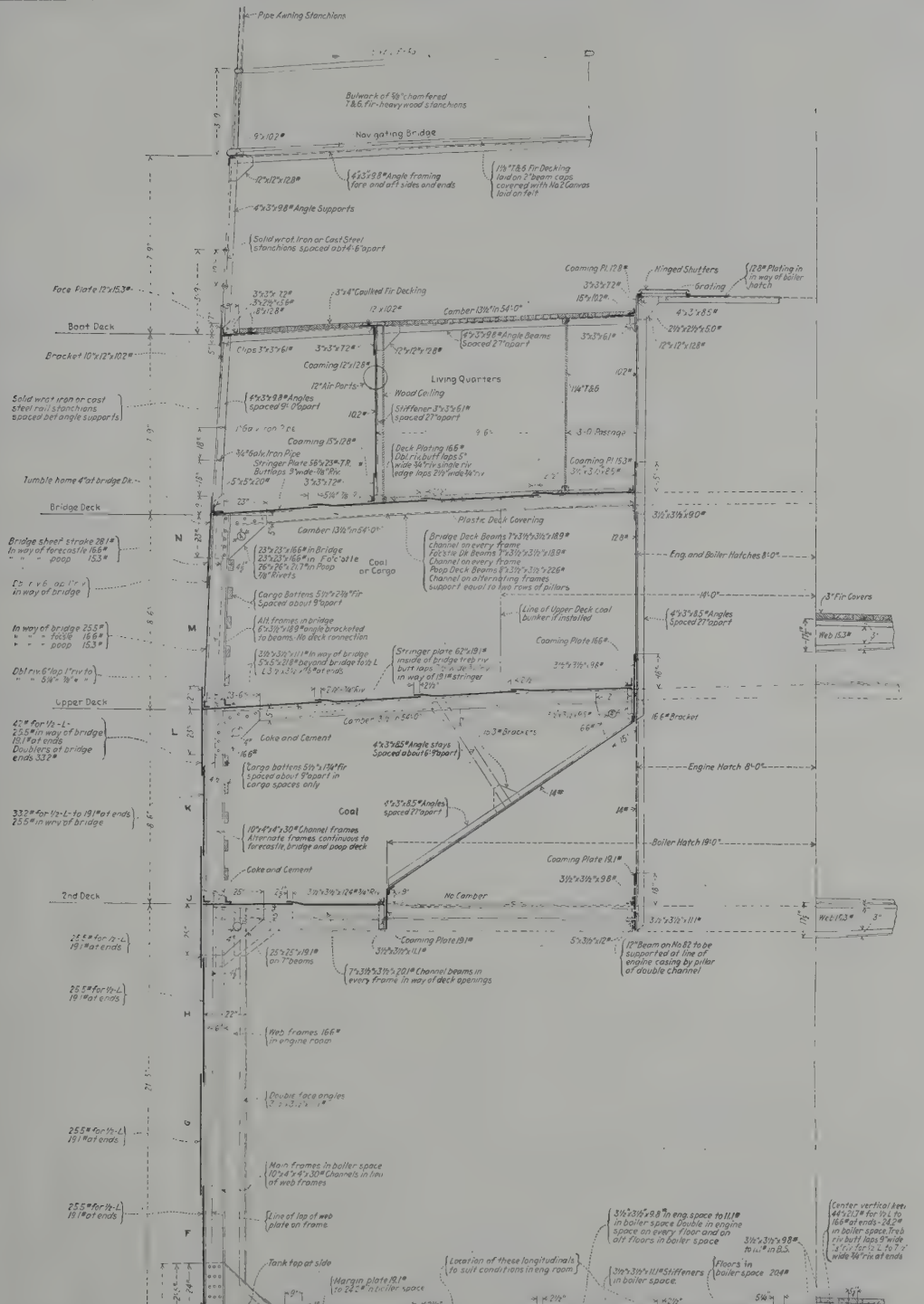
SECTION AT FRAME NO.93
Looking Aft



ARRANGEMENT OF MACHINERY WITH TURBINE INSTALLATION
FOR 9,000-TON D. W. FREIGHTER

PLATE XIV

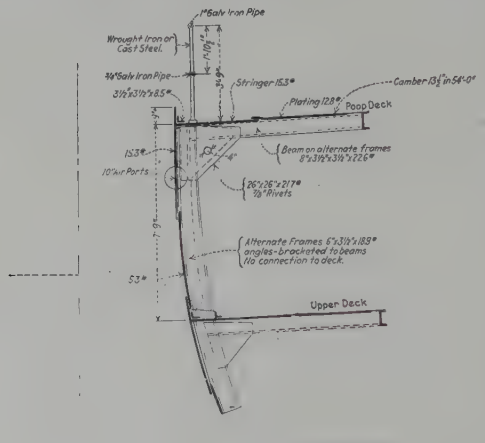
MIDSHIP SECTION


Pipe Awning Stanchions
Bulwark of 5/8" chamfered T.&G. fir-heavy wood stanchions
Navigating Bridge
Solid wrot. iron or Cast Steel stanchions spaced abt 4'-6" apart
Face Plate 12"x15.3#
Boat Deck
Bracket 10"x12"x102#
Solid wrot iron or cast steel rail stanchions spaced bet angle supports
Tumble home 4" at bridge Dk.
Bridge Deck
Bridge Sheer strake 28.1# In way of forecastle 16.6# " " " poop 15.3#
Dbl riv 6" lap 1" riv in way of bridge
In way of bridge 25.5# " " " forc'sle 16.6# " " " poop 15.3#
Dbl riv 6" lap 1" riv to " " 5/16" " "
Upper Deck
42.# for 1/2-L-25.5# in way of bridge 10.1# at ends Doublers at bridge ends 33.2#
33.2# for 1/2-L-to 19.1# at ends 25.5# in way of bridge
2nd Deck
25.5# for 1/2-L 19.1# at ends
25.5# for 1/2-L 19.1# at ends
25.5# for 1/2-L 19.1# at ends
25.5# for 1/2-L 19.1# at ends
Bilge keel for about 1/2-L-
Base Line
Coaming Pl. 12.8#
Ningled Shutters
Grating
12.8# Plating in way of boiler hatch
Camber 13 1/16" in 54'-0"
Living Quarters
Wood Ceiling
Coaming 15"x12.8#
Coaming Pl 15.3#
Deck Plating 16.6#
Plastic Deck Covering
Bridge Deck Beams
Eng. and Boiler Hatches 8'-0"
3" Fir Covers
Line of Upper Deck coal bunker if installed
Coaming Plate 16.6#
Web 15.3#
Cargo Battens
Coke and Cement
Engine Hatch 8'-0"
Boiler Hatch 19'-0"
Coaming Plate 19.1#
No Camber
Coaming Plate 19.1#
Web 16.3#
Tank top at side
Margin plate 19.1# to 24.2# in boiler space
Location of these longitudinals to suit conditions in eng. room
Floors in boiler space 20.4#
Center vertical keel 44"x21.7# for 1/2-L to 16.6# at ends-24.2# in boiler space. Treble riv butt laps 9" wide 2 1/2" c. to c. to 7" wide 7/16" rivets at ends
Keel
Longitudinal 20.4#BS
Throughout
Keel Plate 67"x.42# for 3/4-L-XL to 29.3# at ends-Treble and Quad riv butt straps-1/8" rivets
SECTION THROUGH BOILER SPACE

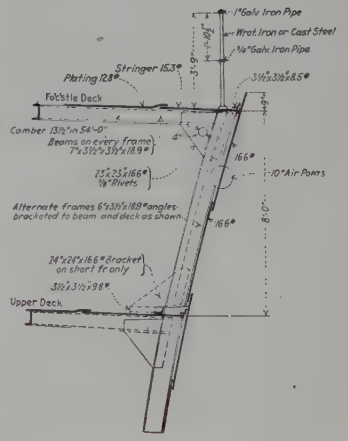
8,800-TON D. W. FREIGHTER

For Notes See Page 413.

MIDSHIP SECTION



SECTION IN WAY OF POOP ENCLOSURE



SECTION IN WAY OF FORECASTLE HEAD

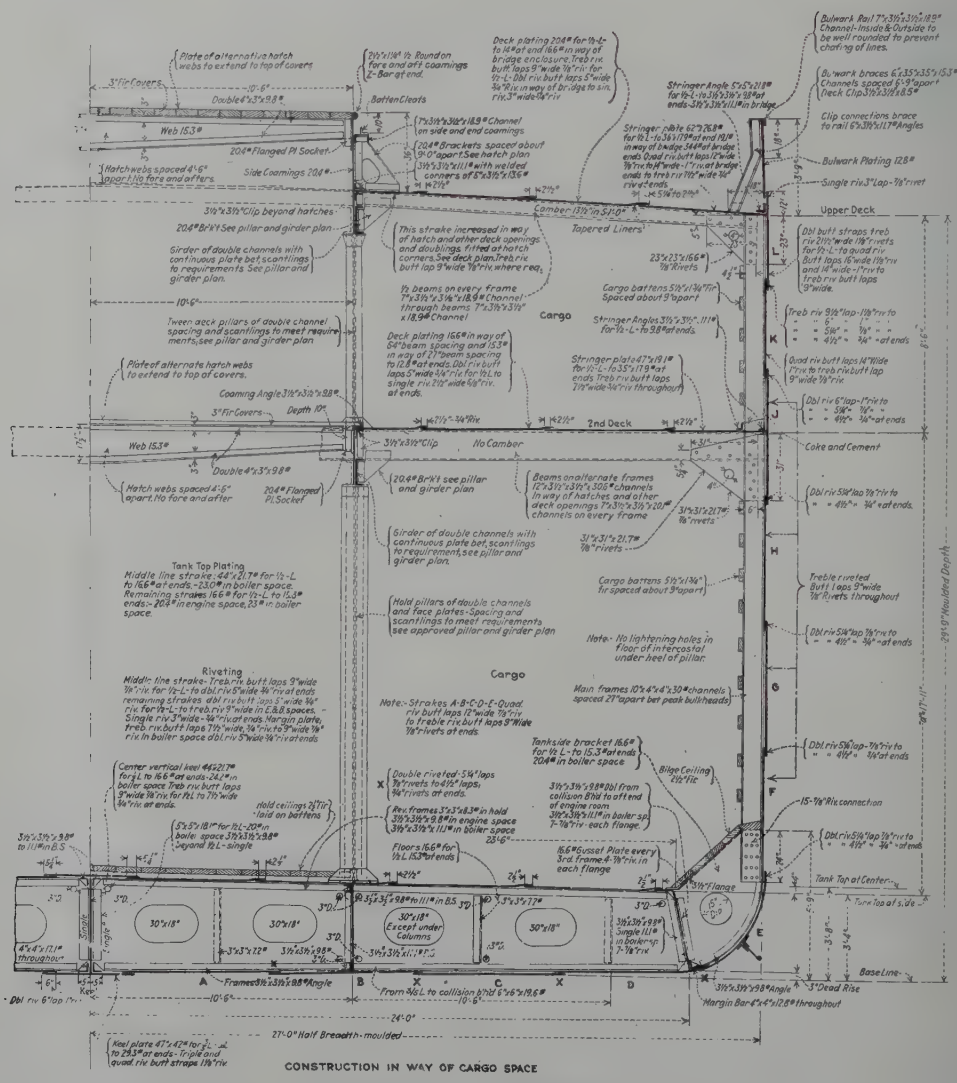
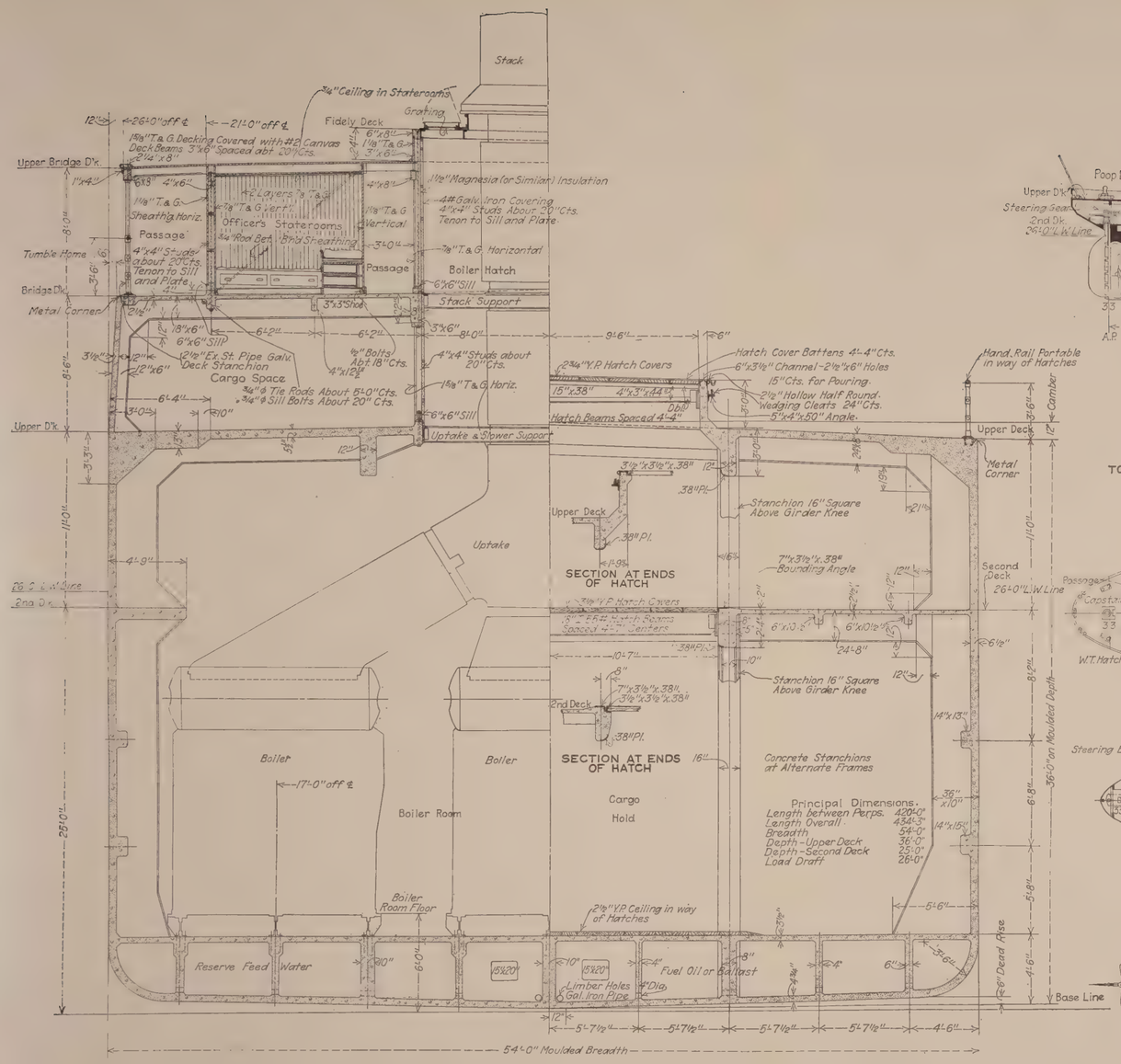


Plate of alternative hatch webs to extend to top of covers
3" Fir Covers
Double 4"x3"x9.8#
Web 15.3#
Hatch webs spaced 4'-6" apart, fore and after
20.4# Flanged Pl Socket
Side Coamings 20.4#
3½"x3½"x.Clip beyond hatches
20.4# Brkt see pillar and girder plan
Girder of double channels with continuous plate bet, scantlings to requirements. See pillar and girder plan.
10'-6"
Tween deck pillars of double channel spacing and scantlings to meet requirements, see pillar and girder plan
Plate of alternate hatch webs to extend to top of covers
Coaming Angle 3½"x3½"x.28#
3" Fir Covers
Depth 10"
Web 15.3#
Double 4"x3"x9.8#
Hatch webs spaced 4'-6" apart, fore and after
20.4# Flanged Pl. Socket
Tank Top Plating
Middle line strake-44"x21.7# for ½-L to 16.6# at ends-23.0# in boiler space. Remaining strakes 16.6# for ½-L to 15.3# ends-20.8# in engine space, 23# in boiler space.
Riveting
Middle line strake-Treb riv butt laps 9" wide ⅞" riv for ½-L-to dbl riv 5" wide ¾" riv at ends remaining strakes dbl riv butt laps 5" wide ¾" riv for ½-L-to treb riv 9" wide in E & B spaces. Single riv 3" wide-¾" riv at ends. Margin plate, treb riv butt laps 7½" wide, ¾" riv to 9" wide ⅞" riv in boiler space. Dbl riv 5" wide ¾" riv at ends
Center vertical keel 44"x21.7# for ½ L to 16.6# at ends-24.2# in boiler space. Treb riv butt laps 9" wide ⅞" riv for ½ L to 7½ wide ¾" riv at ends
Hold ceilings 2½" fir laid on battens
5"x5"x.18# for ½ L-20.4# in boiler space 3½"x3½"x.98# beyond ½ L-single
5½"x3½"x.98# to 111# in B.S.
24"
30"x18"
4"x4"x.17.1# throughout
Stringer
Frames 3½"x3½"x.88# Angle
Keel
Dbl riv 6" lap 1"riv
10'-6"
24'-0"
27'-0" Half Breadth-moulded
Keel plate 47"x.42# for ½ L to 29.3# at ends-Triple and quad riv butt straps .78" riv
Deck plating 20.4# for ½-L-to 16.6# at end 16.6# in way of bridge enclosure. Treb riv butt laps 9" wide ⅞" riv for ½-L-Dbl riv butt laps 5" wide ¾" Riv in way of bridge to sin. riv. 3" wide ¾" riv
7"x3½"x.316"x18.9# Channel on side and end coamings
20.4# Brackets spaced about 3'-0" apart. See hatch plan
3.9#
3½"x3½"x.111# with welded corners of 5"x3½"x.136#
2½"
Camber 13½" in 54'-0"
This strake increased in way of hatch and other deck openings and doublings, fitted at hatch corners. See deck plan. Treb riv butt lap 9" wide ⅞" riv, where req.
½ beams on every frame 7"x3½"x.3¼"x18.9# Channel through beams 7"x3½"x.3½"x18.9# Channel
Cargo
Deck plating 16.6# in way of 64" beam spacing and 15.3# in way of 27" beam spacing to 12.8# at ends. Dbl riv butt laps 3" wide-¾" rivs for ½ L to single riv 2½" wide ⅝" riv. at ends.
2nd Deck
Coke and Cement
Beams on alternate frames 12"x3½"x3½"x.203# channels in way of hatches and other deck openings 7"x3½"x3½"x20.4# channels on every frame
31"x31"x21.7# ⅞" rivets
Girder of double channels with continuous plate bet, scantlings to requirement, see pillar and girder plan.
Hold pillars of double channels and face plates-Spacing and scantlings to meet requirements see approved pillar and girder plan
Cargo
Note:- Strakes A-B-C-D-E-Quad riv butt laps 12" wide ⅞" riv to treble riv butt laps 9" Wide ⅞" rivets at ends.
Double riveted-5¼" laps ⅞" rivets to 41½" laps, ¾" rivets at ends.
Rev. frames 3"x3"x8.3# in hold 3½"x3½"x9.8# in engine space 3½"x3½"x.111# in boiler space
Floors 16.6# for ½ L 15.3# at ends
Tanksides 16.6# for ½ L-to 15.3# at ends 20.4# in boiler space
Bilge Ceiling 2½" fir
3½"x3½"x9.8# Dbl from collision bhd to aft end of engine room 3½"x3½"x.111# in boiler sp. 7-⅞" riv. each flange.
15.6# Gusset Plate every 3rd. frame 4-⅞" riv. in each flange
3½" Flange
Tank Top at Center
Tank top at side
Base Line
3½"x3½"x.98# Angle
Margin Bar 4"x4"x12.8# throughout
From ½ L to collision bhd 6"x6"x19.6#
Bulwark Rail 7"x3½"x.3½"x.18# Channel-Inside & Outside to be well rounded to prevent chafing of lines.
Bulwark braces 6"x3.35"x3.5"x15.3# Channels spaced 6'-9" apart (Deck Clip 3½"x3½"x8.5#
Clip connections brace to rail 6"x3½"x1.17# Angles
Bulwark Plating 12.8#
Single riv 3" Lap-⅞" rivet
Upper Deck
Dbl butt straps treb riv 2½" wide ⅞" rivets for ½-L-to quad riv Butt laps 16" wide ⅞" riv and 14" wide-1" riv to treb riv butt laps 9" wide.
Treb riv 9½" lap-⅞" riv to " " 5⅛" " ⅞" " " " 4½" " ¾" at ends
Quad riv butt laps 14" Wide 1" riv to treb riv butt lap 9" wide ⅞" riv.
Dbl riv 6" lap-1" riv to " " 5⅛" " ⅞" " " " 4½" " ¾" at ends
Coke and Cement
Dbl riv 5¼" lap ⅞" riv to " " 4½" " ¾" at ends.
Treble riveted Butt laps 9" wide ⅞" Rivets throughout
Dbl riv 5¼" lap ⅞" riv to " " 4½" " ¾" at ends
Dbl riv 5¼" lap-⅞" riv to " " 4½" " ¾" at ends
15-⅞" Rivs connection
Dbl riv 5¼" lap ⅞" riv to " " 4½" " ¾" at ends
29'-9" Moulded Depth
Dead Rise

CONSTRUCTION IN WAY OF CARGO SPACE

8,800-TON D. W. FREIGHTER

For Notes See Page 413.

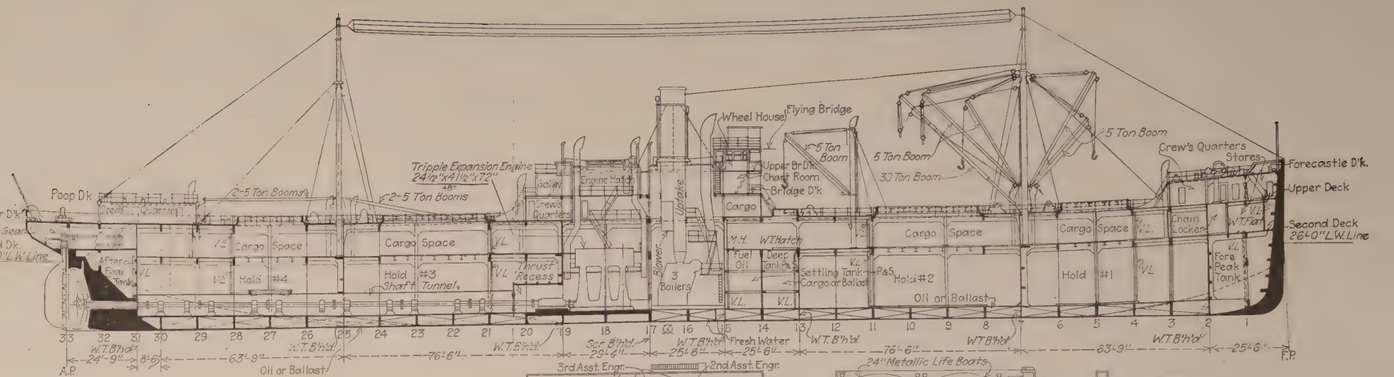


TRANSVERE SECTION IN WAY OF BOILER ROOM

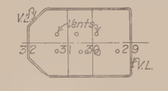
SECTION AT ENDS OF HATCH

SECTION AT ENDS OF HATCH

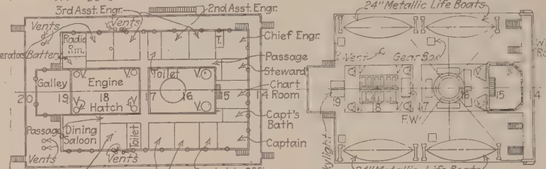
TRANSVERSE SECTION IN WAY OF CARGO HATCH



INBOARD PROFILE

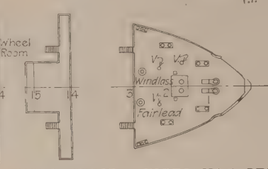


TOP OF AFTER DECK HOUSE (Wood)



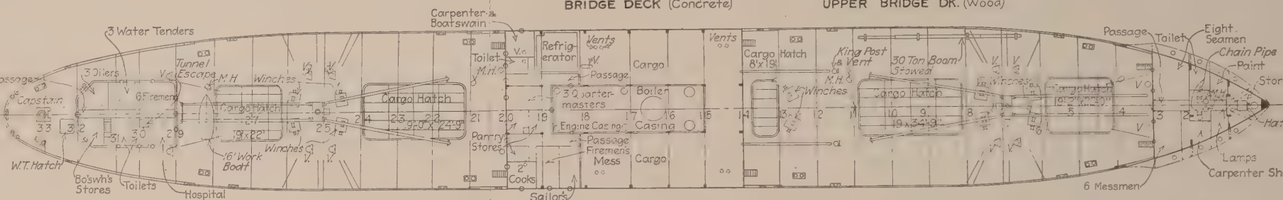
BRIDGE DECK (Concrete)

UPPER BRIDGE DK. (Wood)

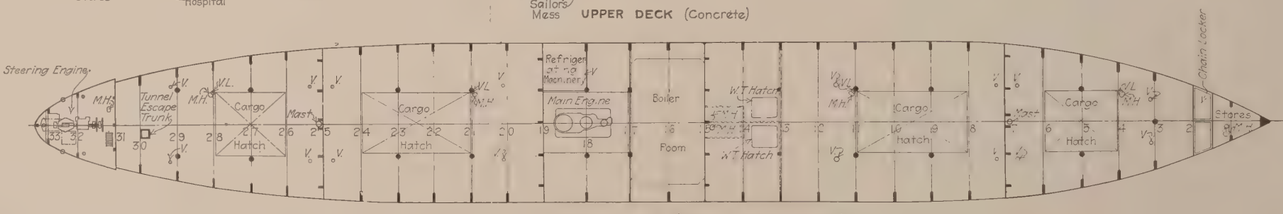


FLYING BRIDGE (Wood)

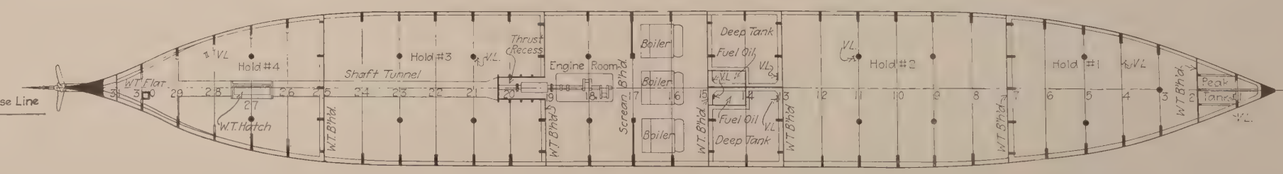
FORECASTLE DECK (Concrete)



UPPER DECK (Concrete)



SECOND DECK (Wood on Concrete Beams)



HOLD PLAN

GENERAL ARRANGEMENT AND TYPE SECTION PLANS
7,500-TON D. W. CONCRETE CARGO VESSEL
Designed by F. B. Webster

PLATE XV

8,800-TON D. W. FREIGHTER

For Midship Sections
See Pages 411 and 412

SCANTLINGS

Stem:—To be fitted in two length, with scarph at upper turn of fore foot. Upper section of bar iron or mild steel 10½" x 2¾"; lower section of cast steel shaped to form.

Stern Frame:—Will be of cast steel in two sections with scarphs at upper part of rudder post and lower part of propeller post. Propeller post 10½" x 8"; rudder post 9" x 8".

Frames:—10" x 4" x 4" 30# channels beyond inner bottom to Upper Deck, spaced 27" apart, from Collision Bhd. to After Peak Bhd. Alternate main frames to run up to Forcastle, Bridge and Poop decks. Intermediate frame in Bridge, 6" x 3½" x 18.9# angles; and in Forecastle and Poop 6" x 3½" x 18.9# angles. All intermediate frames bracketed to deck. Beams over, and in Forecastle, also bracketed to deck. Frames in Peaks 6" x 3½" x 18.9# angles, spaced 24" apart, all to run to Poop or Foc'sle Decks. Frames to be cut in way of W. T. Flats and efficiently bracketed to same or W. T. stapling worked in way of same.
Frames on floors on double bottom 3½" x 3½" x 9.8# angles single. From 3/5 length forward to collision bulkhead 6" x 6" x 19.6# single. Main frames in boiler space to be 10" x 4" x 4" x 30# channels in lieu of web frames. Bilge frames, 3½" x 3½" x 9.8# angles.

Rev. Frames:—On every floor in Double Bottom 3" x 3" x 8.3# in Holds, increased to 3½" x 3½" x 9.8# in Engine Space and 11.1# in Boiler Space. Double in Engine Space on every frame and in Boiler Space on alternated frames. On every frame in both Peaks 3½" x 3½" x 8.5# angles. All to Upper Deck, on alt. frames to Foc'sle Deck. None to Poop Deck.

Web Frames:—22" x 16.6# with double face bars 3½" x 3½" x 11.1#, fitted (3) in Engine Space but omitted in Boiler Space where main channel frames have been increased in lieu of same. Web frames will be fitted in forehold in connection with panting beams and stringers. Webs will be fitted in bridge over bulkheads.

W. T. Bulkhead Frames:—In accordance with approved bulkhead plan.

Floors:—On every frame 44" x 16.6# for ½ length, 15.3# at ends; 20.4# in Engine and Boiler Space. Floors in both Peaks on every frame 40". W. T. floors to have stiffeners 3½" x 3½" x 11.1# angles fitted between longitudinals as shown.

Center Vertical Keel:—44" x 21.7# for ½ length to 16.6# at ends, increased to 24.2# in Boiler Space. Double angles to flat plate keel 4" x 4" x 17.1# throughout. Double angles to tank top plating 3½" x 3½" x 9.8# to 11.1# in Boiler Space.

Longitudinals:—One each side, 16.6# for ½ length, 15.3# at ends and 20.4# in Boiler Space. Half depth longitudinals 15.3# each side, in way of 6" x 6" angle frames forward. Extra full depth longitudinals will be fitted in way of engine foundation as required.

Beams:—2nd deck:—On alternate frames, 12" x 3½" x 3½" x 30.6# channels, except in way of cargo hatches and machinery openings where they will be, 7" x 3½" x 3½" x 20.1# channels, on every frame.

SCANTLINGS—Continued

Upper Deck:—On every frame, thru. beams, 7" x 3½" x 3½" x 18.9# channels; in way of hatches 7" x 3½" x 3½" x 18.9# channels.

Bridge Deck:—On every frame, 7" x 3½" x 3½" x 18.9# channels.

Forecastle Deck:—On every frame, 7" x 3½" x 3½" x 18.9# channels with support equal to two rows of pillars.

Poop Deck:—On alternate frames 8" x 3½" x 3½" x 22.6# channels with support equal to two rows of pillars, hatch end beams at second and upper decks of same scantling as regular beams.

Boat Deck Beams:—4" x 3" x 9.8# angles, spaced 27" apart.

Strong Beams:—In machinery space of scantlings as required by Lloyd's.

W. T. Bulkheads:—Plating to be of required thickness in accordance with depth of bulkhead stiffeners. To be required size for 30" spacing generally and fitted with lugs at top and bottom. Plan of all W. T. bulkheads to be submitted to Lloyd's for approval.

Shaft Tunnel and Recess:—Thickness of plating, size and spacing of stiffeners to be to Lloyd's requirements.

Shell Plating:—At stern frame, to be of midship section thickness. These strakes next to flat plate keel to maintain midship thickness to collision bulkhead. Distribution of thickness of plating, also position of butts to be Lloyd's approval. Doubling plates to be fitted at ends of bridge at hawse pipes and elsewhere as required.

Boss Plating:—To be 30.6#.

Rudder:—Of single plate type. Forged frame with keyed arm opposite each gudgeon. Rudder stock of wrought steel of dia. to Lloyd's approval increased at keyways. Stock to be connected to rudder by a horizontal flange coupling. Stock 10½" dia. Pintles, 4½" dia.

RIVETING

All butt straps, butt laps, seam or edge laps to be of width as required and all riveting throughout to be in accordance with Lloyd's rules.

Bridge side plating to be carried down to deck at ends and doublings fitted.

Upper deck sheer strake and stringer to be doubled or increased in thickness at ends of bridge.

PRINCIPAL DIMENSIONS

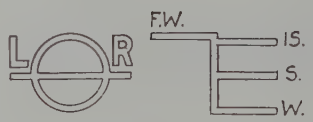
Length Overall	427'—0"
Length B. P.	410'—5 ½"
Breadth Molded	54'—0"
Depth Molded to Upper Deck	29'—9"
Designed Load Draft	24'—2"

EQUIPMENT

2—Bower Anchors, stockless, each	7665#
1—Stream Anchor	2765#
1—Kedge Anchor	1158#

270 Fathoms—2¼" stud link chain cable.
90 Fathoms—3¾" steel wire (stream).
120 Fathoms—5" steel wire tow line.
2—Hawsers each 90 Fathoms—8" Hemp or 2¾" steel wire.
2—Hawsers each 90 Fathoms—7" Hemp or 2½" steel wire.

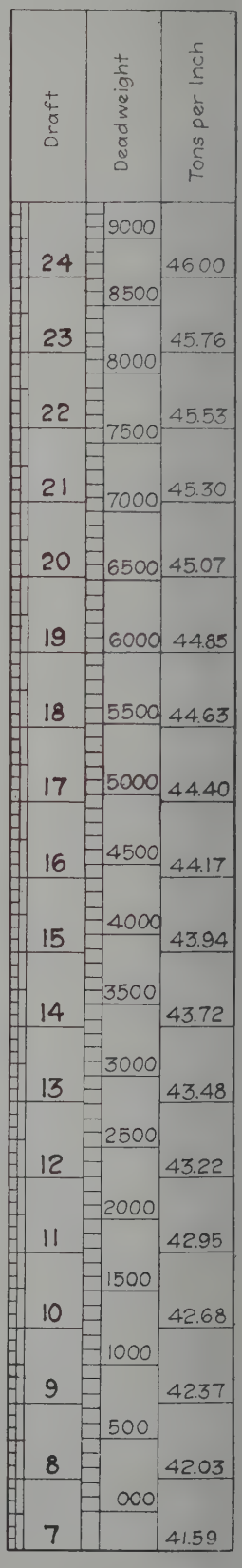
Double Bottom	Cu. Ft.	Tons
Double Bottom Tank No. 1 Starb. Salt Water..	2,800	80
Double Bottom Tank No. 1 Port. Salt Water..	2,800	80
Double Bottom Tank No. 2 Starb. Salt Water..	3,707	106
Double Bottom Tank No. 2 Port. Salt Water..	3,707	106
Double Bottom Tank No. 3 Starb. Salt Water..	3,951	113
Double Bottom Tank No. 3 Port. Salt Water..	3,951	113
Double Bottom Tank No. 4 Starb. Fresh Water	3,448	96
Double Bottom Tank No. 4 Port. Fresh Water.	3,448	96
Double Bottom Tank No. 5 Starb. Salt Water..	4,978	142
Double Bottom Tank No. 5 Port. Salt Water..	4,978	142
Double Bottom Tank No. 6 Starb. Salt Water..	1,874	53
Double Bottom Tank No. 6 Port. Salt Water..	1,874	53
Total	41,516	1,180



Peak Tanks	Cu. Ft.	Tons
Fore Peak ..... Salt Water	4,769	136
After Peak ..... Salt Water	1,236	35
Fresh Water		
Reserve Feed Double Bottom Tank No. 4 Starb.....	3,448	96
Reserve Feed Double Bottom Tank No. 4 Port.....	3,448	96
Potable Water, 2 Tanks Bridge Tween Deck.....	7,490 Gal.	27.8
Potable Water, 1 Tank Boat Deck.....	541 Gal.	2.
Coal Bunkers		
Bunker Tween Deck (Permanent Bunker).....	12,973	288.3
Coal Chutes to Boiler Room.....	551	12.2
Coaling Chute to Bridge Deck	1,150	25.5
Bridge Tween Deck	39,579	879.5
Total	54,253	1205.5

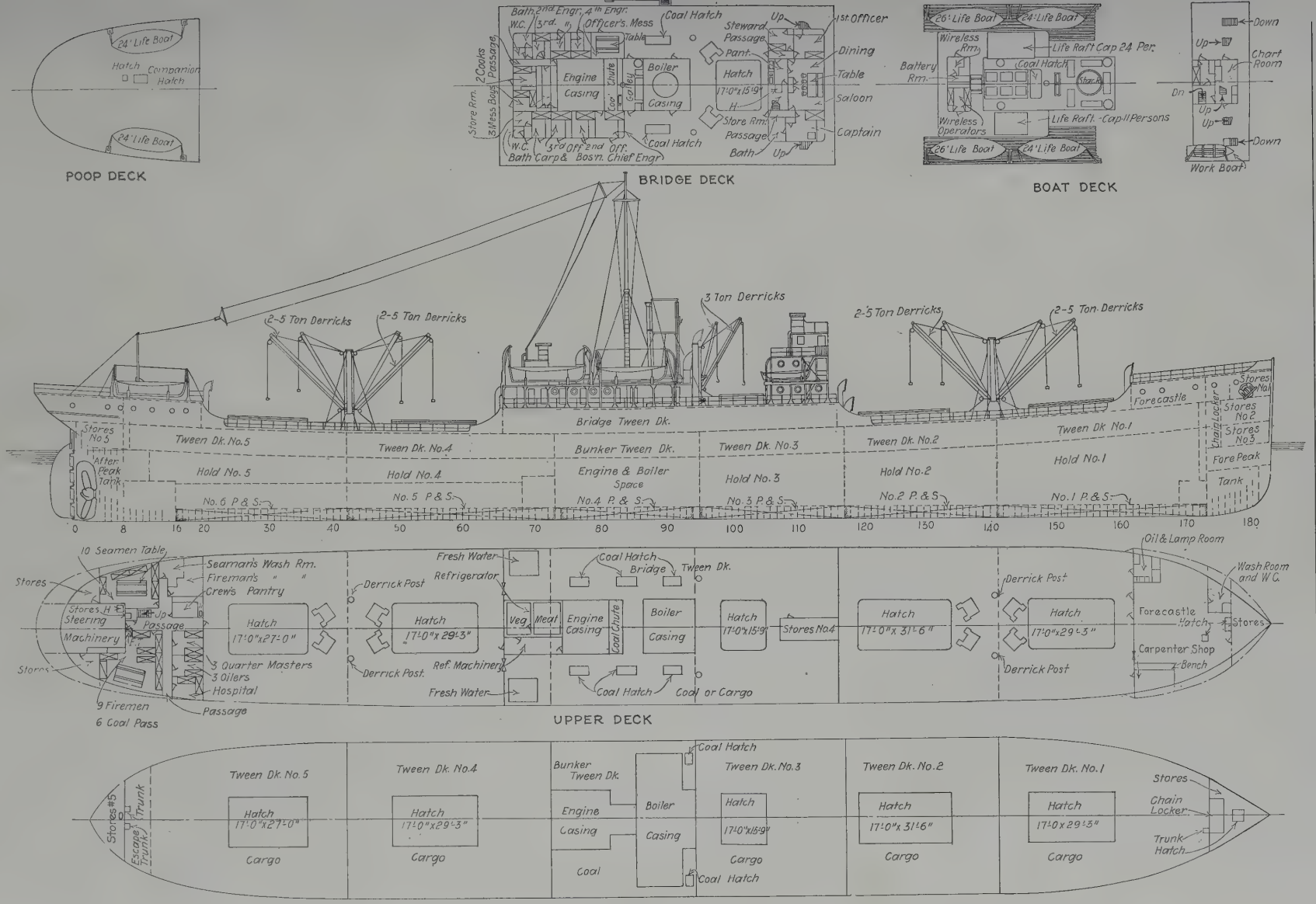
Cargo Capacities Compartment	Bale to inside of ceiling Cu. Ft.	Grain to skin of ship Cu. Ft.
Hold No. 1.....	59,145	65,757
Hold No. 2.....	50,630	55,280
Hold No. 3.....	47,713	52,164
Hold No. 4.....	56,053	61,982
Hold No. 5.....	42,303	47,851
Total Holds	255,844	283,034
Tween Deck Hatches		6,058
Tween Decks No. 1.....	28,464	31,660
Tween Decks No. 2.....	23,140	25,520
Tween Decks No. 3.....	22,822	25,357
Tween Decks No. 4.....	30,760	34,107
Tween Decks No. 5.....	29,638	33,093
Total Tween Decks.....	134,824	149,737
Bridge Tween Deck Hatch		400
Bridge Tween Deck	35,700	39,579
Forecastle	3,423	3,878
Total	39,123	43,857
Total Cargo Capacity	429,791	476,628

Stores	Cu. Ft.
Store Room No. 1.....	1,424
Store Room No. 2.....	3,032
Store Room No. 3.....	2,520
Store Room No. 4.....	1,200
Store Room No. 5.....	3,020
Total	11,196



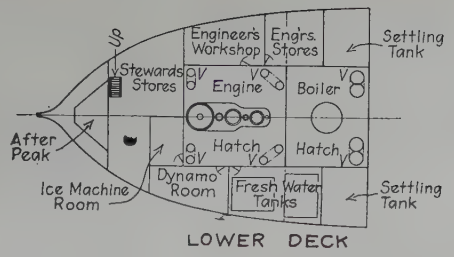
8,700-TON D. W. FREIGHTER

See Opposite Page



8,700-TON D. W. FREIGHTER

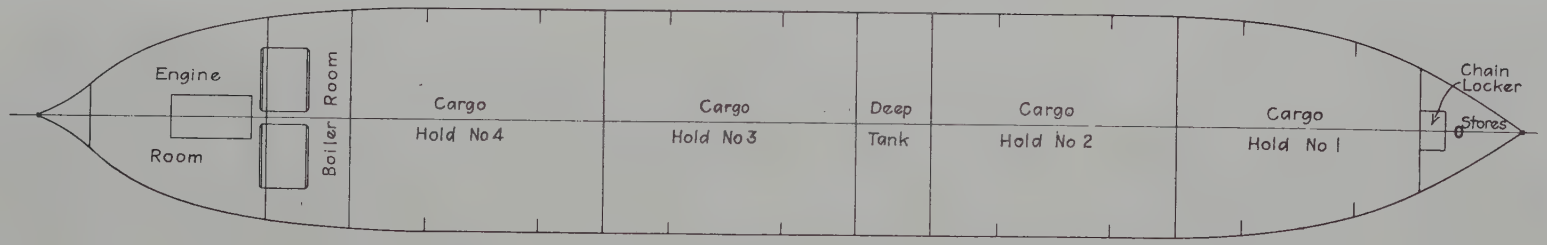
See Opposite Page.



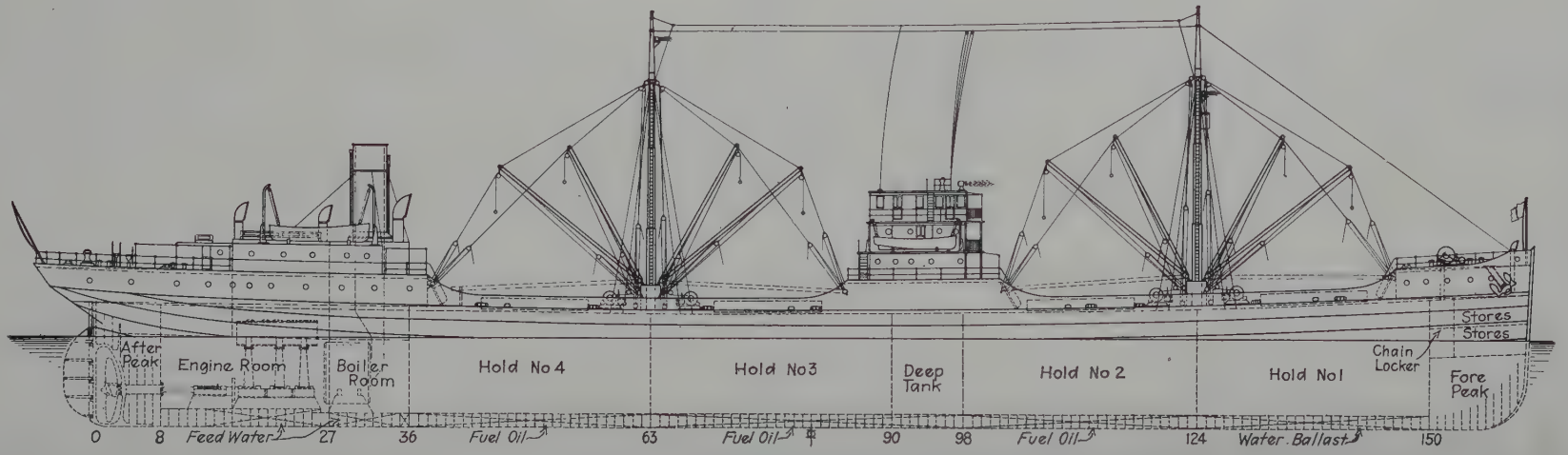
LOWER DECK

Principal Dimensions.

Length Between Perps.	355'-0"
Breadth Molded	52'-6"
Depth Molded	28'-0"



HOLD



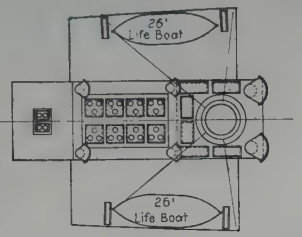
OUTBOARD PROFILE

6,600-TON D. W. BULK FREIGHTER

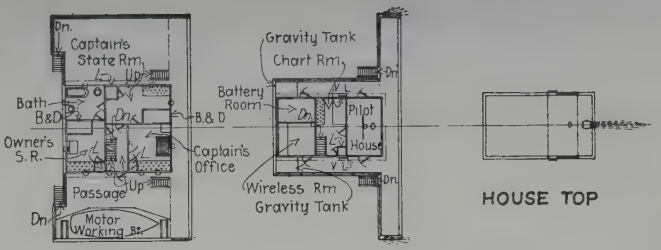
Designed by Frank S. Martin, New York City

Builders, Federal Shipbuilding Co., Kearney. N. J.

See Opposite Page.

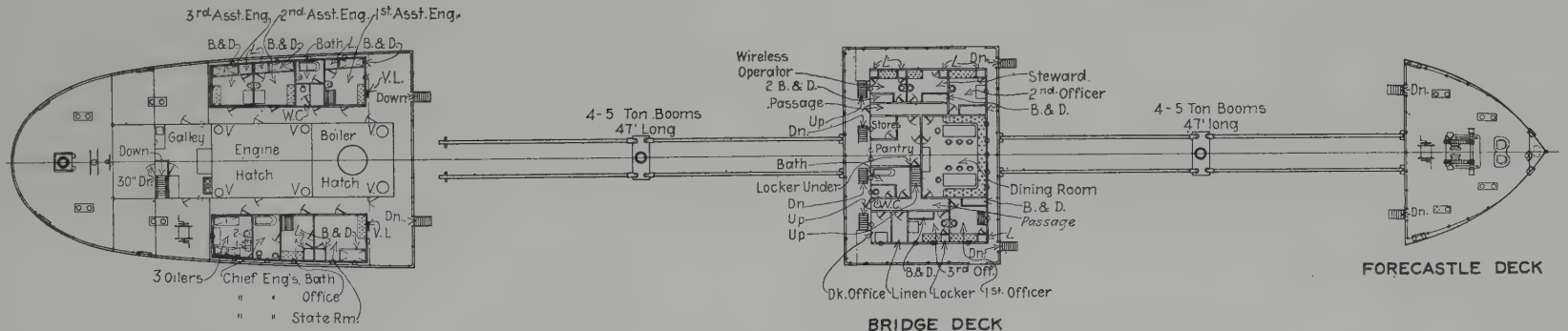


TOP OF HOUSES AND CASING



UPPER BRIDGE DK. FLYING BRIDGE DK.

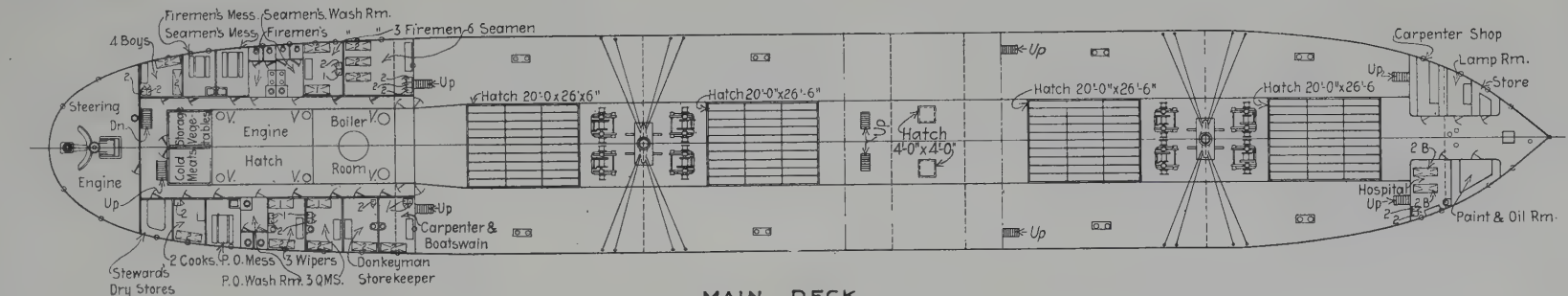
HOUSE TOP



POOP DECK

BRIDGE DECK

FORECASTLE DECK



MAIN DECK

6,600-TON D. W. BULK FREIGHTER

Designed by Frank S. Martin, New York City

Builders, Federal Shipbuilding Co., Kearney, N. J.

See Opposite Page.

RIVETING

Flat Plate Keel Butts, Etc.

Flat Plate Keel Butts—
Single Straps, Treble Riveted. 7/8" Rivs.
Center Girder Butts—
Overlapped, Treble Riveted. 3/4" Rivs.
Horizontal Center Line Keelson—
Overlapped, Treble Riveted. 3/4" Rivs.
Second Deck Stringer Butts—
Overlapped, Double Riveted. 3/4" Rivs.
Second Deck Ties—
Overlapped, Double Riveted. 3/4" Rivs.
Upper Deck Stringer—
Overlapped, Quadruple Riveted to Double at Ends. 3/4" Rivs.
Upper Deck Ties—
Overlapped, Double Riveted. 3/4" Rivs.
Poop, Bridge and Foc's'le Deck Stringers—
Overlapped, Double Riveted. 3/4" Rivs.
Side Keelson Ties—
Overlapped, Treble Riveted. 3/4" Rivs.
Bilge Strake Butts—
Overlapped, Treble Riveted to Double at Ends. 3/4" Rivs.
Second Deck Strake Butts—
Overlapped, Treble Riveted to Double at Ends. 3/4" Rivs.

RIVETING—Continued

Sheer Strake Butts—
Overlapped, Quadruple Riveted to Treble at Ends. 3/4" Rivs.
W. T. Bulkheads Seams and Butts—
Overlapped, Single Riveted. 3/4" Rivs, Except Seam on Lowest Strake, Which Is Double Riveted.
Bunker Casings and Deck Houses Seams and Butts—
Overlapped, Single Riveted. 5/8" and 3/4" Dias.

LUMBER NOTES

The wood keel, stem, garboard, outside planking and deck planking to be yellow pine dense merchantable, as approved and adopted by the Southern Pine Association.

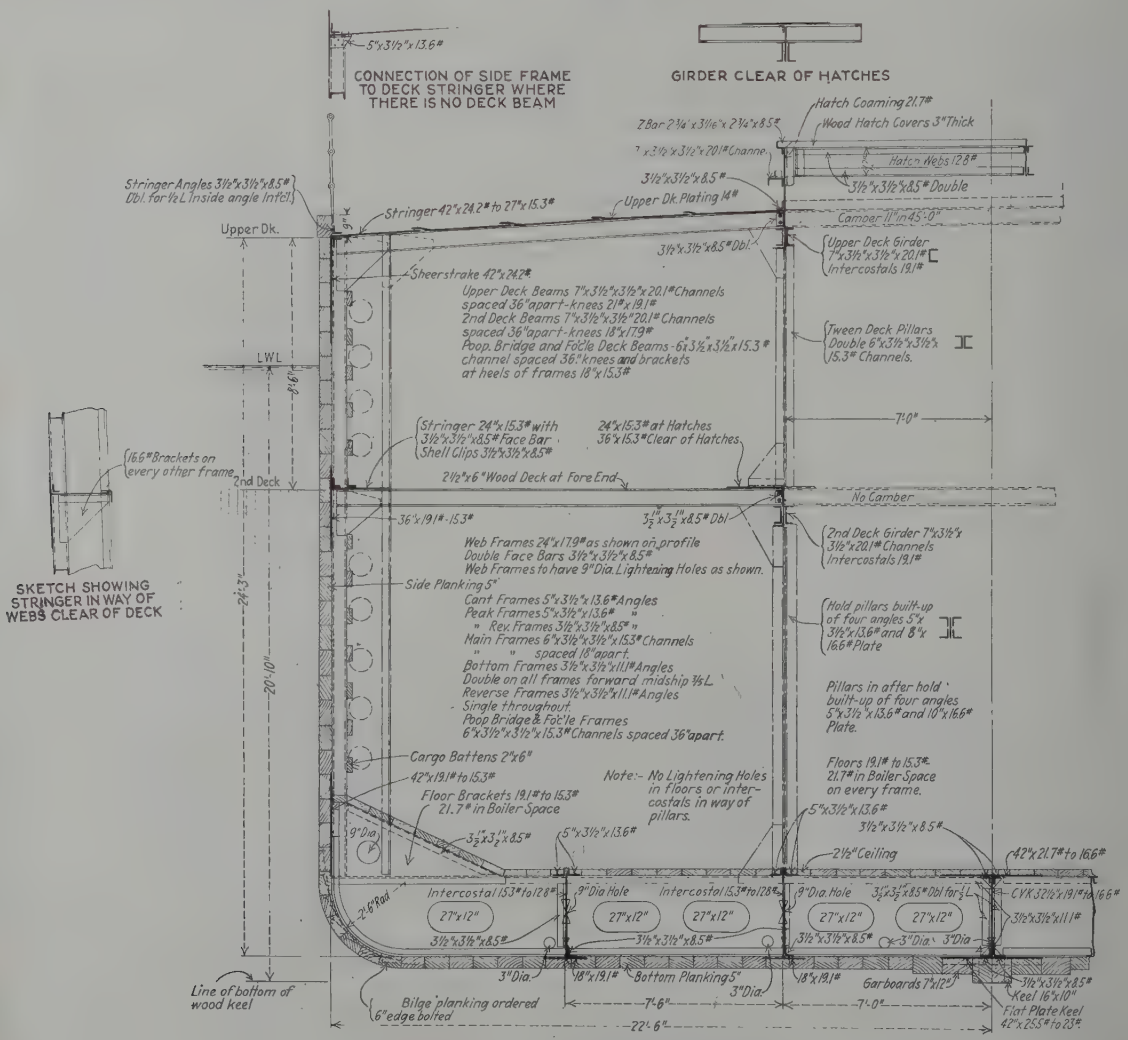
All bolts galvanized.

Wood keel bolts, 1½" dia. One bolt between each frame on port and starboard sides, alternately.

Cross bolts in inner garboard strakes, 1" dia., with square treads and nuts spaced 4'-6" apart. Outside planking to be edge bolted around bilge, with bolts 3/4" dia. All planks to be double fastened with 3/4" bolts.

Butts of outside planking to be bolted to steel straps, 10" x 19.1#, extending from frame to frame and rivited to same.

Deck planking, single fastened, with 5/8" bolts.

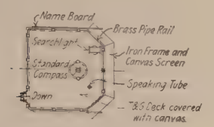

CONNECTION OF SIDE FRAME TO DECK STRINGER WHERE THERE IS NO DECK BEAM
5"x3½"x13.6#
GIRDER CLEAR OF HATCHES
Hatch Coaming 21.7#
Wood Hatch Covers 3" Thick
Z Bar 2¾"x3½"x2¾"x8.5#
Hatch Webs 12.8#
3½"x3½"x8.5# Double
Stringer Angles 3½"x3½"x8.5# Dbl. for ½ L Inside angle Int'cl.
Stringer 42"x24.2# to 27"x15.3#
Upper Dk.
Upper Dk. Plating 14#
Camber 1" in 45'-0"
Upper Deck Girder 7"x3½"x3½"x20.1# Intercostals 19.1#
3½"x3½"x8.5# Dbl.
Sheerstrake 42"x24.2#
Upper Deck Beams 7"x3½"x3½"x20.1# Channels spaced 36" apart-knees 21#x19.1#
2nd Deck Beams 7"x3½"x3½"x20.1# Channels spaced 36" apart-knees 18"x17.9#
Poop, Bridge and Focle Deck Beams-6"x3½"x3½"x15.3# channel spaced 36" knees and brackets at heels of frames 18"x15.3#
Tween Deck Pillars Double 6"x3½"x3½"x15.3# Channels.
LWL
8'-6"
Stringer 24"x15.3# with 3½"x3½"x8.5# Face Bar Shell Clips 3½"x3½"x8.5#
24"x15.3# at Hatches 36"x15.3# Clear of Hatches
7'-0"
16.6# Brackets on every other frame
2nd Deck
2½"x6" Wood Deck at Fore End
No Camber
36"x19.1#-15.3#
3½"x3½"x8.5# Dbl
Web Frames 24"x17.9# as shown on profile
Double Face Bars 3½"x3½"x8.5#
Web Frames to have 9" Dia. Lightening Holes as shown.
2nd Deck Girder 7"x3½"x3½"x20.1# Channels Intercostals 19.1#
SKETCH SHOWING STRINGER IN WAY OF WEBS CLEAR OF DECK
Side Planking 5"
Cant Frames 5"x3½"x13.6# Angles
Peak Frames 5"x3½"x13.6# " "
" Rev. Frames 3½"x3½"x8.5# "
Main Frames 6"x3½"x3½"x15.3# Channels
" " spaced 18" apart.
Bottom Frames 3½"x3½"x11.1# Angles
Double on all frames forward midship ⅓ L
Reverse Frames 3½"x3½"x11.1# Angles
Single throughout.
Poop Bridge & Foc'le Frames 6"x3½"x3½"x15.3# Channels spaced 36" apart.
Hold pillars built-up of four angles 5"x3½"x13.6# and 8"x16.6# Plate
Pillars in after hold built-up of four angles 5"x3½"x13.6# and 10"x16.6# Plate.
24'-3"
20'-10"
Cargo Battens 2"x6"
42"x19.1# to 15.3#
Floor Brackets 19.1# to 15.3# 21.7# in Boiler Space
Note:- No Lightening Holes in floors or intercostals in way of pillars.
Floors 19.1# to 15.3# 21.7# in Boiler Space on every frame.
9" Dia.
3½"x3½"x8.5#
5"x3½"x13.6#
3½"x3½"x8.5#
2½" Ceiling
42"x21.7#-to 16.6#
2'-6" Rad
Intercostal 15.3# to 12.8#
9" Dia Hole
Intercostal 15.3# to 12.8#
9" Dia. Hole
3½"x3½"x8.5# Dbl for ½ L
CVK 32½"x19.1# to 16.6#
27"x12"
27"x12"
27"x12"
27"x12"
27"x12"
3½"x3½"x11.1#
3½"x3½"x8.5#
3½"x3½"x8.5#
3½"x3½"x8.5#
3" Dia.
3" Dia.
3" Dia.
18"x19.1#
Bottom Planking 5"
3" Dia.
18"x19.1#
Garboards 7"x12"
3½"x3½"x8.5# Keel 16"x10"
Line of bottom of wood keel
Bilge planking ordered 6" edge bolted
7'-6"
7'-0"
22'-6"
Flat Plate Keel 42"x25.5# to 23#

3,500-TON D. W. COMPOSITE FREIGHTER

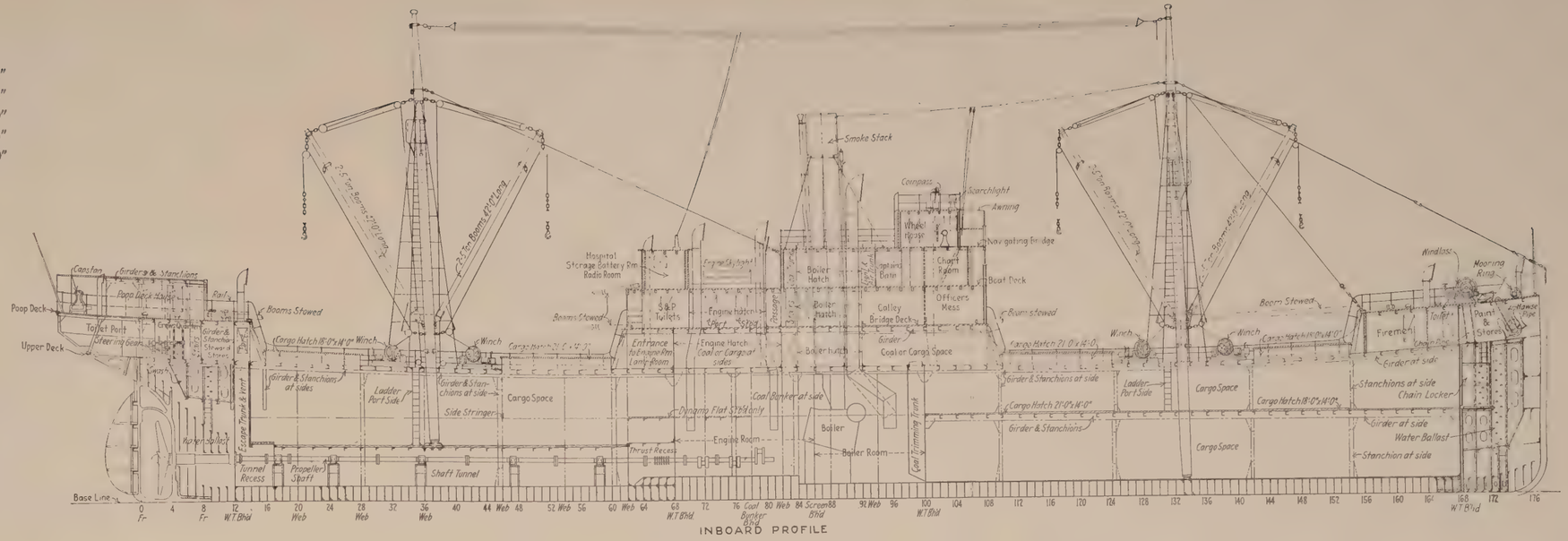
See Opposite Page.

Principal Dimensions

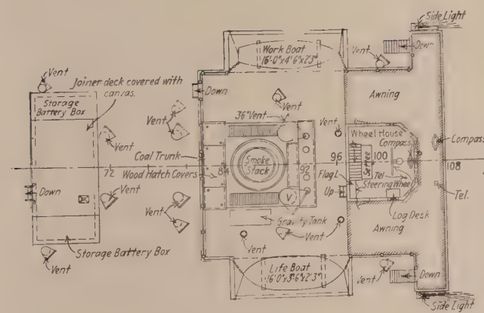
Length B. P.	269'— 1"
Breadth Molded	45'— 0"
Breadth Over Planking	45'—10"
Depth Molded to Upper Deck	24'— 3"
Draft "D" American Bureau Rule	20'— 0"



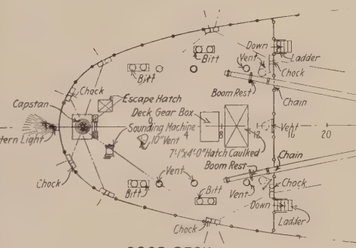
WHEEL HOUSE TOP



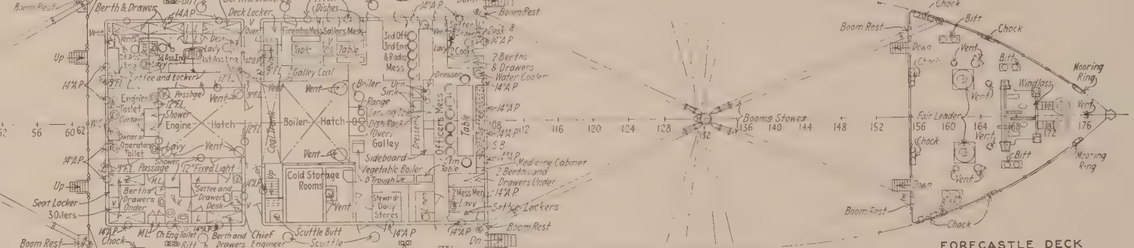
INBOARD PROFILE



NAVIGATING BRIDGE

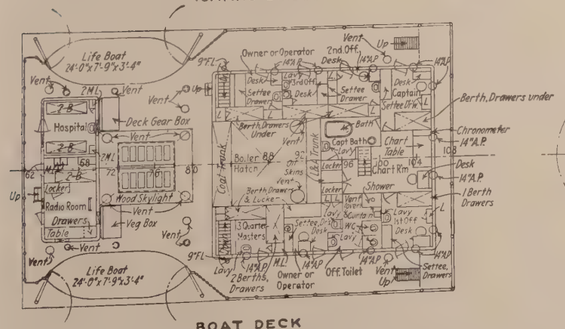


POOP DECK

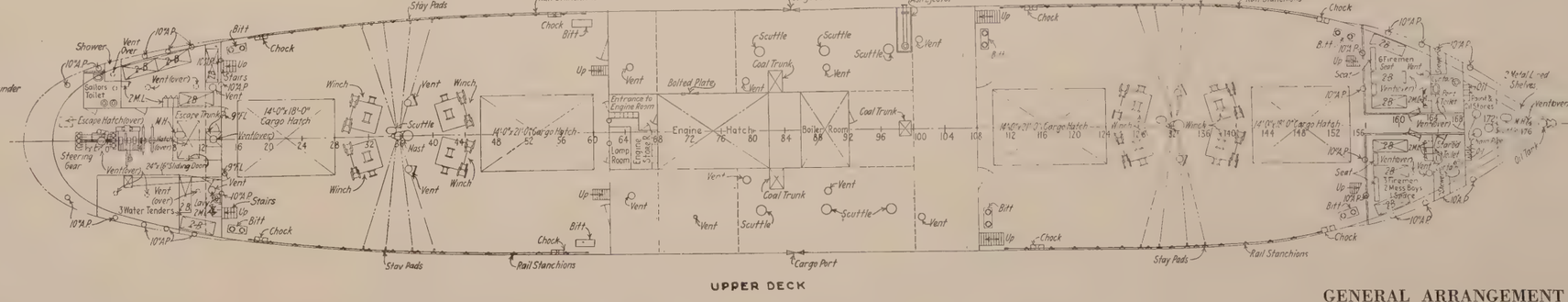


BRIDGE

FORECASTLE DECK



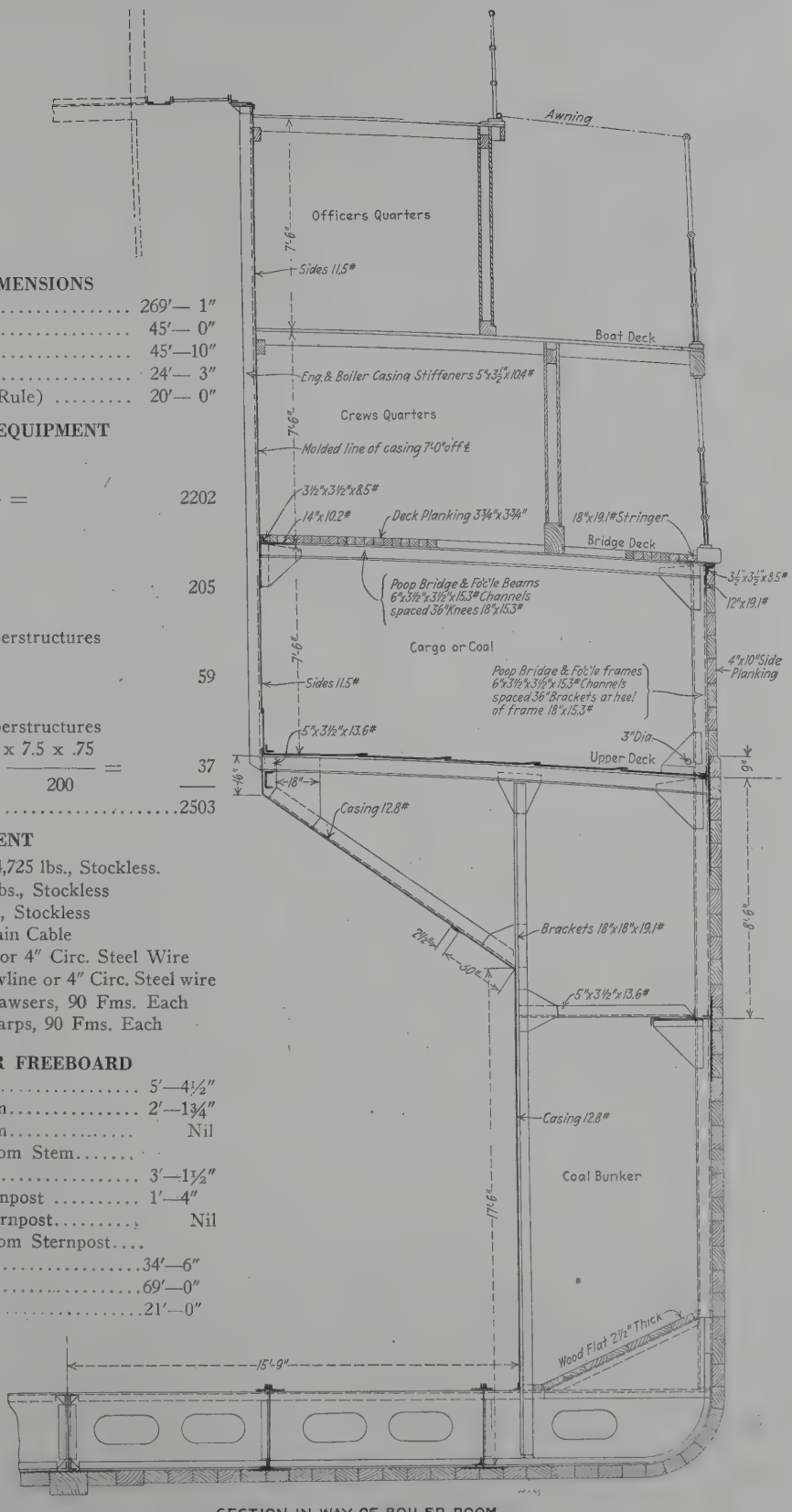
BOAT DECK



UPPER DECK

GENERAL ARRANGEMENT
3,500-TON D. W. COMPOSITE FREIGHTER

PLATE XVI



SECTION IN WAY OF BOILER ROOM

PRINCIPAL DIMENSIONS

Length B. P.	269'— 1"
Breadth Mld.	45'— 0"
Breadth Over Planking	45'—10"
Depth Mld. to Upper Deck	24'— 3"
Draft "d" (American Bureau Rule)	20'— 0"

TONNAGE FOR EQUIPMENT

Tonnage Under Upper Deck

$$\frac{269.08 \times 45 \times 24.25 \times .75}{100} = 2202$$

Superstructures

$$\frac{121.5 \times 45 \times 7.5 \times .75}{150} = 205$$

Superstructures on Top of Superstructures

$$\frac{60 \times 35 \times 7.5 \times .75}{200} = 59$$

Superstructures on Top of Superstructures

$$\Big((36 \times 30.5) + (9 \times 23.5)\Big) \frac{\times\ 7.5 \times .75}{200} = 37$$

Total.....2503

EQUIPMENT

Two Bower Anchors, Each 4,725 lbs., Stockless.
One Stream Anchor, 1,855 lbs., Stockless
One Kedge Anchor, 735 lbs., Stockless
240 Fms. 1⅞" Stud Link Chain Cable
75 Fms. 1⅛" Stream Chain, or 4" Circ. Steel Wire
105 Fms. 12" Circ. Hemp Towline or 4" Circ. Steel wire
Two 7 Inch Circ. Hemp Hawsers, 90 Fms. Each
Two 6 Inch Circ. Hemp Warps, 90 Fms. Each

PARTICULARS FOR FREEBOARD

Sheer at Stem	5'—4½"
Sheer at ⅛ Length from Stem	2'—1¾"
Sheer at ⅜ Length from Stem	Nil
Sheer Becomes Nil 94'—6" from Stem	
Sheer at Sternpost	3'—1½"
Sheer at ⅛ Length from Sternpost	1'—4"
Sheer at ⅜ Length from Sternpost	Nil
Sheer Becomes Nil 85'—6" from Sternpost	
Length of Forecastle	34'—6"
Length of Bridge	69'—0"
Length of Poop	21'—0"

3,500-TON D. W. COMPOSITE FREIGHTER

See Opposite Page.

12,000-TON D. W. TANKER

For Plan of Midship Section
See Opposite Page

RIVETING	Dia. of Rivet	Max. Sp. Dias.
Transverse		
All rivets below upper deck (except wing oil space)	7/8"	..
All rivets above upper deck and in wing oil space	3/4"	..
Clip angles to transverse	Dia. as Above	5
Face angles to transverse	Dia. as Above	6
Butts on trans. plating	Dia. as Above	4
O. T. Bhds.		
Seams and butts of plating	7/8"	3½
Boundary angles	7/8"	5
Horizontal stiffs. 9-10-11-12	7/8"	5
Other horizontal stiffs	7/8"	6
Face angles to vertical stiffs	7/8"	6
Vertical stiffs. to bhds	7/8"	4
Boundary angles to stiffs	7/8"	4
Centerline Bhd.		
O. T. throughout seams and butts	7/8"	3½
Boundary angles grans. and centerline bhds.	7/8"	5
Trans. frames to centerline bhd	7/8"	5
Ex. Tr. Bhd.		
O. T. throughout butts of plating	3/4"	3½
Boundary angles	Staggered. 3/4"	5
Trans. bhd. angles	3/4"	5
Web stiffener clip (both legs)	3/4"	5
Longitudinals	3/4"	6
Floors		
Boundary and clip angles to W. T. floors.	7/8"	4½
Boundary and clip angles to O. T. floors.	7/8"	5
Vertical angles connecting floors to side girders	7/8"	7
Inner Bottom		
Seams and butt laps	7/8"	4
Boundary angles to O. T. bhds.	7/8"	5
Boundary angles to shell O. T.	7/8"	5
Boundary angles to shell W. T.	7/8"	4½
N. W. T. floors to I. B.	7/8"	5
W. T. floors to I. B.	7/8"	4½
O. T. floors to I. B.	7/8"	4½
Inner bottom W. T. in boiler rm. O. T. elsewhere	..	..
Lower Dk.		
O. T. Fr. 8 to 42 W. T. elsewhere	..	..
Seams and butt pltg. O. T.	3/4"	3½
Seams of pltg. W. T.	3/4"	4½
Butts of pltg. W. T.	3/4"	4
Boundary angles O. T. and W. T.	3/4"	5
Boundary angles and longitudinals N. W. T.	3/4"	6
Connection to trans.	3/4"	5
Butts of 22 lbs. plating	7/8"	3½
Upper Dk.		
O. T. 8 to 42 W. T. elsewhere	..	..
O. T. butts of 22 lbs. plating	7/8"	3½
O. T. butts of 22 lbs. plating to 18 lbs.	7/8"	3½
Other O. T. butts and seams	3/4"	3½
W. T. seams of plating	3/4"	4½

RIVETING—Continued	Dia. of Rivet	Max. Sp. Dias.
Upper Dk.—Continued		
W. T. butt laps of plating	3/4"	4
Stringer angle to deck	3/4"	4½
Boundary angle to deck	3/4"	5
Trans. to deck	3/4"	5
Longitudinals to deck	3/4"	6
Centerline bhd. angle to deck	7/8"	5
Shelter Dk.		
W. T. throughout	..	..
Boundary angles	3/5 length ends 7/8"	
	3/4"	5
Connection to trans.	3/5 length ends 7/8"	
	3/4"	5
Seams of deck plating	3/5 length ends 7/8"	
	3/4"	4½
Longitudinals to deck	3/5 length ends 7/8"	
	3/4"	6
Q. R. butt laps and T. R. B. L.	1"	4
Stringer angle to 32 lbs. plating	1"	4½
Stringer angle to other plating	7/8"	4½
Shell		
Lower deck str. angle to shell	7/8"	5
Upper deck str. angle to shell	1"	5
Centerline bhd. angles to keel	1 1/8"	5
Bilge keel to shell	7/8"	5

CLASSIFICATION & LLOYD'S NUMERALS

To class +100A1 at Lloyd's.
Longitudinal framing. To carry oil in bulk.
Also to American Bureau.

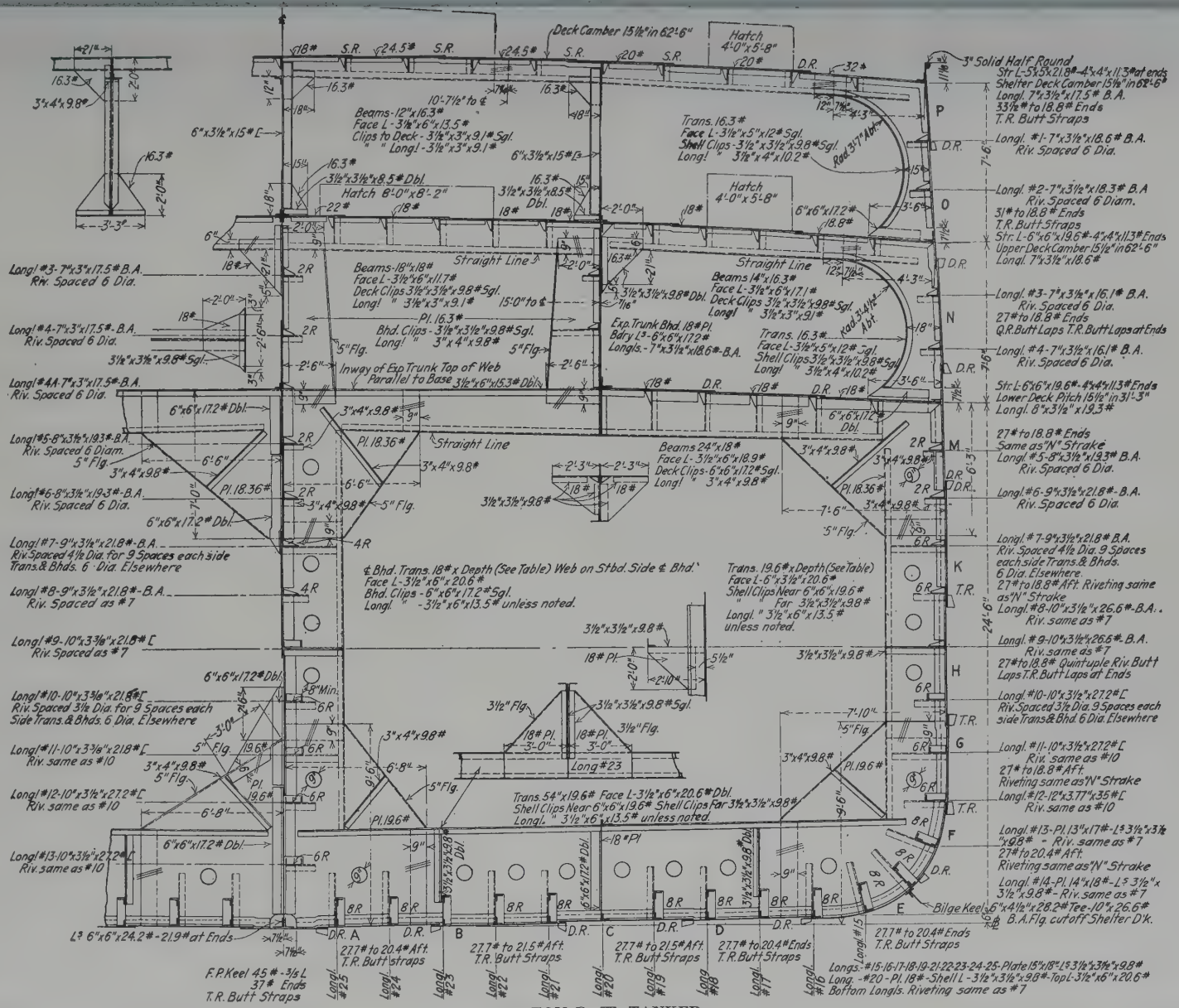
Transverse No.	94.50
Longitudinal No.	44273
Equipment No.	47421

PRINCIPAL DIMENSIONS

Length over all	485'-0"
Length between perps. (Lloyd's)	468'-6"
Beam molded	62'-6"
Depth to shelter deck molded	39'-6"
Depth to upper deck molded	32'-0"
Depth to lower deck molded	24'-6"

ANCHOR CHAINS AND LINES

1—Bower stockless	10,010 lbs.
1—Bower stockless	9,100 lbs.
1—Bower stockless	7,784 lbs.
Stream	Ex. Stock 2,632
Kedge	Ex. Stock 1,232
300 fathoms 2½" stud. link chain	
120 fathoms 5¼" Circ. steel wire-stream	
130 fathoms 6" circ. steel wire-towline	
2—100 fathoms 8" manila hawsers	
2—100 fathoms 8" manila warps	
Stem 11"x3"	
Propeller post 11"x9", pintles 6¾" dia.	
Rudder post 9"x9½"	
Rudder plate 1.16"	
Rudder head 13.5" dia. Speed 11 knots.	
Frame spacing 24" in peaks, 28" under engines.	
Transverse frames 9'-4" in oil spaces.	
Framing in peak 8"x3½"—21.2 lbs. B. A. web pl. 20.4 lbs.	

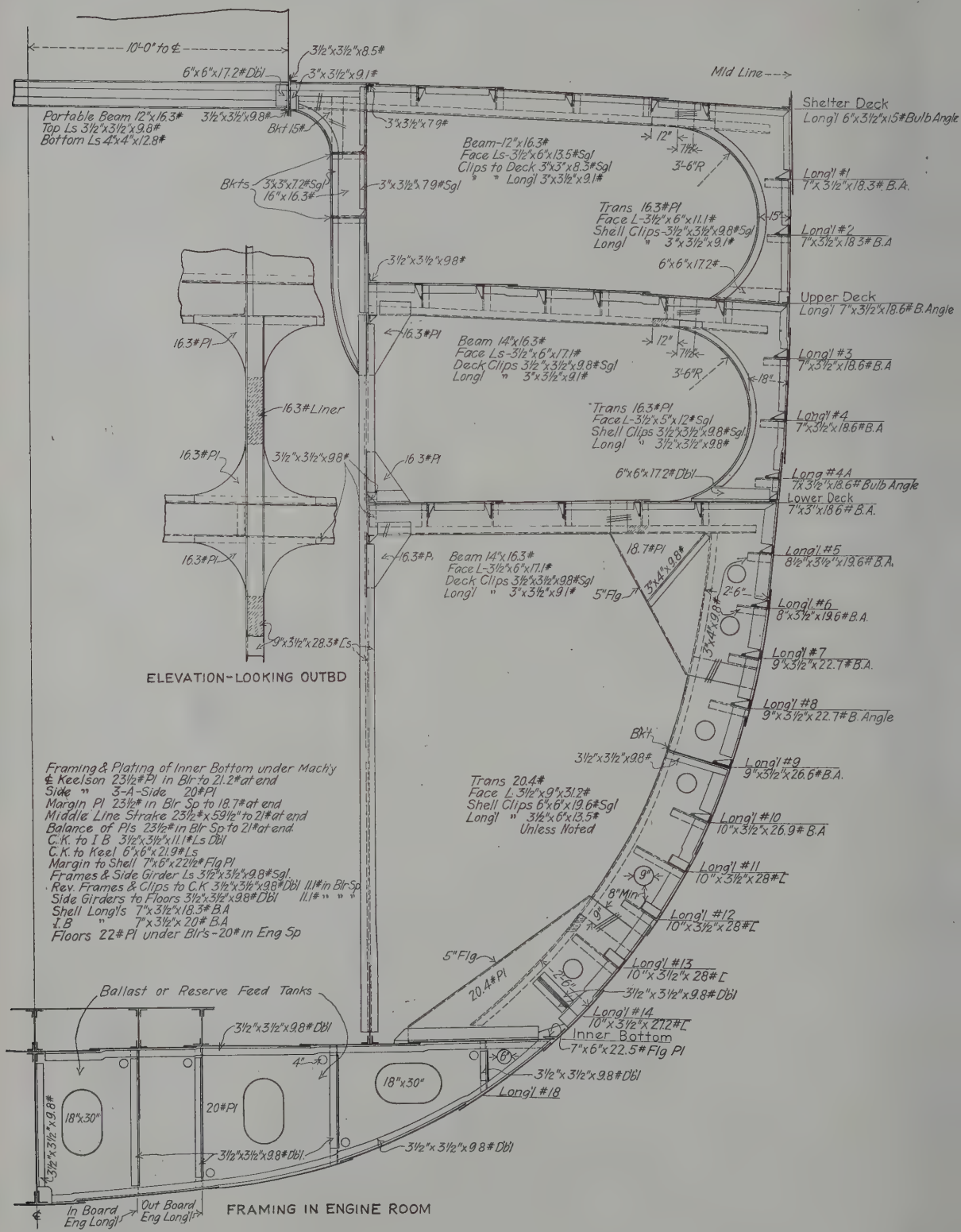


12,000-TON D. W. TANKER

Builders, Bethlehem Shipbuilding Corp.

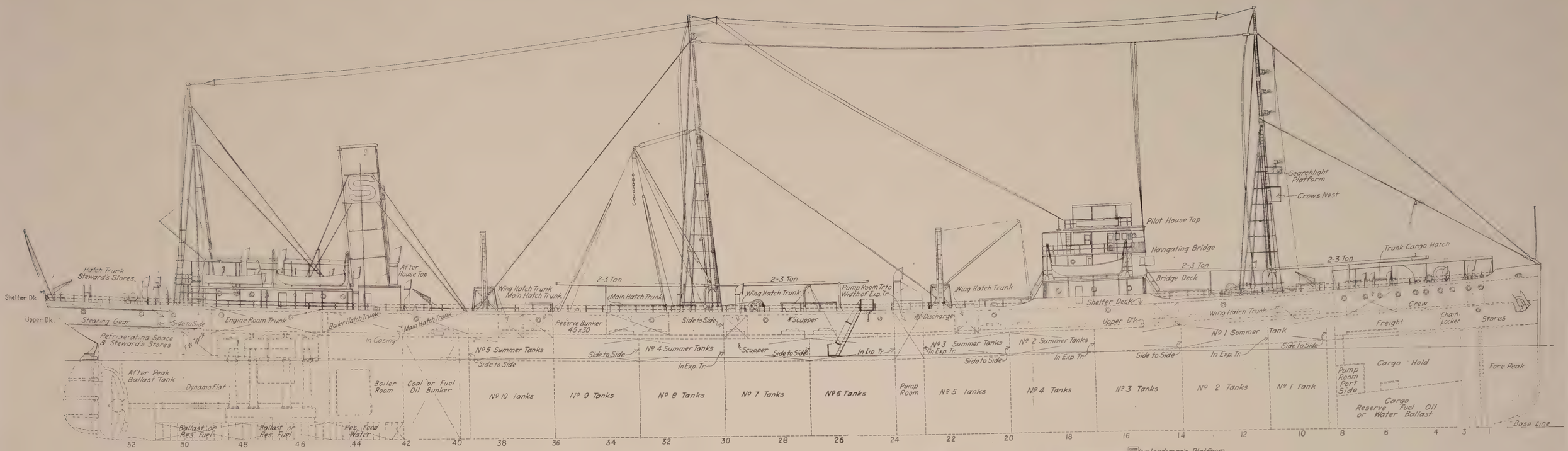
See Opposite Page.

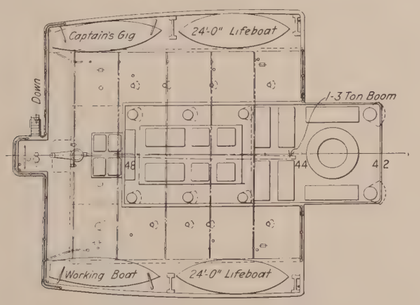
SECTION THRU ENGINE ROOM



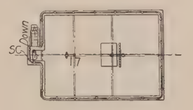
12,000-TON D. W. TANKER

Builders, Bethlehem Shipbuilding Corp.

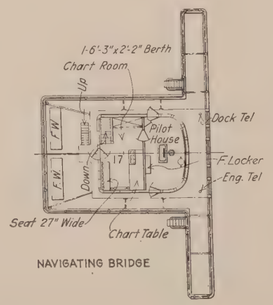




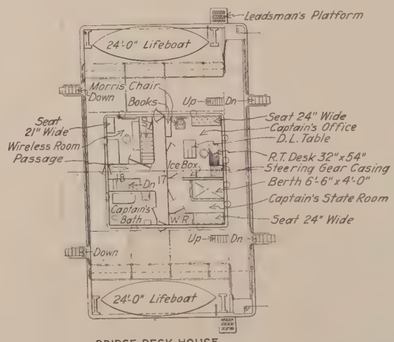
AFTER DECK HOUSE



PILOT HOUSE TOP



NAVIGATING BRIDGE



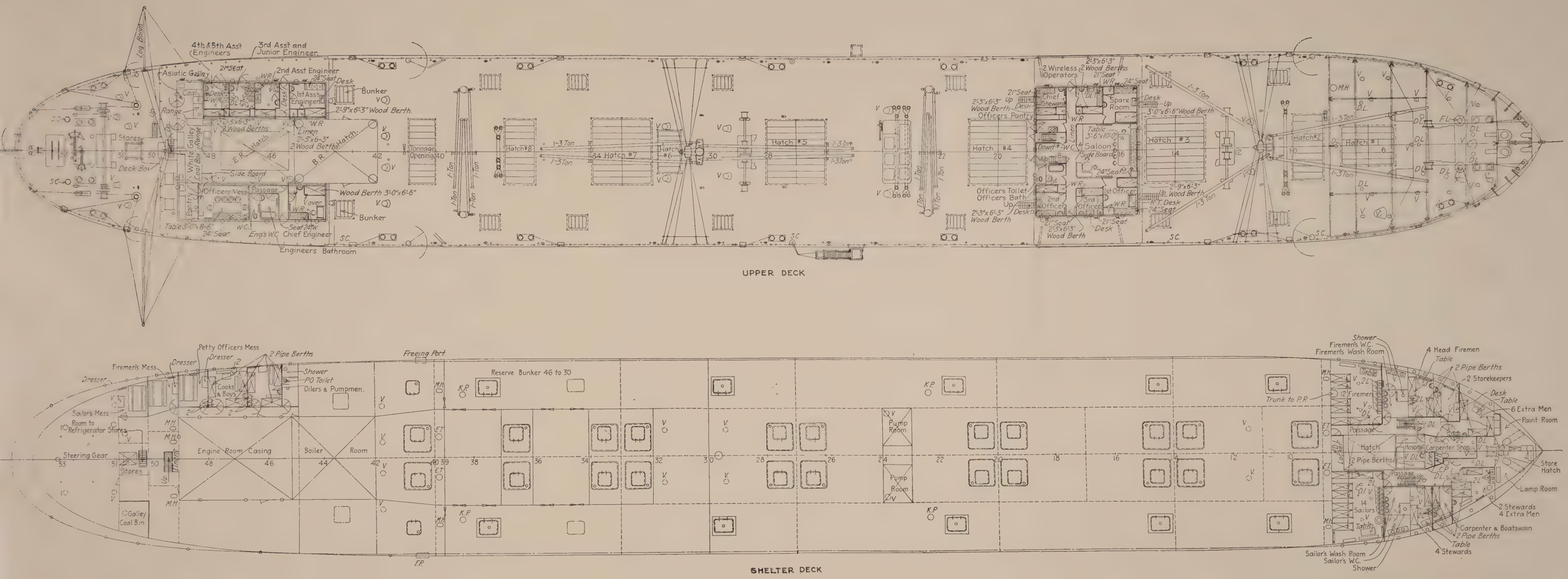
BRIDGE DECK HOUSE

Principal Dimensions

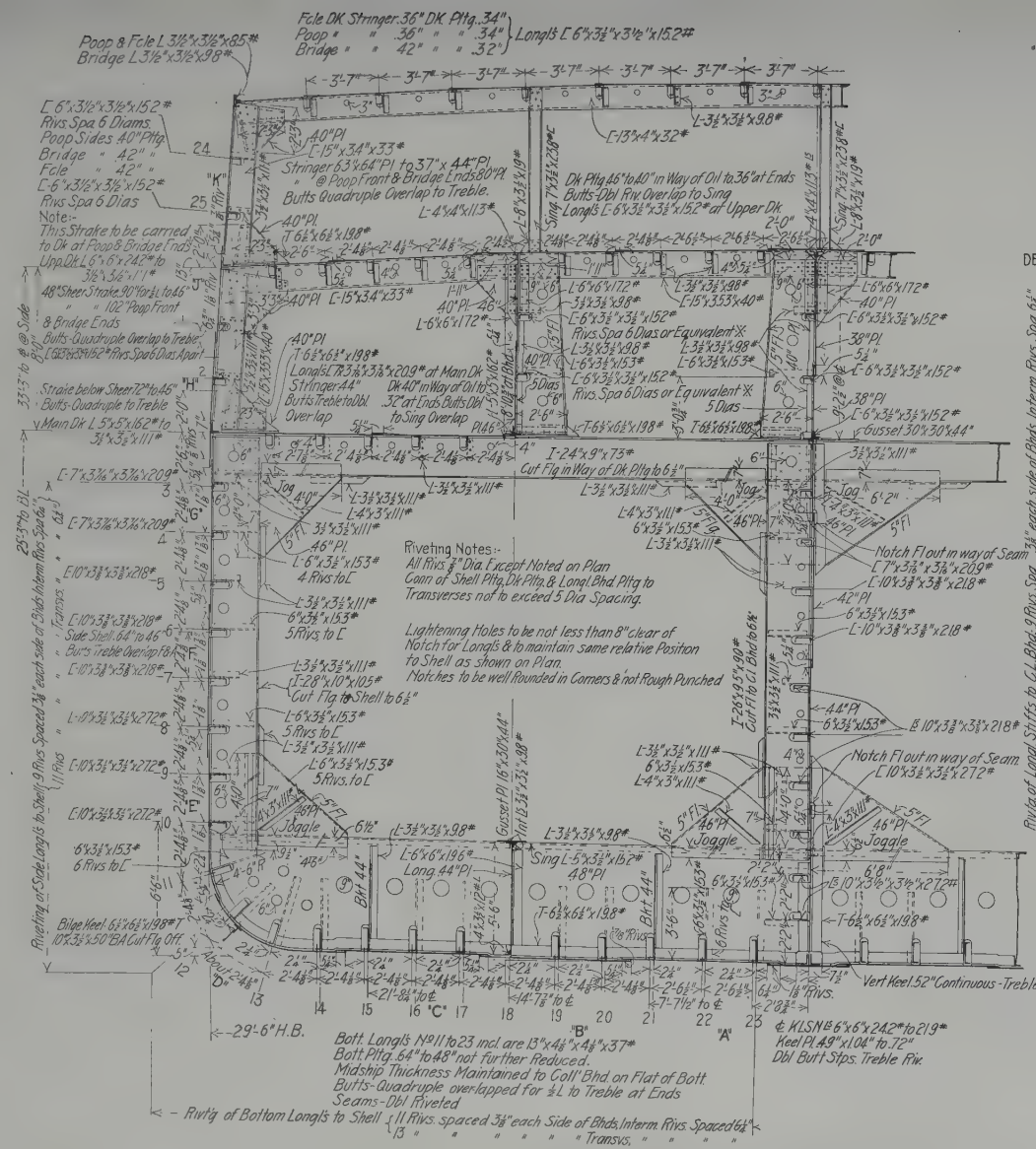
Length O. A.	485'—0"
Length B. P.	468'—6"
Beam molded	62'—6"
Depth to Upper Deck	32'—0"

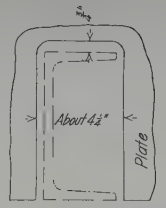
OUTBOARD PROFILE AND ARRANGEMENT OF DECK HOUSES
12,000-TON D. W. TANKER
Builders, Bethlehem Shipbuilding Corp.

PLATE XVII



ARRANGEMENT OF UPPER AND SHELTER DECK
12,000-TON D. W. TANKER
Builders, Bethlehem Shipbuilding Corp.


Fcle DK Stringer 36" DK Pltg 34"
Poop " " 36" " " 34"
Bridge " " 42" " " 32" } Longl's L 6"x3½"x3½"x15.2#
Poop & Fcle L 3½"x3½"x85#
Bridge L 3½"x3½"x98#
L 6"x3½"x3½"x152#
Rivs Spa 6 Diams.
Poop Sides 40" Pltg
Bridge " 42" "
Fcle " 42" "
L 6"x3½"x3½"x152#
Rivs Spa 6 Dias
Note:- This Strake to be carried to Dk at Poop & Bridge Ends
Upp Dk L 6"x6"x24.2# to 3½"x3½"x11"#
48" Sheer Strake 90" for ½L to 46" " " 102" Poop Front & Bridge Ends
Butts-Quadruple Overlap to Treble
L 6"x3½"x3½"x152# Rivs Spa 6 Dias Apart
Strake below Sheer 72" to 46"
Butts-Quadruple to Treble
Main Dk L 5"x5"x16.2# to 3½"x3½"x11"#
L 7"x3⅞"x3⅞"x209#
L 10"x3⅞"x3⅞"x218#
Side Shell .64" to 46"
Butts Treble Overlap f & A
L 10"x3½"x3½"x272#
11 Rivs
Riveting of Side Longl's to Shell 9 Rivs Spaced 3⅜" each side of Bhds Interm Rivs Spaced 6½" " " Transvs.
40" Pl
T 6½"x6½"x19.8#
Longl's L 7"x3⅜"x3⅜"x20.9# at Main Dk
Stringer 44"
Butts Treble to Obl Overlap
Dk 40" in Way of Oil to 32" at Ends Butts Obl to Sing Overlap
Pl 46"
Sing 7"x3½"x23.8#
Dk Pltg 46" to 40" in Way of Oil to 36" at Ends
Butts-Obl Riv Overlap to Sing
Longl's L 6"x3½"x3½"x15.2# at Upper Dk
L 13"x4"x32#
L 15"x34"x33#
Stringer 63¼"x64" Pl to 37"x 44" Pl
" @ Poop Front & Bridge Ends 80" Pl
Butts Quadruple Overlap to Treble.
L 4"x4"x11.3#
L 3½"x3½"x9.8#
L 8"x3½"x19#
L 6"x6"x17.2#
L 15"x35.3"x40#
L 6"x3½"x3½"x152#
Rivs Spa 6 Dias or Equivalent ※
5 Dias
38" Pl
Gusset 30"x30"x44"
I 24"x9"x73#
Cut Flg in Way of Dk Pltg to 6½"
Riveting Notes:-
All Rivs ⅞" Dia. Except Noted on Plan
Gain of Shell Pltg, Dk Pltg, & Longl Bhd Pltg to Transverses not to exceed 5 Dia Spacing.
Lightening Holes to be not less than 8" clear of Notch for Longl's & to maintain same relative Position to Shell as shown on Plan.
Notches to be well Rounded in Corners & not Rough Punched
L 3½"x3½"x111#
6"x3½"x153#
5 Rivs. to ℄
I 28"x10"x105#
Cut Flg to Shell to 6½"
Joggle
Gusset Pl 16"x30"x44"
Trim 13.5"x25"x.88#
Sing L 5"x3½"x15.2#
48" Pl
Long 44" Pl
Bilge Keel 6½"x6½"x19.8#
10"x3½"x50" BA Cut Flg Off
T 6½"x6½"x19.8#
Vert Keel 52" Continuous - Treble Overlap Butts
℄ WLSN 16 6"x6"x24.2# to 219#
Keel Pl 49"x.104" to 72"
Dbl Butt-Stps. Treble Riv.
Bott. Longl's № 11 to 23 incl. are 13"x4⅛"x37#
Bott Pltg .64" to 48" not further Reduced.
Midship Thickness Maintained to Coll Bhd. on Flat of Bott.
Butts-Quadruple overlapped for ½L to Treble at Ends
Seams-Dbl. Riveted
Rivtg of Bottom Longl's to Shell { 11 Rivs. spaced 3⅜" each Side of Bhds. Interm. Rivs. Spaced 6½" / 13 " " " " " " Transvs. " " " "
Rivtg of Longl Stiffs to C.L. Bhd. 9 Rivs Spa ⅜" each side of Bhds. Interm. Rivs. Spa 6½" " " " " " " " " " " " Transvs. " " " "
Riveting Note:-
Dk Pltg to Longl's Rivets spaced 6 Dias. or as an Equivalent - Same № of Rivets Spaced ⅜" each side of Bhd & Transvs. respectively to 6½" Spa for Interm Rivets
Above Note Applies to Bhd. Stiffs Where indicated on Plan thus ※
This Spacing arranged to suit Multiple Punch.
Length B.P. 430'-0"
Breadth 59'-0"
Depth M'ld. 33'-3"
Trans. No. 92.25
Longl No 39694
& Upper Dk 12.94
-29'-6" H.B.
"B"
"A"
"C"
"K"
"H"
"G"
"F"
"E"
"D"



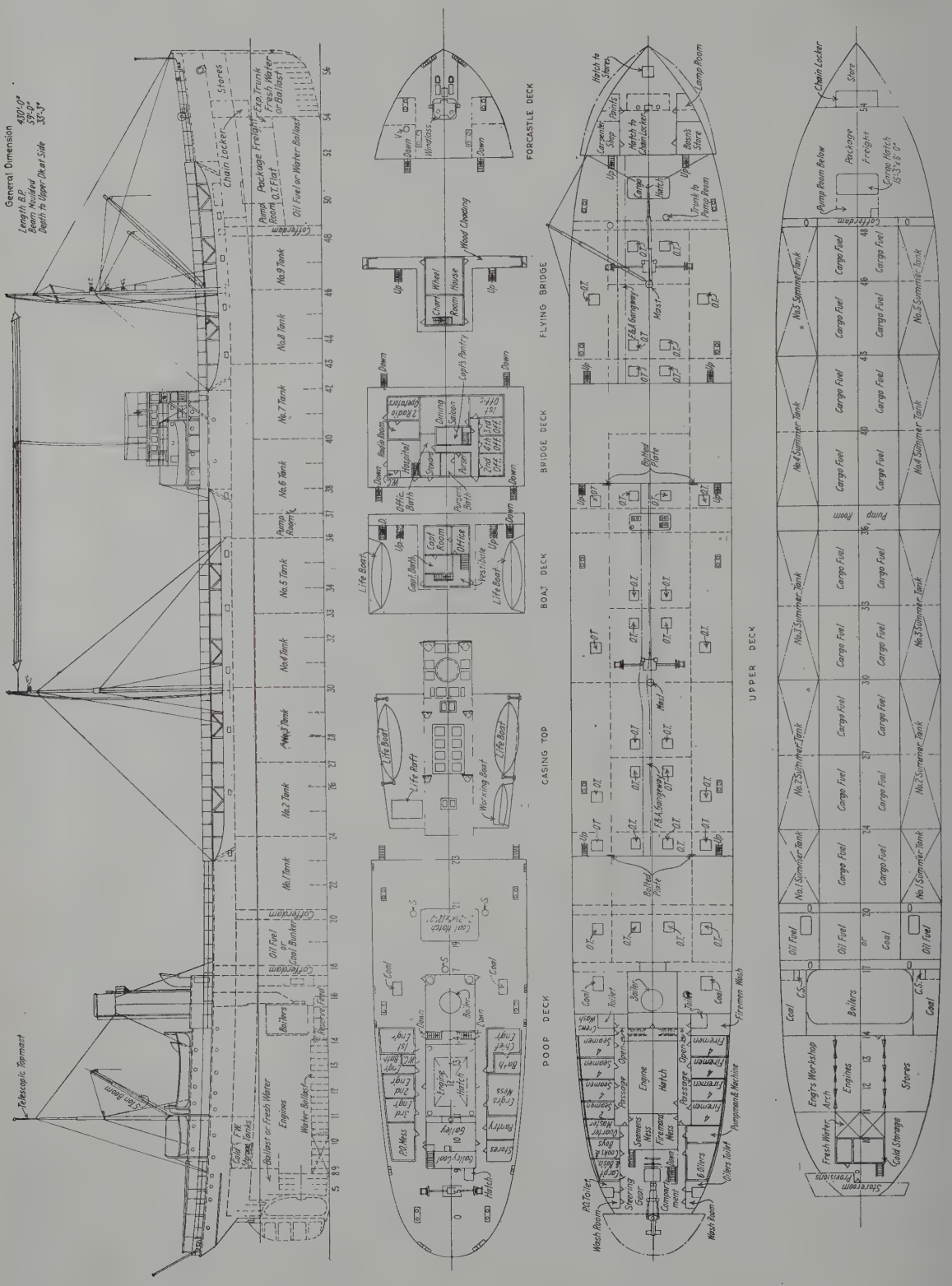
DETAIL OF NOTCH FOR CHANNELS.

EQUIPMENT № 41339

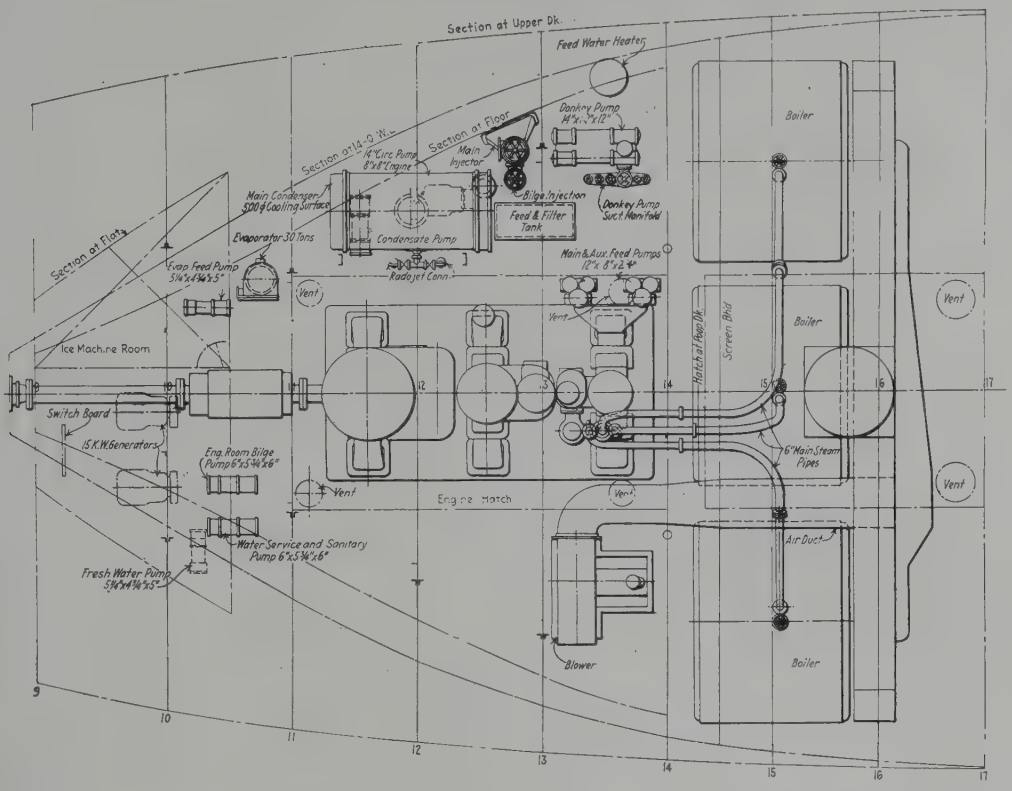
2-Bower Anchors Stockless		8100 Lbs
1- " "	"	7000 "
1- Stream "	"	2870 "
1- Kedge "	"	1260 "
300 Fathoms 2⅜" Stud Chain Cable		
120 " 5" Circ. Steel Wire Hawser		
130 " 5½" " " " Towline		
400 " 8" " Manila Hawser & Warps		

Rudder Stock 11½" Dia
" Plate 1.12"
" Post 9"x8⅛"
Propeller Post 10½"x8½"
Stem 10⅛"x2⅞"
Total Rudder Area Abaft ℄ of Pintles 179 Sq ft C.G. = 4'-0" A x D = 716.
Speed of Vessel in Knots 10.5

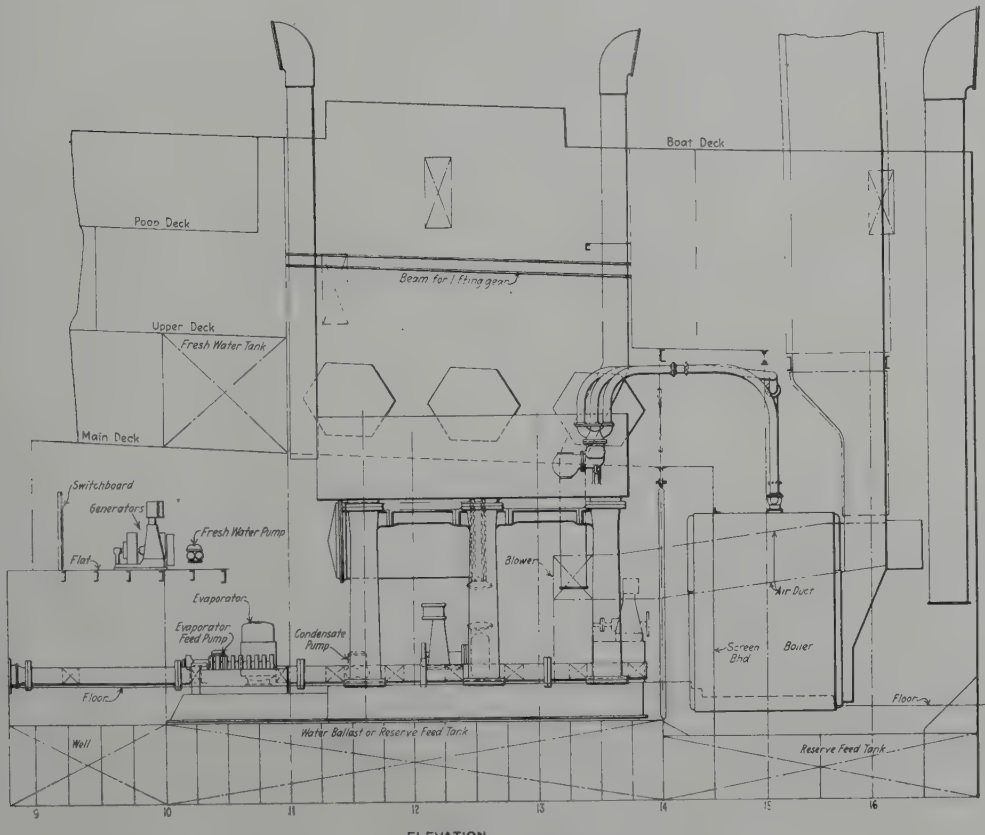
10,000-TON D. W. STANDARD TANKER
Sun Shipbuilding Co., Chester, Pa.



GENERAL ARRANGEMENT PLANS OF A 10,000-TON D. W. STANDARD TANKER

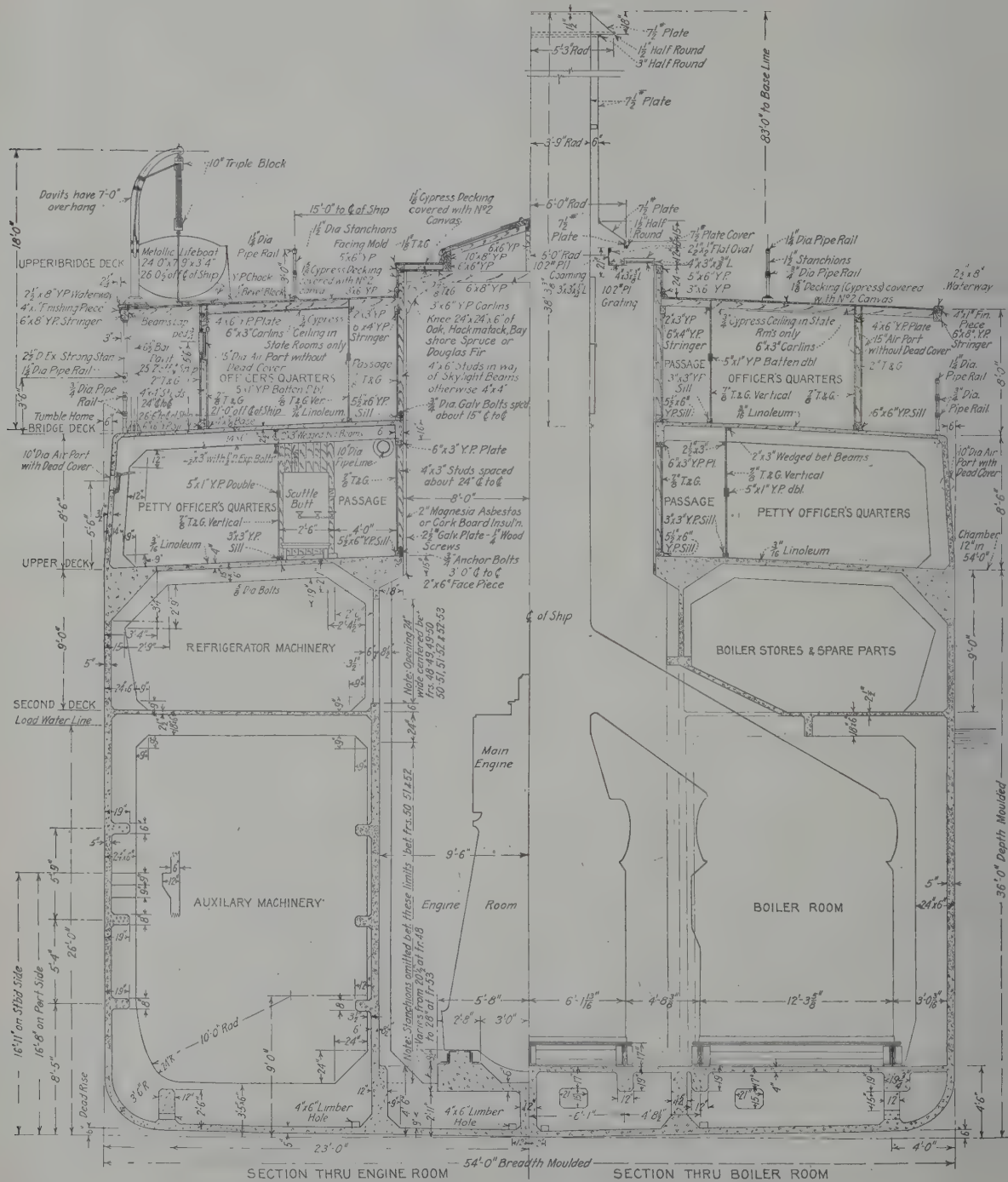


PLAN

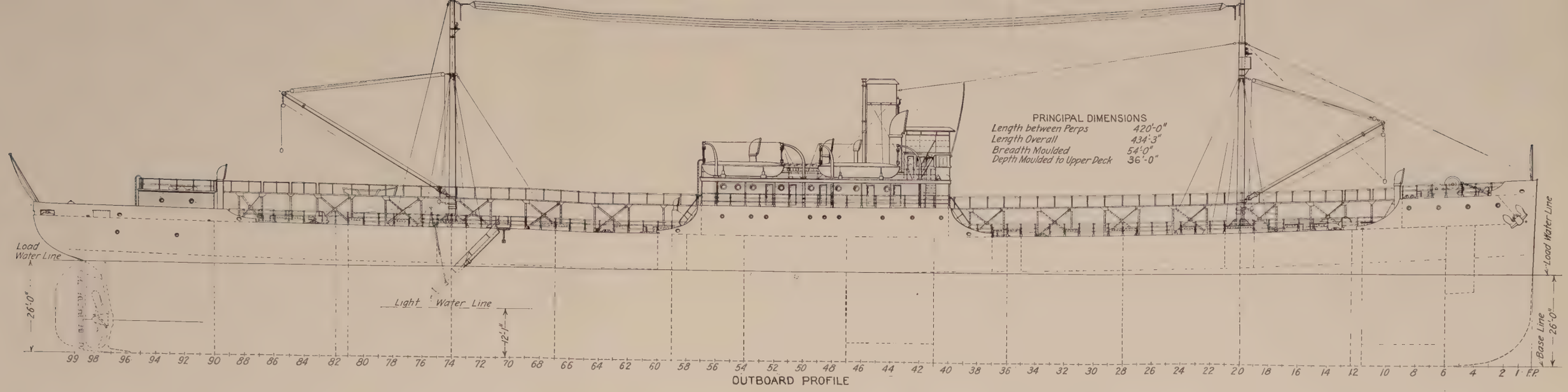


ELEVATION
looking Outboard

10,000-TON D. W. STANDARD TANKER
Sun Shipbuilding Co., Chester, Pa.



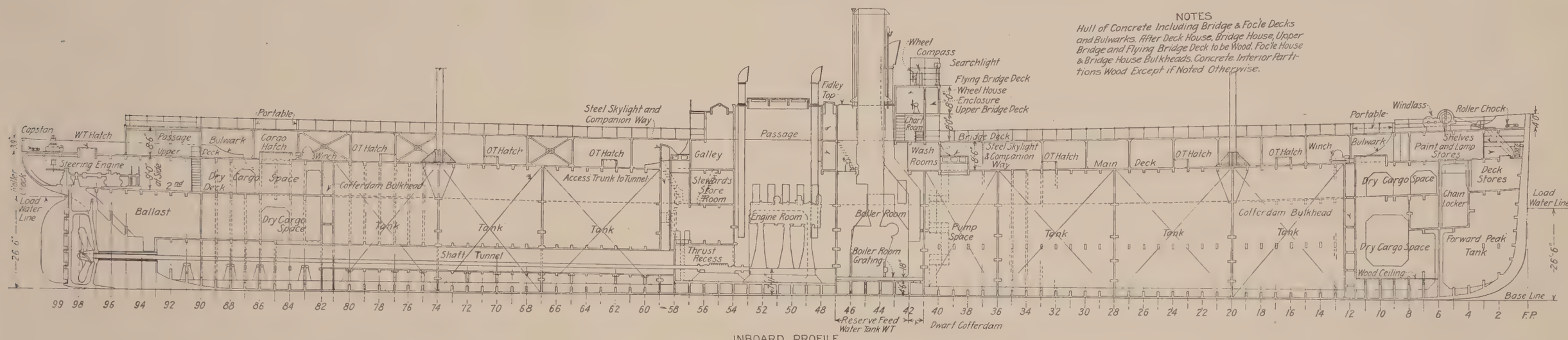
7,500-TON D. W. CONCRETE TANKER


PRINCIPAL DIMENSIONS
Length between Perps 420'-0"
Length Overall 434'-3"
Breadth Moulded 54'-0"
Depth Moulded to Upper Deck 36'-0"
Load Water Line
Light Water Line
Base Line
26'-0"
12'-1"
99 98 96 94 92 90 88 86 84 82 80 78 76 74 72 70 68 66 64 62 60 58 56 54 52 50 48 46 44 42 40 38 36 34 32 30 28 26 24 22 20 18 16 14 12 10 8 6 4 2 1 F.P.

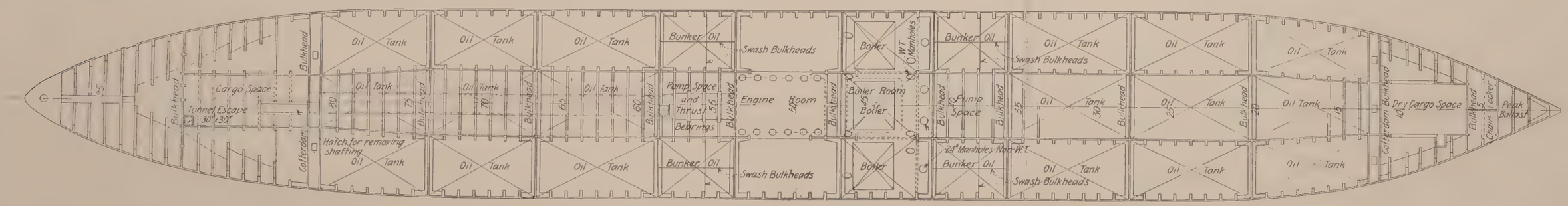
OUTBOARD PROFILE

NOTES

Hull of Concrete Including Bridge & Fo'c'le Decks and Bulwarks. After Deck House, Bridge House, Upper Bridge and Flying Bridge Deck to be Wood. Fo'c'le House & Bridge House Bulkheads. Concrete. Interior Partitions Wood Except if Noted Otherwise.



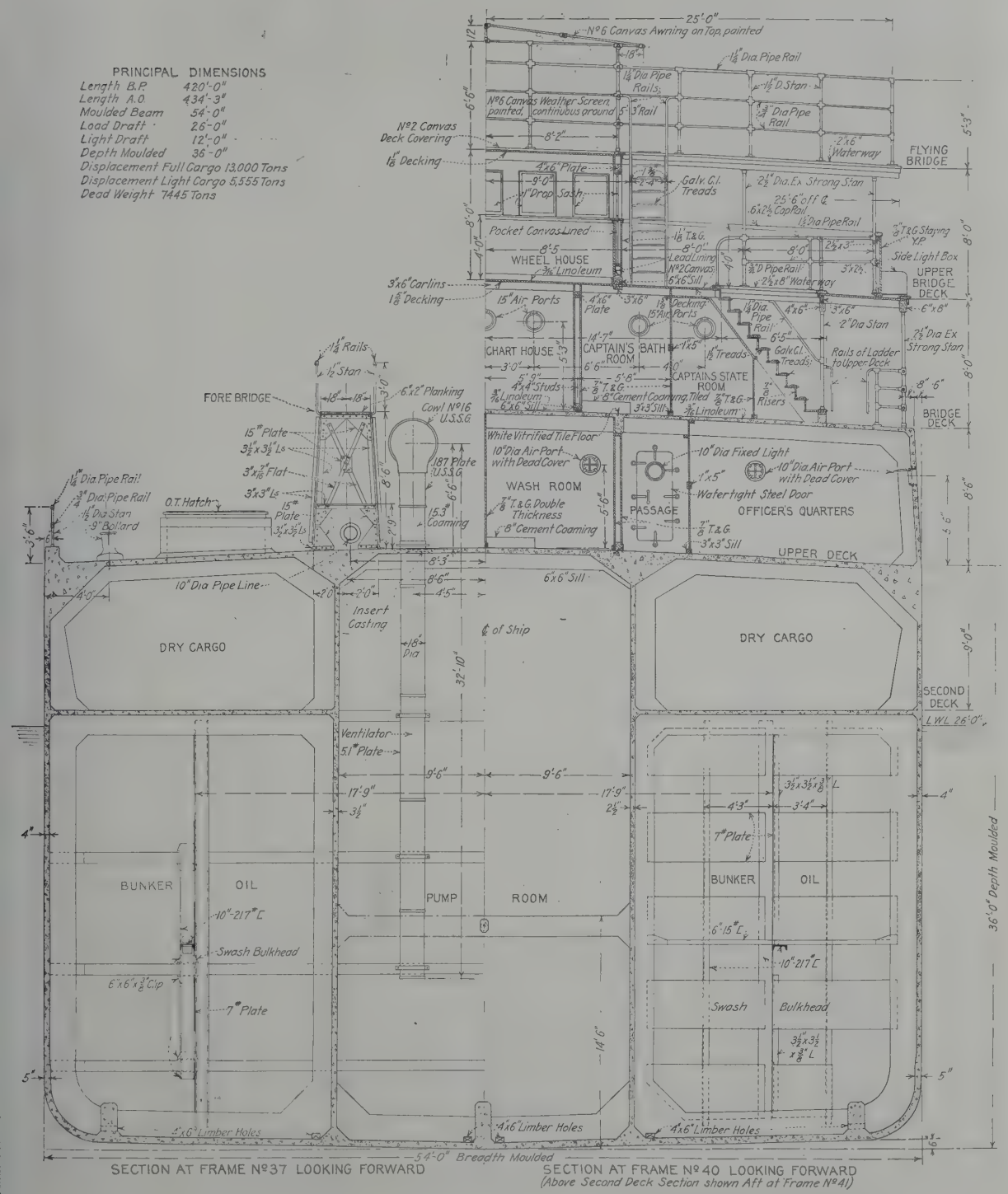
INBOARD PROFILE



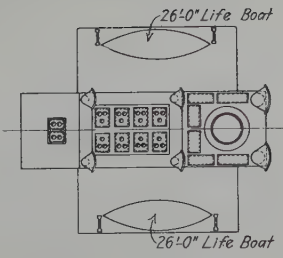
HOLD

OUTBOARD PROFILE, INBOARD PROFILE AND HOLD PLAN
7,500-TON D. W. CONCRETE TANKER

PLATE XIX



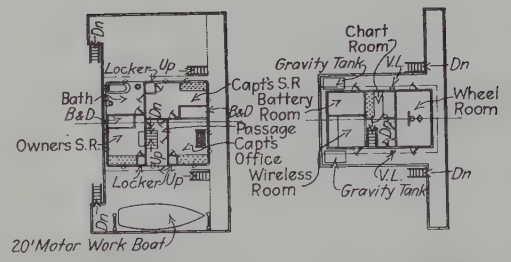
7,500-TON D. W. CONCRETE TANKER



BOAT DECK

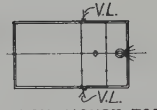
Principal Dimensions

Length, B.P.	355'-0"
Beam, Molded	52'-6"
Depth, Molded	28'-0"

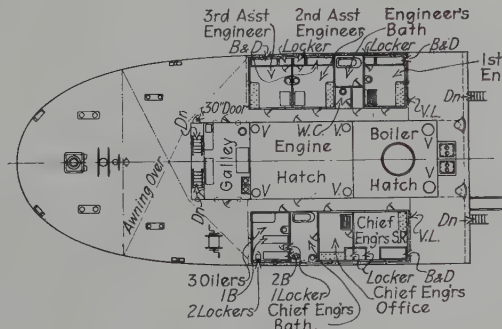


UPPER BRIDGE

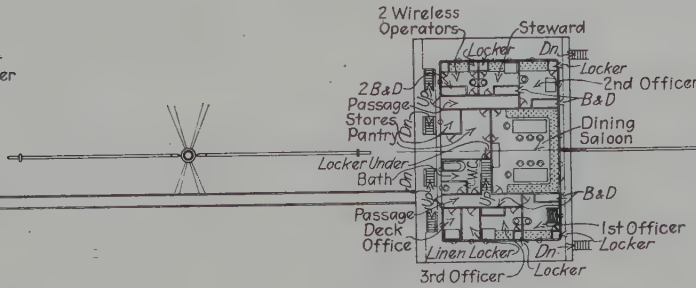
FLYING BRIDGE



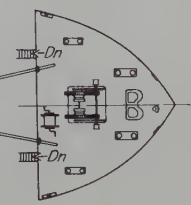
PILOT HOUSE TOP



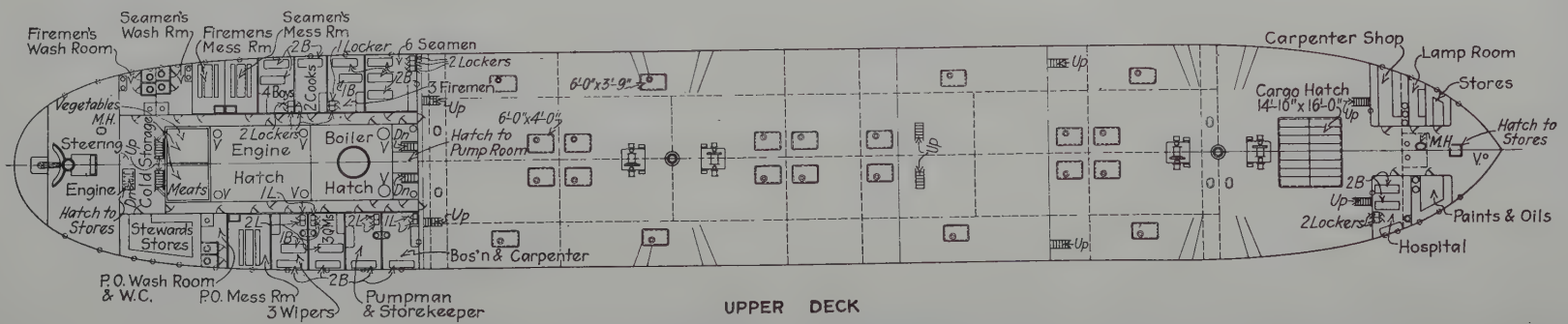
POOP DECK



BRIDGE DECK



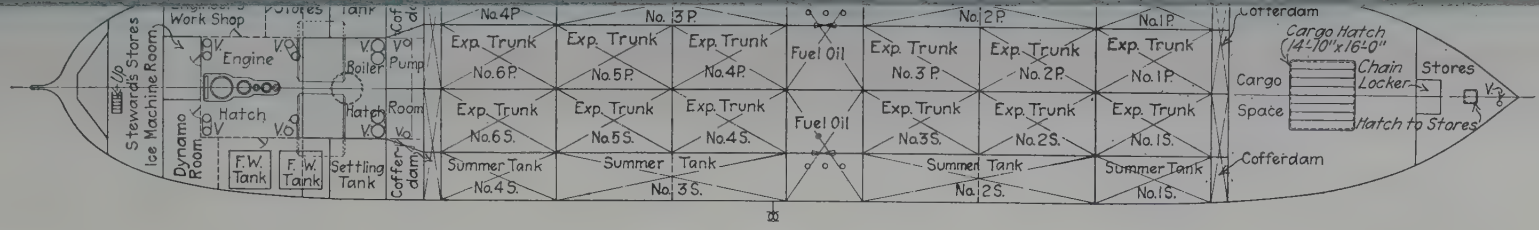
FORECASTLE DECK



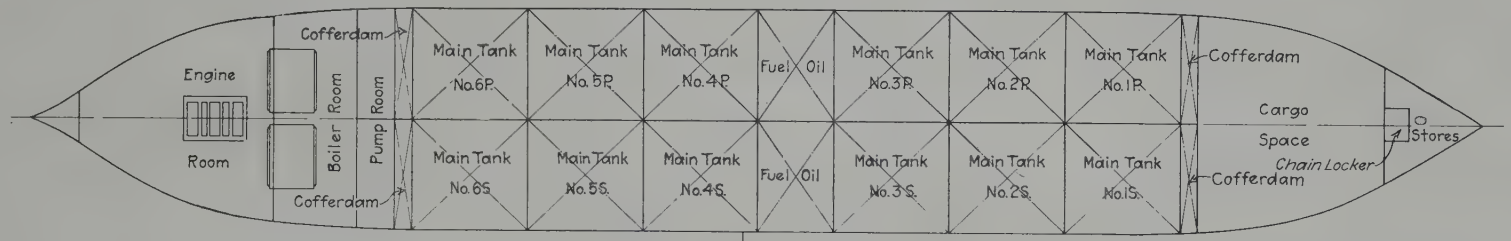
UPPER DECK

6,300-TON D. W. TANKER
Designed by Frank S. Martin, New York City
Builders, Federal Shipbuilding Co., Kearney, N. J.

See Opposite Page.



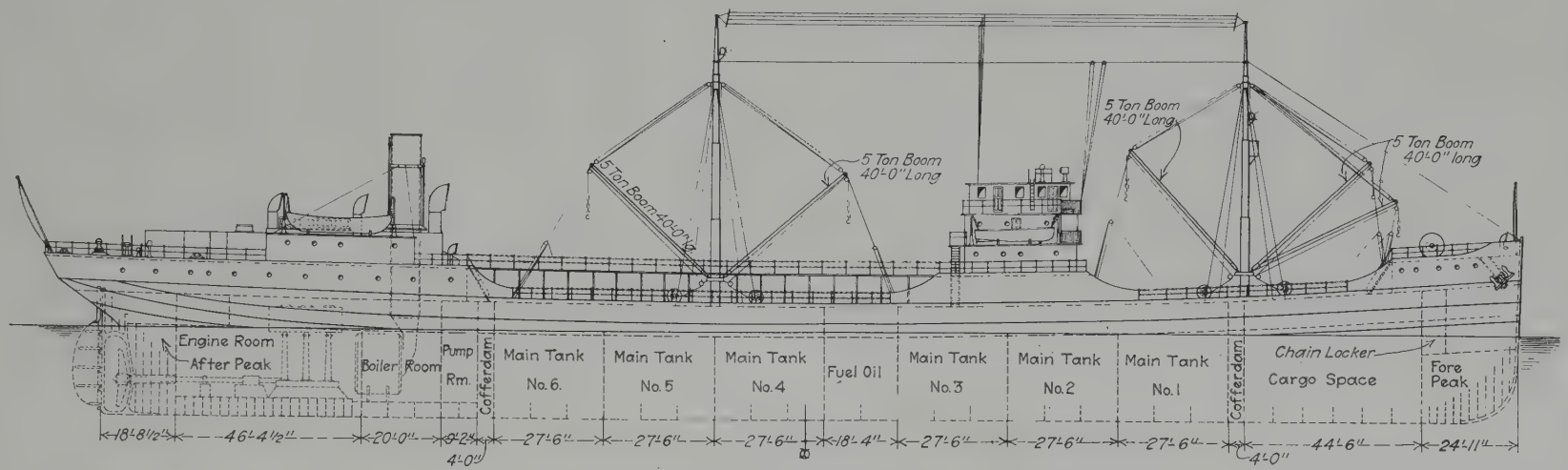
MAIN DECK



HOLD

Principal Dimensions.

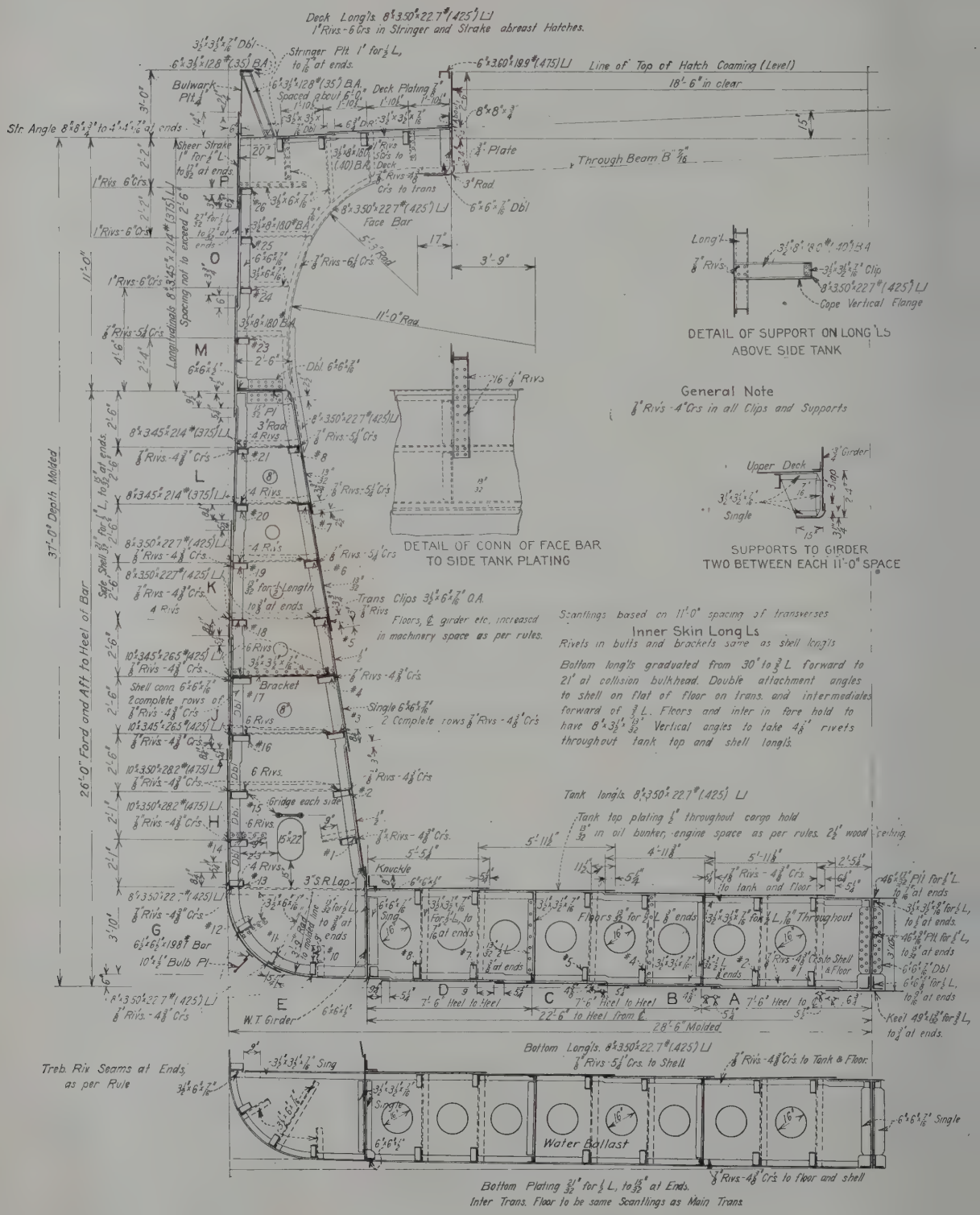
Length B.P.	355'-0"
Beam Molded	52'-6"
Depth "	28'-0"

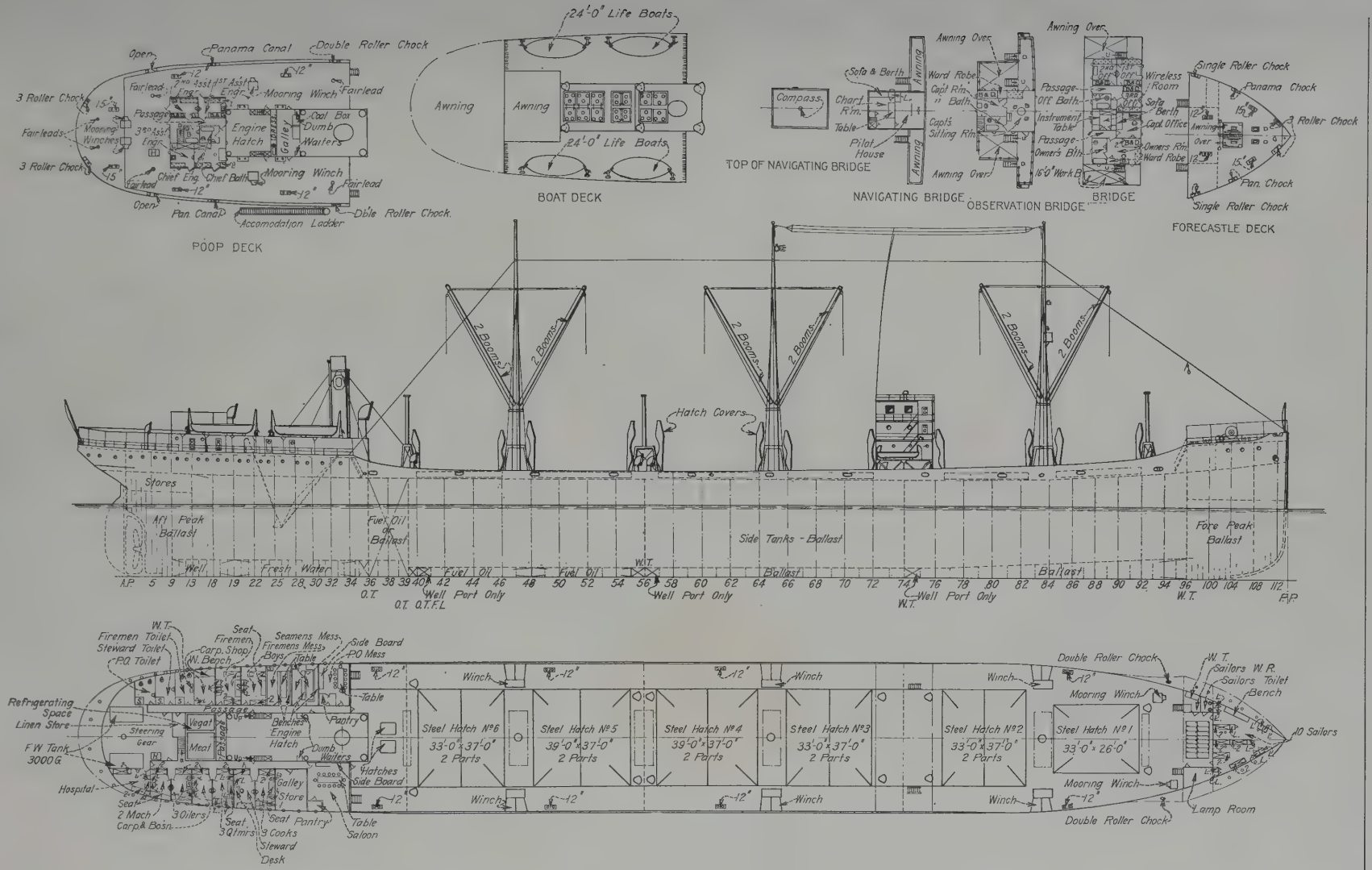


PROFILE

6,300-TON D. W. TANKER
Designed by Frank S. Martin, New York City
Builders, Federal Shipbuilding Co., Kearney, N. J.

See Opposite Page.


Deck Long'ls 8"x3.50"x22.7#(425) LJ
1"Rivs-6 Crs in Stringer and Strake abreast Hatches.
Stringer Plt 1" for ½ L, to 7/16" at ends.
Bulwark Plt ¼
Str. Angle 8"x8"x¾" to 4"x4"x7/16" at ends
Sheer Strake 1" for ¼ L, to 9/32" at ends
Line of Top of Hatch Coaming (Level)
18'-6" in clear
Deck Plating ⅞"
Through Beam B
Face Bar
Rad
Dbl
Long'l
Clip
Cope Vertical Flange
DETAIL OF SUPPORT ON LONG'LS ABOVE SIDE TANK
General Note
⅞" Rivs-4" Crs in all Clips and Supports
DETAIL OF CONN OF FACE BAR TO SIDE TANK PLATING
Upper Deck
Girder
Single
SUPPORTS TO GIRDER TWO BETWEEN EACH 11'-0" SPACE
Scantlings based on 11'-0" spacing of transverses
Inner Skin Long'ls
Rivets in butts and brackets same as shell long'ls
Bottom long'ls graduated from 30° to ⅔ L forward to 21' at collision bulkhead. Double attachment angles to shell on flat of floor on trans. and intermediates forward of ⅔ L. Floors and inter in fore hold to have 8"x3½"x 29/32" Vertical angles to take 4⅞" rivets throughout tank top and shell long'ls.
Tank long'ls. 8"x3.50"x22.7#(425) LJ
Tank top plating ½" throughout cargo hold 13/32" in oil bunker, engine space as per rules. 2½" wood ceiling.
Floors ⅝" for ⅜ L, ⅞" ends
Throughout
Keel 49"x15/32" for ¾ L, to ⅜" at ends.
Bottom Long'ls. 8"x3.50"x22.7#(425) LJ
⅞" Rivs-5¼" Crs. to Shell
⅞" Rivs-4⅞" Crs. to Tank & Floor.
Water Ballast
⅞" Rivs-4⅞" Crs to floor and shell
Bottom Plating 31/32" for ½ L, to 15/32" at Ends.
Inter Trans. Floor to be same Scantlings as Main Trans.
Treb. Riv Seams at Ends as per Rule
Sing
Single
Dbl
Knuckle
W.T Girder
Bracket
Trans Clips 3½"x6"x⅞" O.A.
Floors, ℄ girder etc. increased in machinery space as per rules.
Shell conn 6"x6"x⅞" 2 complete rows of ⅞" Rivs-4⅞" Crs
2 Complete rows ⅞" Rivs-4⅞" Crs
Gridge each side
3" S.R Lap
Shell Plating
Longitudinals 8"x3.45"x21.4#(375) LJ
Spacing not to exceed 2'-6"
Side Shell ⅝" for ½ L, to 9/16" at ends.
Deck Plating ⅞" Spaced about 6'-0"
Rivs-4⅞" Crs to Deck
Rivs-4⅞" Crs to Trans
Rivs-4⅞" Crs to Shell & Floor
Rivs-4⅞" Crs to tank and floor
Rivs-4⅞" Crs to Shell & Floor
Floors ⅝" for ⅜ L, ⅞" ends
Through Beam B
Face Bar
Rad
Dbl
Long'l
Clip
Cope Vertical Flange
Upper Deck
Girder
Single
Keel
Bulwark Plt
Sheer Strake
Deck Plating
Stringer Plt
Shell Plating
Bracket
Knuckle
W.T Girder
Sing
Single
Dbl
Rivs
Crs
Plt
Rad
Trans
Long'l
Clip
Cope
Keel
Bottom Long'ls
Water Ballast
Inter Trans. Floor
Main Trans
Rivs-4⅞" Crs to Shell
Rivs-4⅞" Crs to Tank & Floor
Rivs-4⅞" Crs to floor and shell
Bottom Plating
Treb. Riv Seams at Ends as per Rule
Tank long'ls
Tank top plating
Bunker
Engine space
Wood ceiling
Bottom Long'ls
Shell
Floor
Tank
Inner Skin Long'ls
Scantlings
Rivets
Vertical angles
Rivets
Throughout
Ends
Trans
Floors
Girder
Single
Upper Deck
Supports
Two
Space
Clips
Rivs
Crs
Plt
Rad
Dbl
Long'l
Clip
Cope
Keel
Bulwark
Sheer Strake
Deck Plating
Stringer

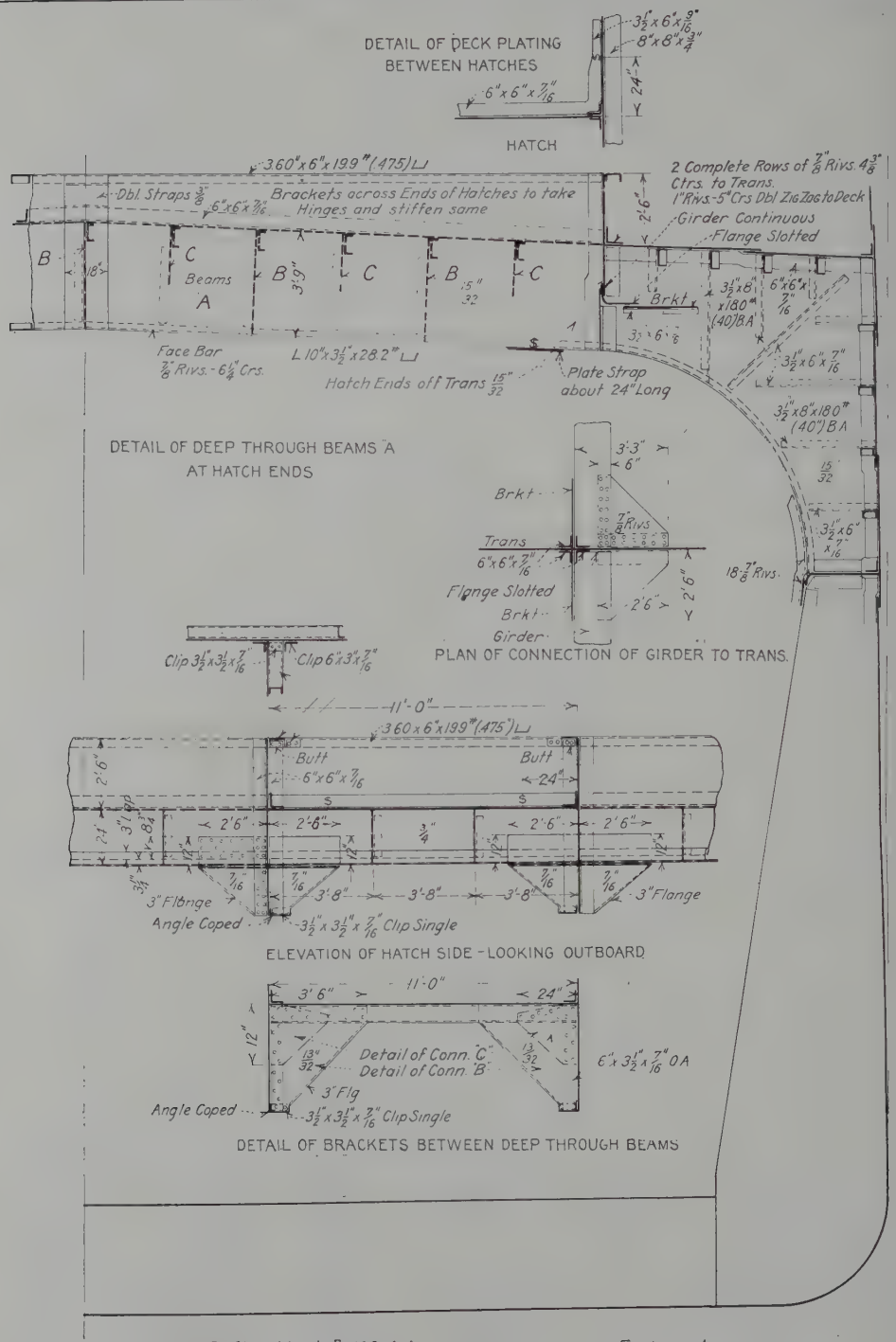


L. O. A.—468′—0¼″; L. B. P.—450′—0″; Beam Mld—57′—0″; Depth Mld—37′—0″.

11,500-TON D. W. ORE CARRIER

Builders, Bethlehem Shipbuilding Corp.

MIDSHIP SECTION

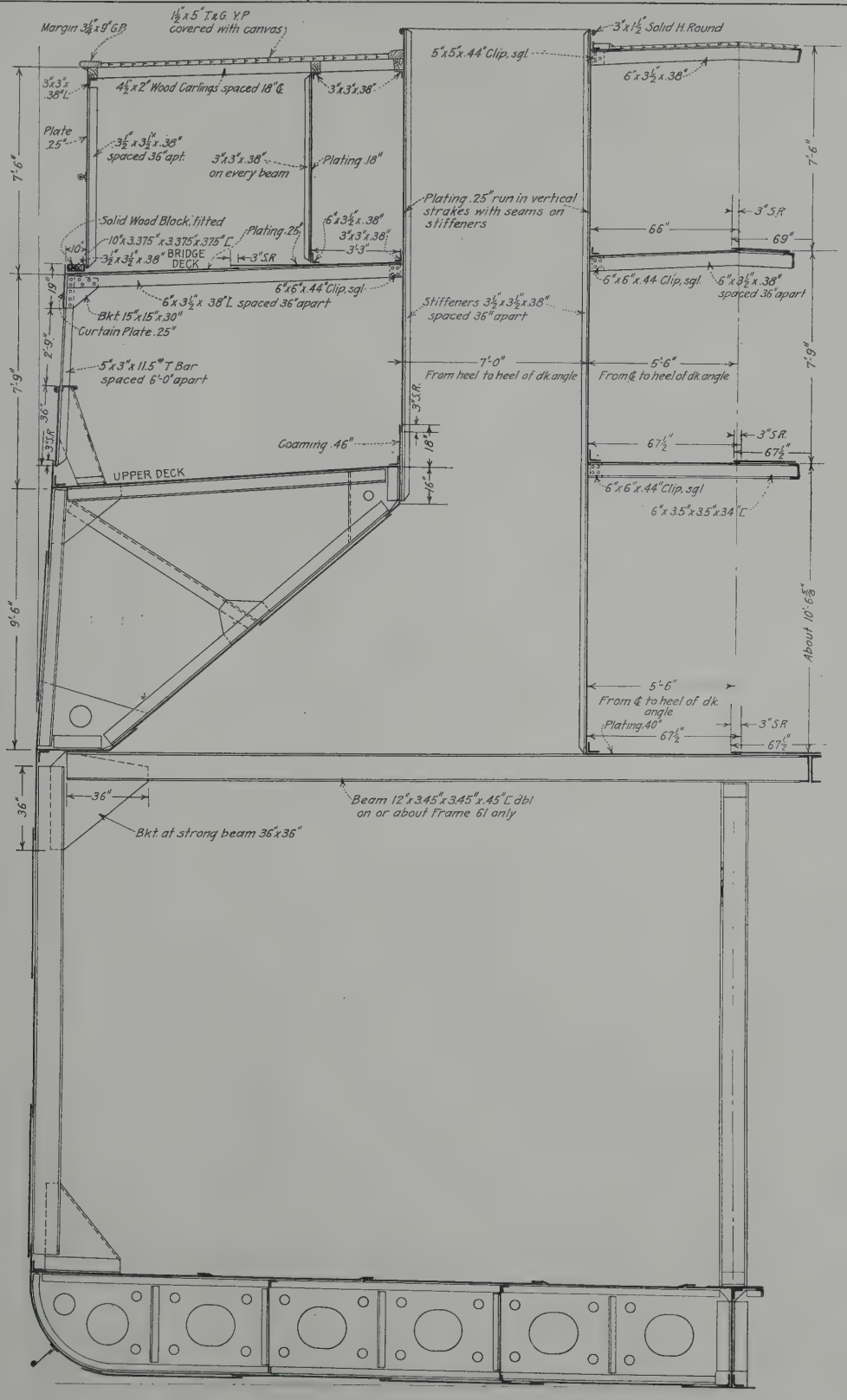

DETAIL OF DECK PLATING BETWEEN HATCHES
HATCH
DETAIL OF DEEP THROUGH BEAMS "A" AT HATCH ENDS
PLAN OF CONNECTION OF GIRDER TO TRANS.
ELEVATION OF HATCH SIDE - LOOKING OUTBOARD
DETAIL OF BRACKETS BETWEEN DEEP THROUGH BEAMS

To Class Lloyds ✠ 100-A-1	
Longitudinal System	
Lloyds Numerals	
Trans No.	9400
Long'l No.	42300
L/D	1216
Equipment No.	43270

Principal Dimensions	
Length Over All	468'-0¼"
Length bet Perp's	450'-0"
Beam Moulded	57'-0"
Depth Moulded.	37'-0"

Equipment	
Bower Anchor Stockless	2 at 9415 #
" " "	1 at 7980
Stream Anchor Ex. Stock	1 at 2716
Kedge Anchor " "	1 at 1148
300 Fathoms of 2 7/16 Stud Link Cable	
90 " " 5" Cir. Steel Wire - Stream	
130 " " 5¾" " " " - Tow Line	
2-90 " " 8" - Manila Hawser	
2-90 " " 8" - " Warps	

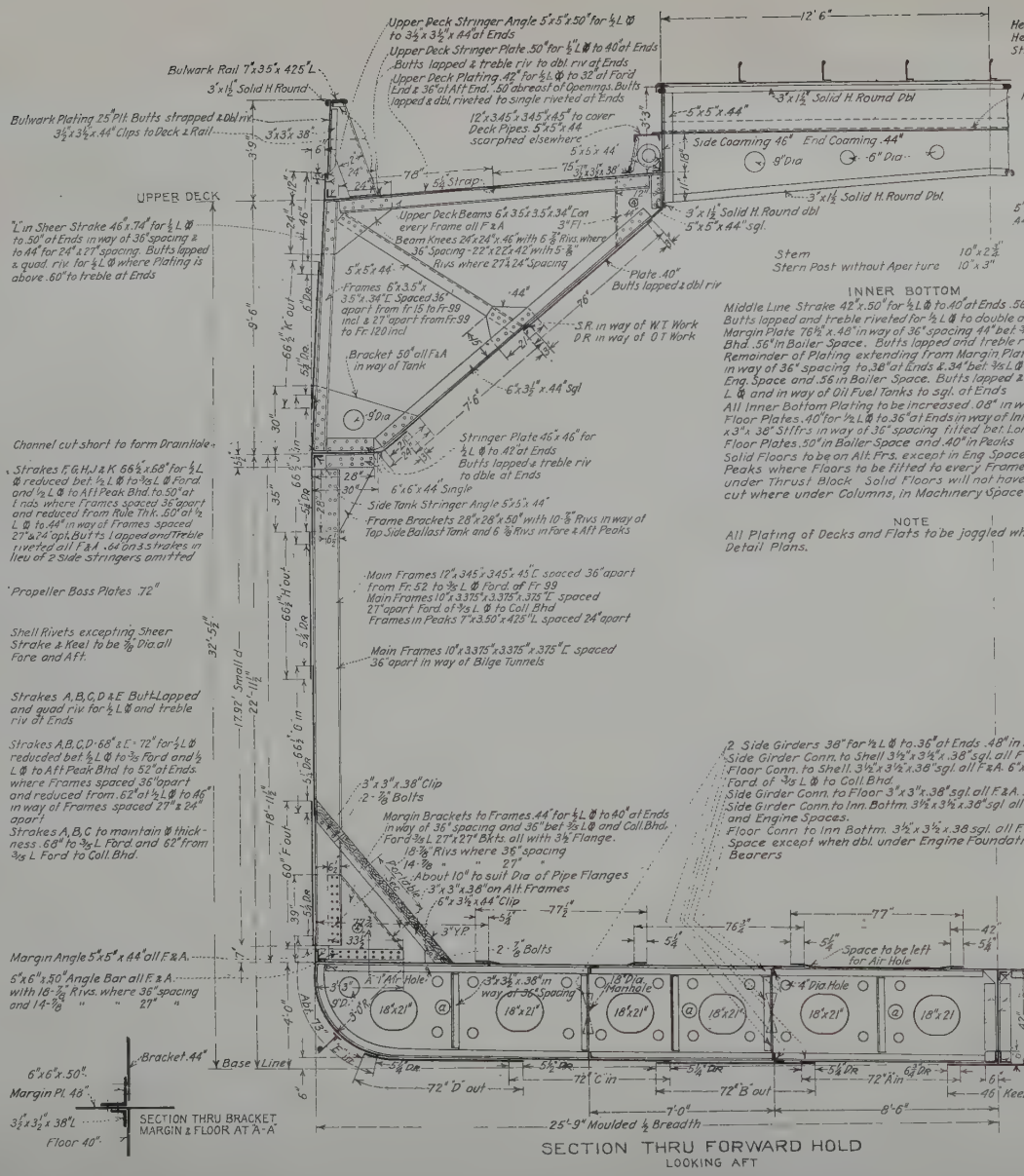
11,500-TON D. W. ORE CARRIER
Builders, Bethlehem Shipbuilding Corp.



SECTION THRU ENGINE ROOM
LOOKING AFT

7,300-TON D. W. BULK FREIGHTER FOR COAL OR SULPHUR

Designed by George Simpson, New York City
Builders, Newburgh Shipyards, Inc., Newburgh, N. Y.


Upper Deck Stringer Angle 5"x5"x.50" for ½ L @ to 3½"x3½"x.44" at Ends
Upper Deck Stringer Plate .50" for ½ L @ to 40" at Ends
Butts lapped & treble riv to dbl riv at Ends
Upper Deck Plating .42" for ½ L @ to 32" at Ford. End & 36" at Aft End. .50" abreast of Openings. Butts lapped & dbl. riveted to single riveted at Ends
Bulwark Rail 7"x35"x.425" L
3"x½" Solid H Round
Bulwark Plating .25" Plt. Butts strapped & dbl rivd
3½"x3½"x.44" Clips to Deck & Rail
3"x3"x.38"
UPPER DECK
"L" in Sheer Strake 46"x.74" for ½ L @ to .50" at Ends in way of 36" spacing & to 44" for 24" & 27" spacing. Butts lapped & quad. riv. for ½ L @ where Plating is above .60" to treble at Ends
12"x3.45"x3.45"x.45" to cover Deck Pipes. 5"x5"x.44 scarphed elsewhere
5"x5"x.44
5"x5"x.44
Side Coaming 46" End Coaming .44"
9" Dia
6" Dia
3"x1½" Solid H. Round Dbl.
3"x1½" Solid H. Round dbl
5"x5"x.44" Sgl.
Upper Deck Beams 6"x3.5"x3.5"x.34" Con every Frame all F & A
3" FI
Beam Knees 24"x24"x.46" with 6-⅞" Rivs. where 36" Spacing - 22"x22"x.42" with 5-⅞" Rivs where 27" & 24" Spacing
Frames 6"x3.5"x3.5"x.34" L Spaced 36" apart from Fr. 15 to Fr. 99 incl & 27" apart from Fr. 99 to Fr. 120 incl
Bracket .50" all F & A in way of Tank
6"x3½"x.44" Sgl
Plate .40" Butts lapped & dbl riv
S.R. in way of W.T. Work
D.R. in way of O.T. Work
Stringer Plate 46"x.46" for ½ L @ to 42" at Ends Butts lapped & treble riv to dble at Ends
6"x6"x.44" Single
Side Tank Stringer Angle 5"x5"x.44"
Frame Brackets 28"x28"x.50" with 10-⅞" Rivs in way of Top Side Ballast Tank and 6-⅞" Rivs in Fore & Aft Peaks
Channel cut short to form Drain Hole
Strakes F, G, H, J & K 66½"x.68" for ½ L @ reduced bet. ½ L @ to ⅜ L @ Ford. and ½ L @ to Aft Peak Bhd. to .50" at 1 nds. where Frames spaced 36" apart and reduced from Rule Thk. .60" at ½ L @ to .44" in way of Frames spaced 27" & 24" opk. Butts lapped and Treble riveted all F & A. .64" on 3.5 strakes in lieu of 2 Side Stringers omitted
Propeller Boss Plates .72"
Shell Rivets excepting Sheer Strake & Keel to be ⅞" Dia all Fore and Aft.
Strakes A, B, C, D & E But. Lapped and quad riv. for ½ L @ and treble riv at Ends
Strakes A, B, C, D: .68" & E = .72" for ½ L @ reduced bet ½ L @ to ⅜ Ford and ½ L @ to Aft Peak Bhd to .52" at Ends. where Frames spaced 36" apart and reduced from .62" at ½ L @ to .46" in way of Frames spaced 27" & 24" apart
Strakes A, B, C to maintain @ thickness .68" to ⅜ L Ford. and .62" from ⅜ L Ford to Coll. Bhd.
Main Frames 12"x.345"x.345"x.45" L spaced 36" apart from Fr. 52 to ⅜ L @ Ford. of Fr. 99
Main Frames 10"x.3375"x.3375"x.375" L spaced 27" apart Ford. of ⅜ L @ to Coll. Bhd
Frames in Peaks 7"x3.50"x.425" L spaced 24" apart
Main Frames 10"x.3375"x.3375"x.375" L spaced 36" apart in way of Bilge Tunnels
3"x3"x.38" Clip
2-⅞" Bolts
Margin Brackets to Frames .44" for ½ L @ to 40" at Ends in way of 36" spacing and 36" bet ⅜ L @ and Coll. Bhd. Ford ⅜ L 27"x27" Bk'ts. all with 3½" Flange.
18-⅞" Rivs where 36" spacing
14-⅞" " " 27" "
About 10" to suit Dia of Pipe Flanges
3"x3"x.38" on Alt Frames
6"x3½"x.44" Clip
3" Y.P.
2-⅞" Bolts
Margin Angle 5"x5"x.44" all F & A.
5"x6"x.50" Angle Bar all F & A with 16-⅞" Rivs. where 36" spacing and 14-⅞" " " 27" "
3"x3½"x.38" in way at 36" Spacing
18" Dia Manhole
4" Dia Hole
A-1 Air Hole
18"x21"
6"x6"x.50"
Margin Pl. .48"
3½"x3½"x.38" L
Floor .40"
Bracket .44"
Base Line
SECTION THRU BRACKET MARGIN & FLOOR AT A-A
72" 'D' out
72" 'C' in
72" 'B' out
72" 'A' in
7'-0"
8'-6"
25'-9" Moulded ½ Breadth
2 Side Girders 38" for ½ L @ to .36" at Ends .48" in Boiler Space
Side Girder Conn. to Shell 3½"x3½"x.38" sgl. all F & A.
Floor Conn. to Shell. 3½"x3½"x.38" sgl. all F & A. 6"x6"x.44" sgl
Ford. of ⅜ L @ to Coll. Bhd.
Side Girder Conn. to Floor 3"x3"x.38" sgl. all F & A. .50" in Boiler Space
Side Girder Conn. to Inn. Bottm. 3½"x3½"x.36" sgl all F & A. .50" in Boiler and Engine Spaces.
Floor Conn to Inn Bottm. 3½"x3½"x.38 sgl. all F & A. .50" in Boiler Space except when dbl. under Engine Foundations and Boiler Bearers
5"x5"x.56" all F & A and .62" in Boiler Space (Twin Screw Turbines)
6"x6"x.50" with 14-⅞" Rivs. for ½ L @ to 3½"x3½"x.36" sgl. at Ends.
Cent. Girder 42"x.50" for ½ L @ to .40" at Ends .60" in Boiler Space O.T. Butts lapped and treble riv. all F & A.
5"x5"x.56" for ½ L @ to .50" at Ends
Flat Keel 46"x.96" for ⅜ L @ to .68" at Ends, quadr riv. Butt Laps where Plg. is above .76" to treble at Ends.
Keel
Stem
Stern Post without Aperture
10"x2¾"
10"x.3"
INNER BOTTOM
Middle Line Strake 42"x.50" for ½ L @ to .40" at Ends .56" in Boiler Space
Butts lapped and treble riveted for ½ L @ to double at Ends
Margin Plate 76½"x.48" in way of .36" spacing 44" bet. ⅜ @ Ford to Coll Bhd .56" in Boiler Space. Butts lapped and treble riveted all F & A.
Remainder of Plating extending from Margin Plate to ℄ Stroke .46" in way of 36" spacing to .38" at Ends & .34" bet. ⅜ L @ & Coll Bhd. .52" in Eng. Space and .56" in Boiler Space. Butts lapped & dbl riveted for ½ L @ and in way of Oil Fuel Tanks to sgl. at Ends
All Inner Bottom Plating to be increased .08" in way of Cargo Hatches
Floor Plates .40" for ½ L @ to .36" at Ends in way of Inner bottom with 3½" x 3½" x .38" Stiffrs in way of .36" spacing, fitted bet. Long Members
Floor Plates .50" in Boiler Space and .40" in Peaks
Solid Floors to be on Alt. Frs. except in Eng Space, Ford of ⅜ L @ and Peaks where Floors to be fitted to every Frame. Partial Floors under Thrust Block. Solid Floors will not have Lightening Holes cut where under Columns, in Machinery Space or elsewhere
NOTE
All Plating of Decks and Flats to be joggled where shown on Detail Plans.
PITCH & CAMBER OF UPPER DECK
Height of Deck Camber 12'-6 from ℄ at Ship = 11" above Deck at Side @
Height of Deck at ℄ Ford. & Aft of Hatch Platforms 13" above Deck at Side @
Straight Pitch throughout
Beam Bkt. .46" with 8-⅞" Rivets in each Leg where 36" spacing and 5-⅞" Rivs. where 27" spacing
Flat between hatches level
10"x3.375"x3.375"x.375" L all Fore & Aft in way of raised U Dk except in Bhds. Coam. and Web Beams.
3½"x3½"x.38" L
3"x1½" Solid H Round
5"x5"x.44" Sgl
SECTION THRU RAISED DECK BETWEEN HATCHES

SECTION THRU FORWARD HOLD
LOOKING AFT

PRINCIPAL DIMENSIONS

Length B.P. L.W.L.	355'-0"
Length Lloyds B.P.	356'-0"
Beam Molded	51'-6"
Depth Molded	32'-5½"
Draft L.W.L. Molded Designed	24'-6"

LLOYDS REGISTER

Class @ 100-A-1

Transverse Number = (B×D) + (51.50 + 32.45) = 83.958

Longitudinal Number = L + (B×D) + (3560 + 839) = 29.889

Small a @ = 32.45 - (4.00 + 3.95 + 1.04) × (32.458 - 14.54) = 17.92 (Allowance for Deep Brackets)

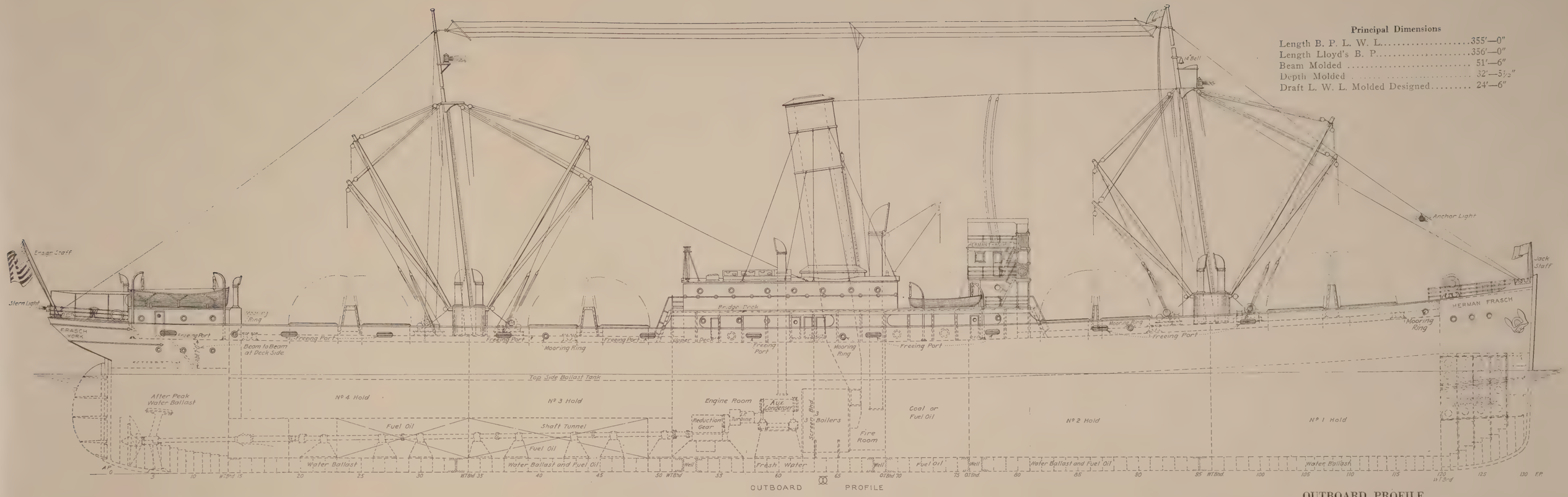
Length to Depth at Upper Dk = 356 ÷ 32.45 = 10.97

Equipment Number = 30.609	
Longitudinal Number	29.889
Addition for Deck House Aft	97
Addition for Deck House @ U.E. Dk	318
Addition for Deck House @ above U.E. Dk	202
Addition for Deck House under Bridge	46
Addition for Deck House above Bridge	46
Equipment Number	30.598

EQUIPMENT

2	Bower Anchors Stockless	each	6285#
1	Bower Anchor	"	5350#
1	Stream Anchor	"	2100#
1	Kedge Anchor	"	909#
270 Fathoms Stud Link Cable =			2¾"
90 Fathoms Stream Steel Wire =			4¼" Cir (for 3¾" spec. Flexible)
120 Fathoms Towline Steel Wire =			4¼" Cir (for 3¾" spec. Flexible)
2-90 Hawser =			7" Cir.
2-90 Hawser =			7" Cir.

7,300-TON D. W. BULK FREIGHTER FOR COAL OR SULPHUR
Designed by George Simpson, New York City
Builders, Newburgh Shipyards, Inc., Newburgh, N. Y.



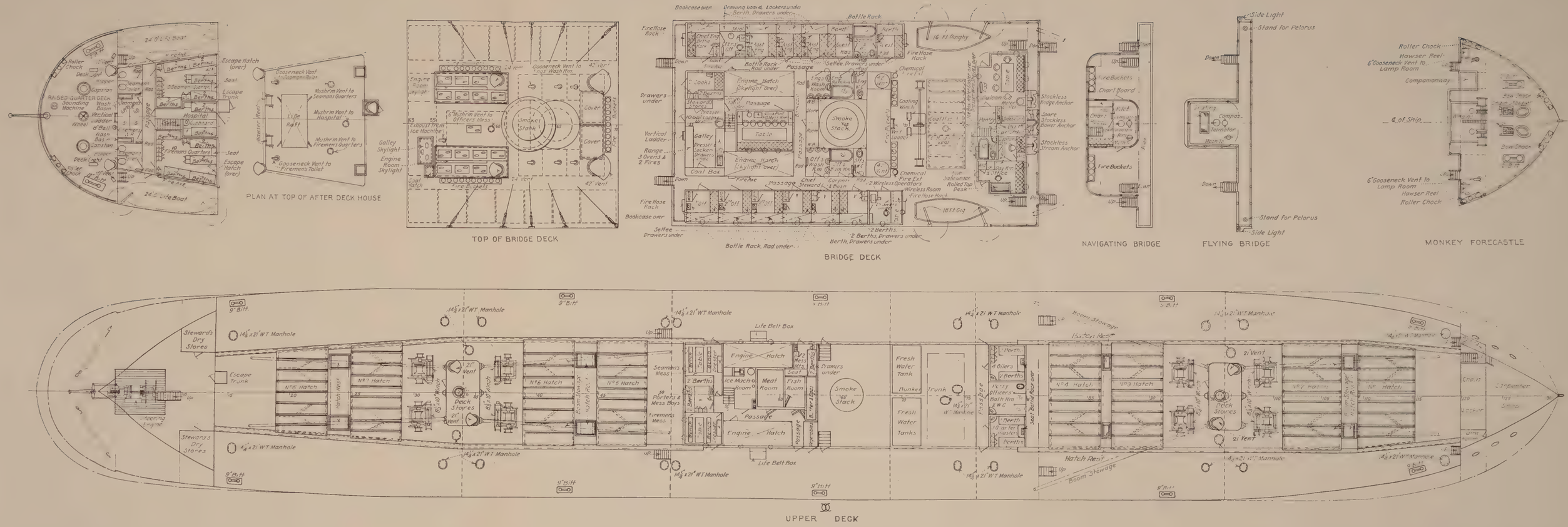
OUTBOARD PROFILE

7,300-TON D. W. BULK FREIGHTER FOR COAL OR SULPHUR

Designed by George Simpson, New York City

Builders, Newburgh Shipyards, Inc., Newburgh, N. Y.

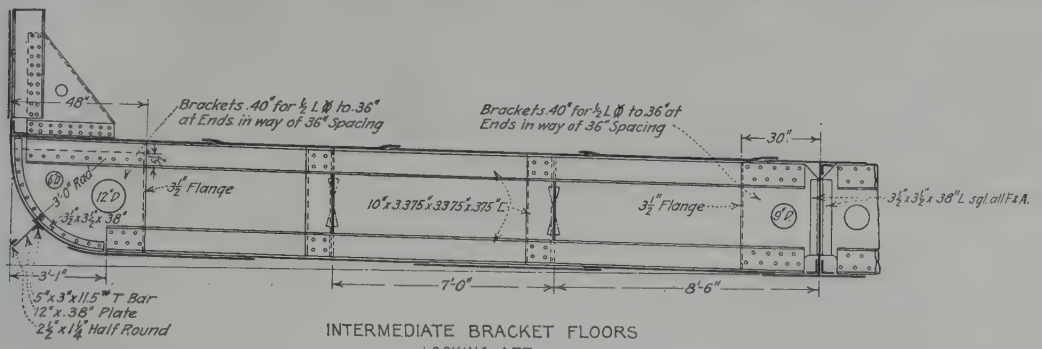
PLATE XX



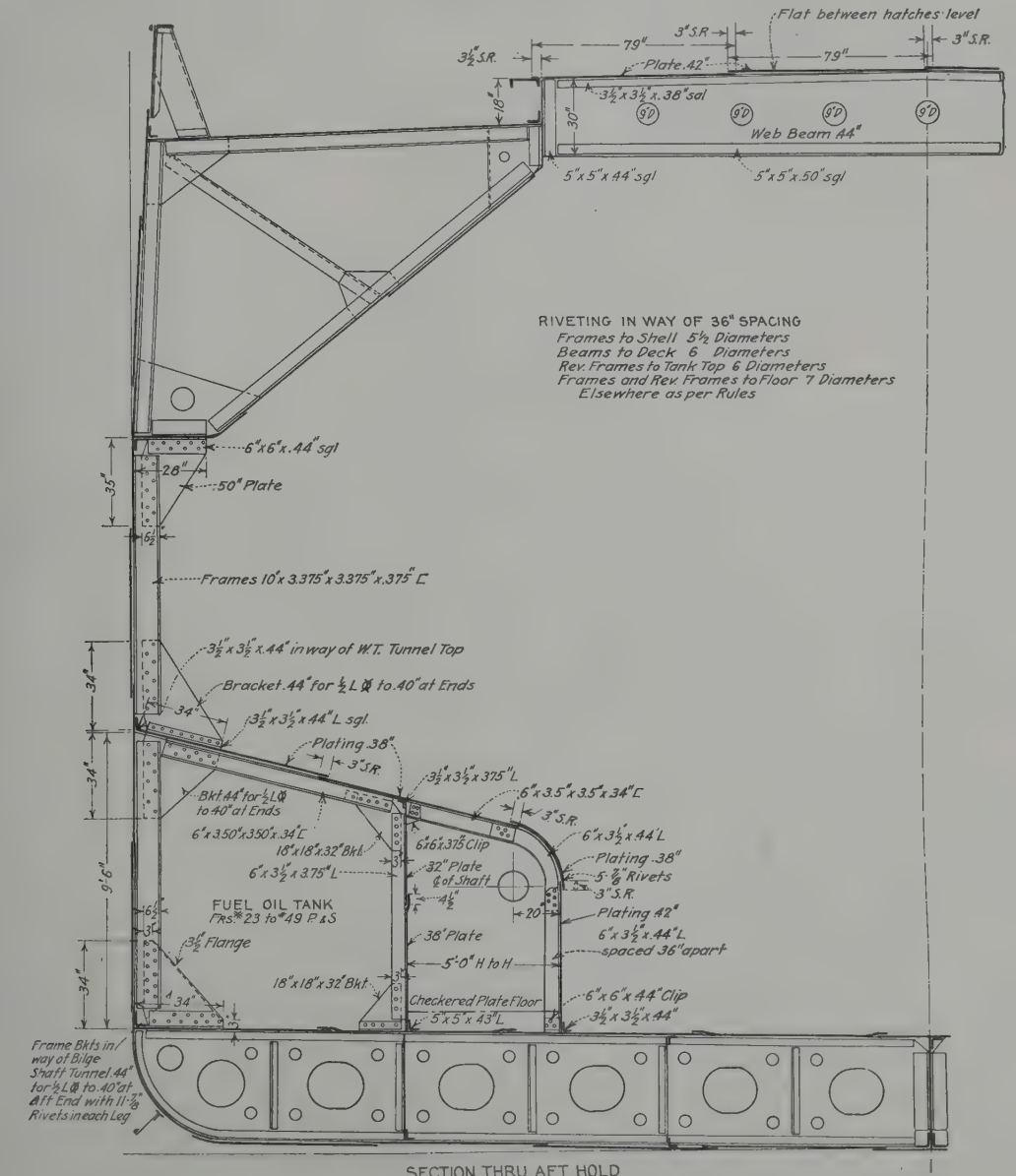
ARRANGEMENT OF DECKS
7,300-TON D. W. BULK FREIGHTER FOR COAL OR SULPHUR
Designed by George Simpson, New York City
Builders, Newburgh Shipyards, Inc., Newburgh, N. Y.

PLATE XXI

SECTION THRU AFTER HOLD AND INTERMEDIATE BRACKET FLOORS



INTERMEDIATE BRACKET FLOORS
LOOKING AFT

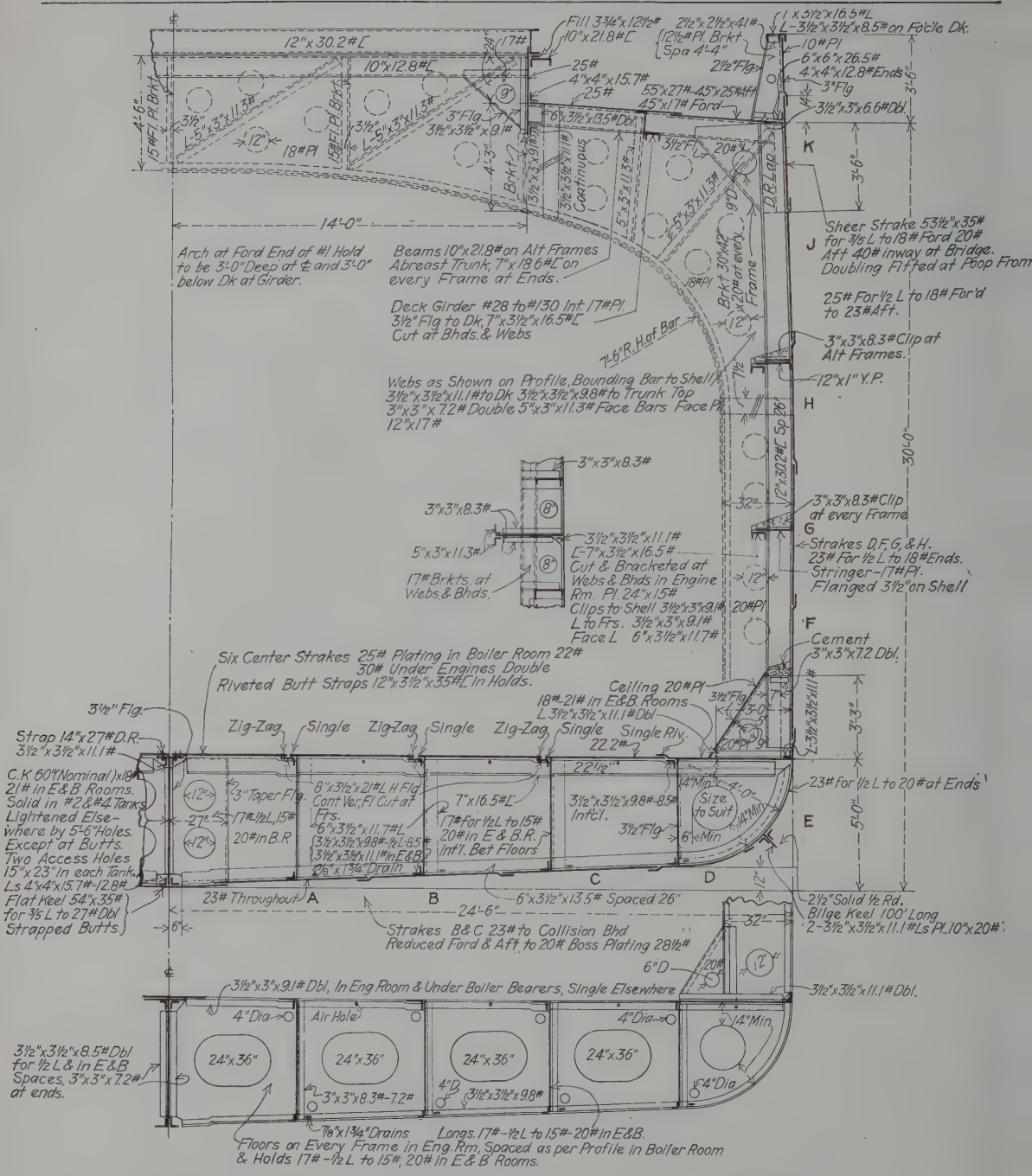


SECTION THRU AFT HOLD
LOOKING AFT

7,300-TON D. W. BULK FREIGHTER FOR COAL OR SULPHUR

Designed by George Simpson, New York City
Builders, Newburgh Shipyards, Inc., Newburgh, N. Y.

MIDSHIP SECTION


12"x30.2#C
10"x12.8#C
Fill 3¾"x12½#
10"x21.8#C
2½"x21½"x41#
(12½"# Pl. Brkt Spa 4'-4"
1 x 3½"x16.5#L
L-3½"x3½"x8.5# on Fo'cle Dk.
10"# Pl
6"x6"x26.5#
4"x4"x12.8# Ends
3"Flg
3½"x3"x6.6# Dbl
25#
4"x4"x15.7#
25#
55"x27#-45"x25#Aft
45"x17# Ford
6"x3½"x13.5# Dbl
3½"x3½"x9.1#
3"Flg
3½"x3½"x9.1#
3½"Fl
20#
K
3'-6"
14'-0"
Arch at Ford End of #1 Hold to be 3'-0" Deep at ℄ and 3'-0" below Dk at Girder.
Beams 10"x21.8# on Alt Frames Abreast Trunk, 7"x18.6#L on every Frame at Ends.
Deck Girder #28 to #30 Int 17# Pl. 3½" Flg to Dk, 7"x3½"x16.5#L Cut at Bhds. & Webs
Brkt 30"x40" x20# at every Frame
D.R. Lap
Sheer Strake 53½"x35# for ⅜ L to 18# Ford 20# Aft 40# inway at Bridge. Doubling Fitted at Poop From
J
25# For ½ L to 18# For'd to 23# Aft.
3"x3"x8.3# Clip at Alt Frames.
12"x1" Y.P.
7'-6" R. Hof Bar
Webs as Shown on Profile, Bounding Bar to Shell 3½"x3½"x11.1# to Dk 3½"x3½"x9.8# to Trunk Top 3"x3"x7.2# Double 5"x3"x11.3# Face Bars Face Pl 12"x17#
H
12"x30.2#C Sp 26"
30'-0"
3"x3"x8.3#
3"x3"x8.3#
3½"x3½"x11.1#
L-7"x3½"x16.5#
Cut & Bracketed at Webs & Bhds in Engine Rm. Pl 24"x15# Clips to Shell 3½"x3"x9.1# L to Frs. 3½"x3"x9.1# Face L 6"x3½"x11.7#
5"x3"x11.3#
17# Brkts at Webs & Bhds.
3"x3"x8.3# Clip at every Frame
G
Strakes D, F, G, & H. 23# For ½ L to 18# Ends.
Stringer-17# Pl. Flanged 3½" on Shell
Six Center Strakes 25# Plating in Boiler Room 22# 30# Under Engines Double Riveted Butt Straps 12"x3½"x35#L In Holds.
Ceiling 20# Pl
18#-21# in E&B Rooms
L 3½"x3½"x11.1# Dbl
3½"Flg
F
Cement
3"x3"x7.2 Dbl.
3'-3"
3½" Flg.
Strap 14"x27#D.R.-3½"x3½"x11.1#
Zig-Zag
Single
Zig-Zag
Single
Zig-Zag
Single
Single Rlv.
22.2#
20# Pl
9
C.K 60"(Nominal)x18"x21# in E&B Rooms. Solid in #2 & #4 Tanks Lightened Elsewhere by 5'-6" Holes. Except at Butts. Two Access Holes 15"x23" in each Tank. Ls 4"x4"x15.7#-12.8# Flat Keel 54"x35# for ⅜ L to 27# Dbl Strapped Butts.
3" Taper Flg.
17#-½L, 15# 20# in B.R.
6"x3½"x21#L H Flg Cont Ver. Fl Cut at Frs.
6"x3½"x11.7#L
3½"x3½"x9.8#-½L-8.5#
3½"x3½"x11.1# in E&B
⅞" x 1¾" Drain
7"x16.5#L
17# for ½L to 15# 20# in E & B.R. Intl. Bet Floors
22½"
3½"x3½"x9.8#-8.5# Intcl.
3½"Flg
14" Min
4'-0"
Size to Suit
14" Min
6" Min
23# for ½ L to 20# at Ends
E
5'-0"
23# Throughout
A
B
C
D
6"x3½"x13.5# Spaced 26"
24'-6"
Strakes B & C 23# to Collision Bhd Reduced Ford & Aft to 20# Boss Plating 28½#
2½" Solid ½ Rd. Bilge Keel 100' Long 2-3½"x3½"x11.1#Ls Pl. 10"x20#
6"D
3½"x3"x9.1# Dbl, In Eng Room & Under Boiler Bearers, Single Elsewhere
3½"x3½"x11.1# Dbl.
4" Dia
Air Hole
4" Dia
14" Min
24"x36"
24"x36"
24"x36"
24"x36"
3½"x3½"x8.5# Dbl for ½ L & in E&B Spaces, 3"x3"x7.2# at ends.
3"x3"x8.3#-7.2#
4"D
3½"x3½"x9.8#
4" Dia
⅞"x1¾" Drains
Longs. 17#-½L to 15#-20# in E&B.
Floors on Every Frame in Eng. Rm, Spaced as per Profile in Boiler Room & Holds 17#-½L to 15#, 20# in E & B Rooms.

Principal Dimensions

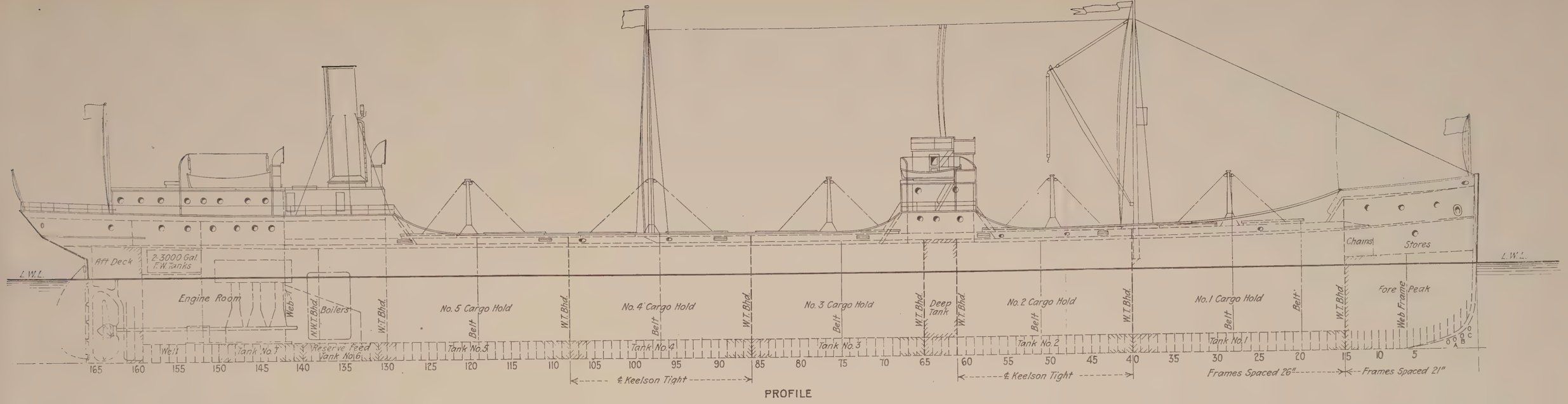
Length B. P.		360'-0"
Breadth Molded		49'-0"
Depth Molded		30'-0"
½ Beam = 24.5	1st Numeral	107.5
Depth = 31.0	x Rule Length	353.0
½ Girth = 52.0	2nd Numeral =	37947.5
1st Numeral 107.5	L/B = 7.20	L/D = 11.39

Equipment

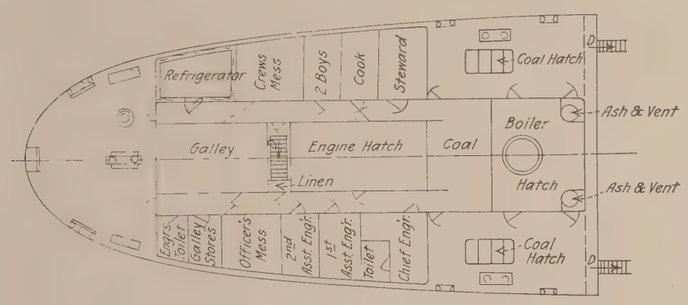
2 Bower Anchors (Stockless)	6500# Each
1 Bower Anchor (Stockless)	4000#
1 Stream Anchor	1200#
1 Kedge Anchor	875#

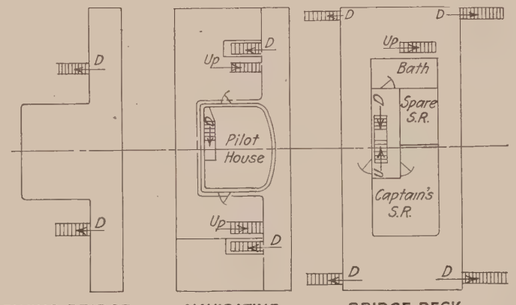
240 Fathoms 2⅛" Dia. Stud Link Chain Cable.
90 Fathoms 4½" Cir. Steel Wire Stream Line.
100 Fathoms 4" Cir. Steel Wire Towline.
Two—90 Fathoms Each 7" Cir. Manilla Hawsers.
Two—90 Fathoms Each 7" Cir. Manilla Warps.

6,422-TON D. W. COLLIER
New York Shipbuilding Corp., Camden, N. J.
See Opposite Page.

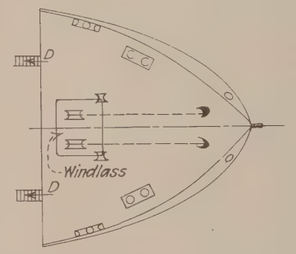


PROFILE

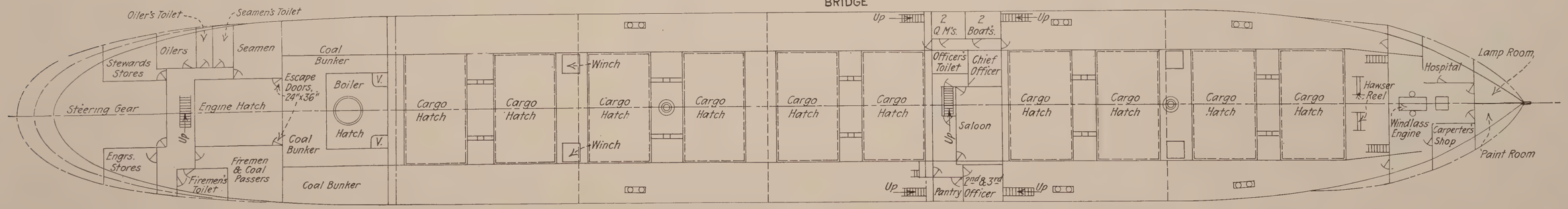




FLYING BRIDGE NAVIGATING BRIDGE BRIDGE DECK



FORECASTLE DECK



MAIN DECK

Principal Dimensions

Length O. A.	377′—0½″
Length B. P.	360′—0″
Beam molded	49′—0″
Depth to Upper Deck	30′—0″
Draft loaded	23′—5″

GENERAL ARRANGEMENT PLAN, 6,422-TON D. W. COLLIER
New York Shipbuilding Corp., Camden, N. J.

PLATE XXII

GENERAL NOTES

Stem: 11″ x 3″ W. I. Bar C. S. Heel.

Stern Frame: C. S. Propeller Post 13½″ x 7¼″ below Boss, 12″ x 8″ above Boss, Rudder Post 9″ x 7½″.

Rudder Stock: 10″ dia.

Frames: 12″ x 30.2# channels. Spacing to be 26″ from frame No. 15 to stern. Forward of frame No. 15, spacing to be 21″ to stem. In Peaks 6″ x 3½″ x 11.7# frames, 3″ x 3½″ x 7.9# reverse frames, alternate to Foc's'le Deck forward. All to Main Deck Aft.

Poop and Forecastle Frames: 6″ x 3½″ x 11.7# angles.

Bridge Frames: 7″ x 3½″ x 16.5# channels.

Cant Frames: 6″ x 3½″ x 11.7# angles. Reverse frames 3½″ x 3″ x 7.9#.

Forecastle Side Plating 16#: Beams every frame 6″ x 3½″ x 3½″ x 15# channels. Brackets 15″ x 15″ x 17#, Stringer 40″ x 15#, Plating 12½#, Stringer angle 3½″ x 3½″ x 8.5#.

Bridge Side Plating 16#: Beams every frame 6″ x 3½″ x 3½″ x 15# Channels. Brackets 15″ x 15″ x 17#, Stringer 38″ x 17#, Ties 15#, Stringer angle 3½″ x 3½″ x 8.5#.

Poop Side Plating 15#: Beams every frame over bunkers 6″ x 3½″ x 15# Channels. Brackets 15″ x 16″ x 17#, Beams over quarters 7″ x 3½″ x 18.6# channels on alternating frames. Brackets 17″ x 17″ x 17#, Stringer 36″ x 15#, Plating 12½#, Ties 16″ x 12½#, Stringer angle 3½″ x 3½″ x 8.5#.

Main Deck Beams: 10″ x 21.8# channels on alternate frames abreast trunk, 7″ x 3½″ x 18.6# channels every frame at ends. Brackets 30″ x 42″ x 20# for 10″ Beams, 21″ x 36″ x 18# for 7″ Beams. Stringer plating at ends 45″ x 17#, Plating 14#.

Gallery Deck Beams: On every frame 6″ x 3½″ x 15# channels. Brackets 24″ x 30″ x 15#, Stringer 40″ x 17#, Plating 10#.

Fore Peak Flat Beams: On every frame 7″ x 3½″ x 18.6# channels. Brackets 24″ x 24″ x 17#, Stringer 36″ x 15#, Plating 12½#, Stringer angle 3½″ x 3½″ x 8.5#.

Panting Stringers, Beams: Spaced 5′-3″, 10″ x 3½″ x 21.8# channels. No brackets, Stringer 24″ x 15#, Angle to frames 3″ x 3″ x 8.3#.

Shell Clips: 3½″ x 3½″ x 8.5#. Face angle 6″ x 3½″ x 11.7#.

Bulkheads: Plating 16# to 13#. Webs at trunk sides as per detail. Other vertical stiffeners 10″ x 21.8# channels spaced 28″. Stringer at bulkhead No. 130, 15′-6″ above double bottom plating, 24″ x 15#.

Fore Peak: 17# to 14#; stiffeners 12″ x 30.2# channel spaced 24″.

Deep Tank: Plating 17#. Stiffeners 12″ x 30.2# channels spaced 21″. Web plates 30″ to 18″ x 17#, with 6″ x 3½″ x 13.5# face angle in line with trunk side, bracketed top and bottom. Horizontal stiffeners ⅓ depth of bulkhead above inner bottom of 17# plating, face angle 6″ x 3½″ x 13.5#. Diamond plating 24″ x 24″ x 17#, connected to face angle on web. Seams and butts of tank bulkheads double riveted. Center line bulkhead in deep tank, plating 17#, stiffeners horizontal lower half, 7″ x 3½″ x 16.5# channels, upper half 6″ x 3½″ x 15# channels spaced 24″. Brackets at each end 24″, connected to vertical stiffeners on transverse bulkheads.

After Peak Bulkhead: Stiffeners 10″ x 3½″ x 21.8# channel at center line; 6″ x 3½″ x 15# channels at sides, spaced 24″, plating 16# to 13#, 30# double plating at stern tube.

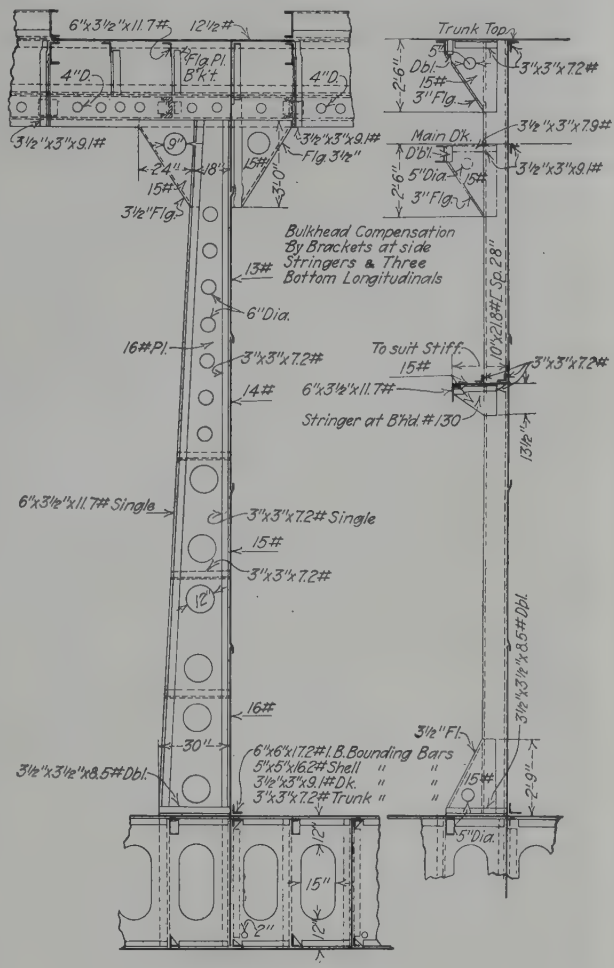
Coal Bunker Bulkheads: Plating 12#. Bounding bar to Inner Bottom 3½″ x 3″ x 9.1#. To Transverse Bulkheads 3″ x 3″ x 7.2#. Stiffeners 5″ x 3″ x 8.2# spaced 26″. Ties to frames 3″ x 3″ x 7.2#.

Screen Bulkhead: Plating 15# and 7½#. Bounding bar to Inner Bottom 3½″ x 3″ x 11.1#. To bunker bulkhead 3″ x 3″ x 7.2#. Stiffeners 3″ x 2½″ x 4.5#, spaced 30″.

Swash Plates: in Peaks 15#, stiffeners 6″ x 3½″ x 15# channels, spaced 5′ 3″.

Swash Plates: in Deep Tank 17#.

Chain Locker: 4′ 0″ high, plating 14#, stiffeners 6″ 3½″ x 15# channels, spaced 21″.



SECTION THRO B'HDS

GENERAL NOTES—Continued

Boiler Casings: Coamings 16#. Plating 12#. Bounding bar 3″ x 3″ x 7.2#. Stiffeners 4″ x 3″ x 8.5#, spaced 26″.

Engine Casings: Coamings, lower 16#, upper 10#, plating 8#, bounding bar 3″ x 3″ x 7.2#, stiffeners 4″ x 3″ x 8.5#, spaced 26″.

Bulkhead at End of Foc's'le: Plating 14#, bounding bar 3½″ x 3″ x 9.1#, stiffeners 6″ x 3½″ x 11.7# spaced 24″.

Bulkhead at Forward End of Bridge: Plating 15½#, bounding bar 3½″ x 3½″ x 8.5#, stiffeners 7″ x 3½″ x 16.5# channels, spaced 28″, brackets 15″ x 15″ x 15# top and bottom.

Bulkhead at Aft End of Bridge: Plating 12½#, bounding bar 3½″ x 3½″ x 8.5#, stiffeners 6″ x 3″½ x 11.7#, spaced 28″.

Bulkhead at Forward End of Poop: Plating 15#, bounding bar 3½″ x 3½″ x 8.5#, stiffeners 7″ x 3½″ x 16.5# channels, spaced 28″, brackets 19″ x 19″ x 15# top.

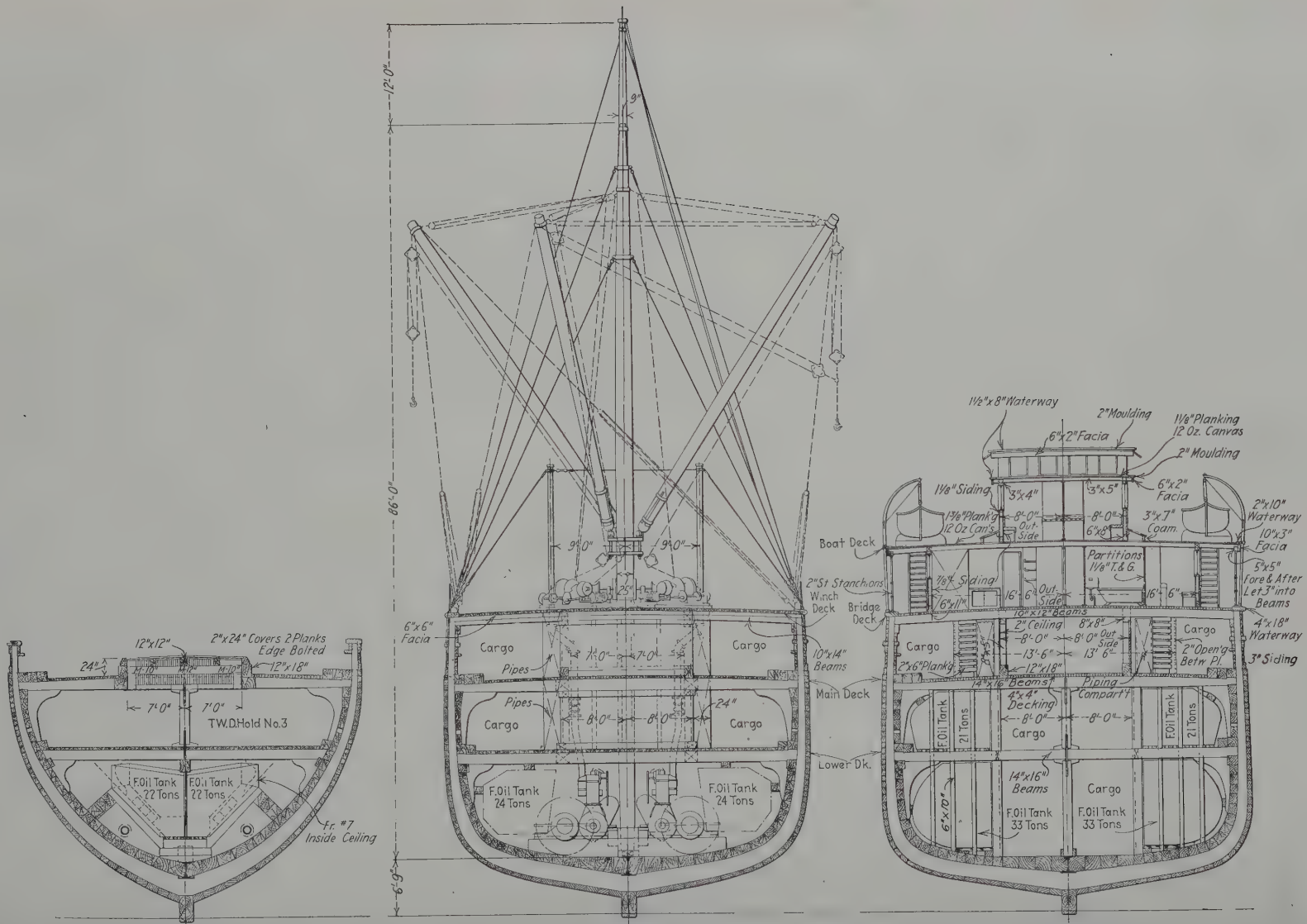
Bridge Deck House: Coamings 10#, plating 10# except aft end 8#, bounding bar 3″ x 3″ x 7.2#.

Poop Deck House: Coamings 10#, plating 8# except forward end 12#, bounding bar 3″ x 3″ x 7.2#. Stiffeners 4″ x 3″ x 7.2#, stringers and ties 10#. Beams 4″ x 3″ x 7.2#.

Bulkheads: Plating 8# Bounding Bar, bottom 6″ x 3½″ x 11.7#, top 3″ x 3″ x 7.2#. Corner Angles 2½″ x 2½″ x 4.1#. Stiffeners 3″ x 2½″ x 5.6#, spaced 26″ to 30″.

6,422-TON D. W. COLLIER
New York Shipbuilding Corp., Camden, N. J.

See Opposite Page.

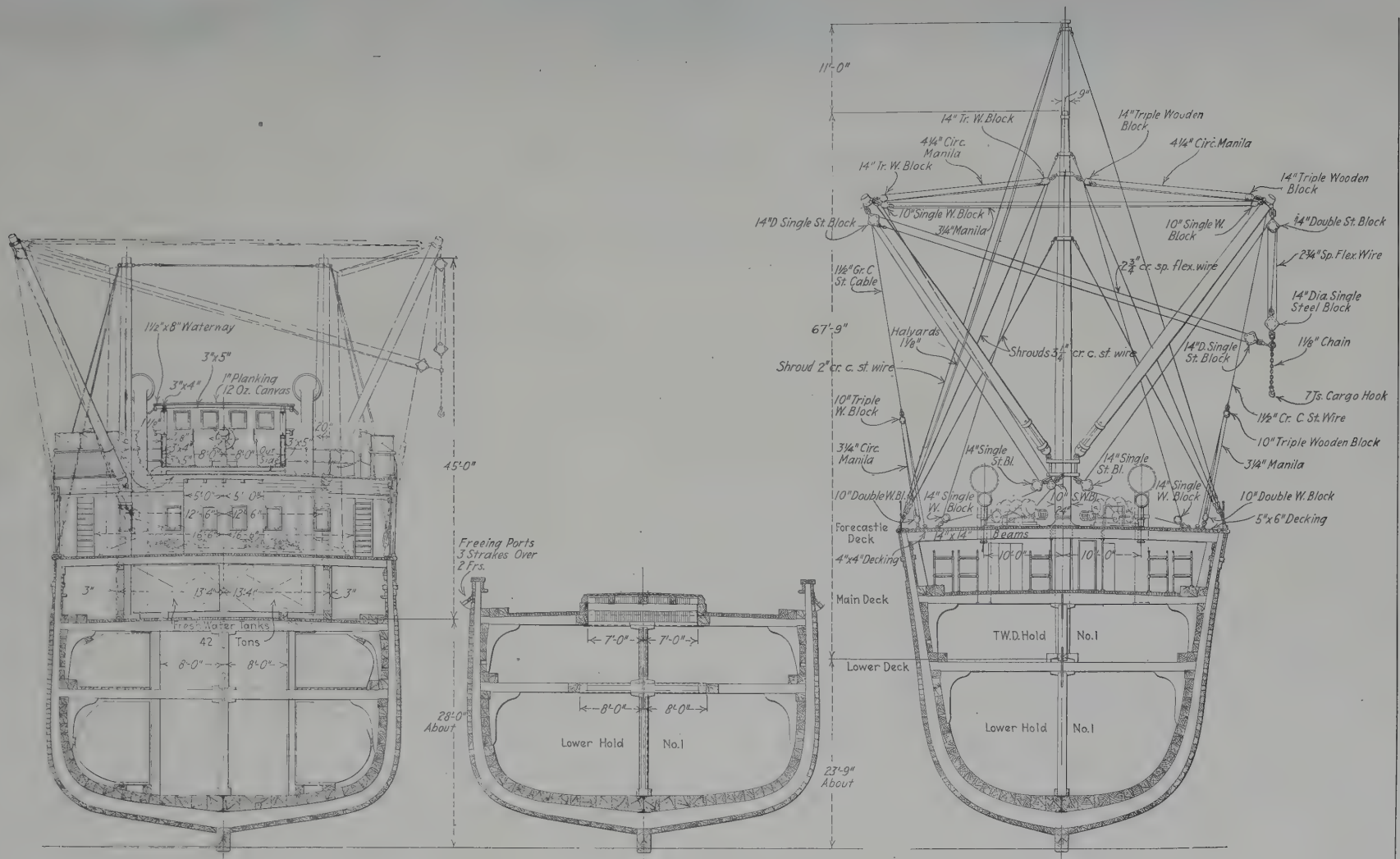


SECTION 13
Looking Forward

SECTION 25
Looking Aft.

SECTION 45
Looking Forward

WOODEN MOTOR SHIP
Designed by Cox & Stevens, New York City



SECTION 55
Looking Aft.

SECTION 65
Looking Forward

SECTION 85
Looking Forward

WOODEN MOTOR SHIP

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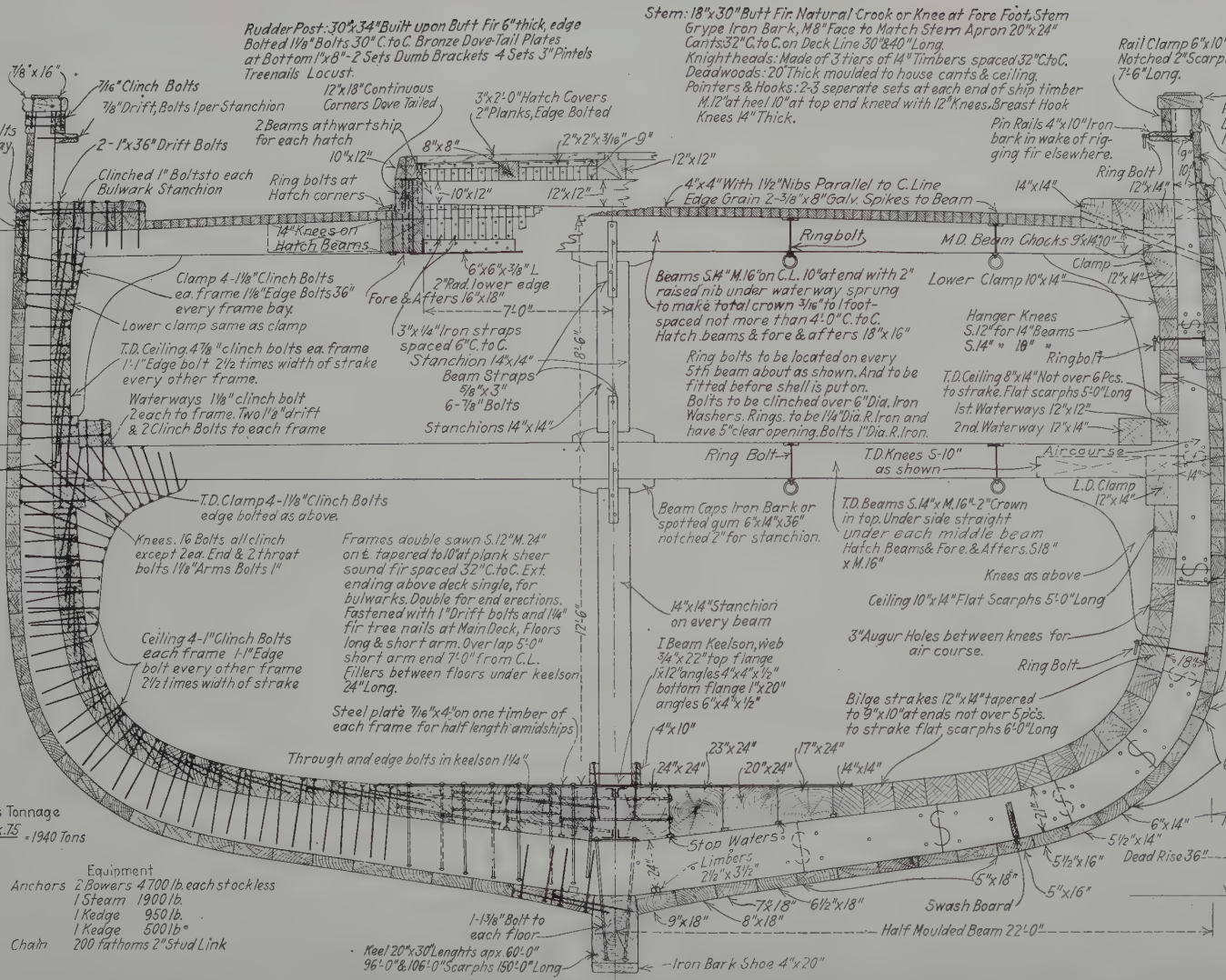
Rudder Post: 30"x34" Built upon Butt Fir 6" thick, edge Bolted 1⅛" Bolts 30" C. to C. Bronze Dove-Tail Plates at Bottom 1"x8" - 2 Sets Dumb Brackets 4 Sets 3" Pintels Treenails Locust.
Stem: 18"x30" Butt Fir. Natural Crook or Knee at Fore Foot. Stem Grype Iron Bark, M8" Face to Match Stern Apron 20"x24" Cants 32" C. to C. on Deck Line 30" & 40" Long. Knightheads: Made of 3 tiers of 14" Timbers spaced 32" C. to C. Deadwoods: 20" Thick moulded to house cants & ceiling. Pointers & Hooks: 2-3 seperate sets at each end of ship timber M. 12" at heel 10" at top end kneed with 12" Knees, Breast Hook Knees 14" Thick.
Rail Clamp 6"x10" Notched 2" Scarphs 7'-6" Long.
7/8"x16"
7/8" Clinch Bolts
7/8" Drift, Bolts 1 per Stanchion
3-1" Clinch Bolts per Frame Bay
2-1"x36" Drift Bolts
Sheerstrake Edge Bolted ¾"x26"
Beam to Clamp. 2-1" Bolts
12"x18" Continuous Corners Dove Tailed
3"x2'-0" Hatch Covers 2" Planks, Edge Bolted
2 Beams athwartship for each hatch
10"x12"
8"x8"
2"x2"x3/16"
9"
12"x12"
Clinched 1" Bolts to each Bulwark Stanchion
Ring bolts at Hatch corners
10"x12"
12"x12"
4"x4" With 1½" Nibs Parallel to C. Line Edge Grain 2-⅜"x8" Galv. Spikes to Beam
14"x14"
Pin Rails 4"x10" Iron bark in wake of rigging fir elsewhere.
Ring Bolt 12"x14"
Rail 6"x20" Scarphs 16'-0" Long Let over Stanchion 1½"-2-⅞"x16" Galv. Bolts
Rail Strake 4"x10"
9"
10"
Waists 3"x5" "V" Bead
3" Freeing Ports to Side
14" Knees on Hatch Beams
Ringbolt
M.D. Beam Chocks 9"x14"x10"
Clamp 12"x14"
Lower Clamp 10"x14"
Bead Strake 4½"x9½" Scuppered abaft mainmast & 1¼" holes forward.
Clamp 4-1⅛" Clinch Bolts ea. frame 1⅛" Edge Bolts 36" every frame bay.
Lower clamp same as clamp
Fore & Afters 16"x18"
6"x6"x⅜" L
2" Rad. lower edge
7'-0"
3"x¼" Iron straps spaced 6" C. to C.
Stanchion 14"x14"
Beam Straps ⅝"x3"
6-⅞" Bolts
Stanchions 14"x14"
8'-0"
8'-6"
Beams S.14" M.16" on C.L. 10" at end with 2" raised nib under waterway sprung to make total crown 3/16" to 1 foot - spaced not more than 4'-0" C. to C. Hatch beams & fore & afters 18"x16"
Hanger Knees S.12" for 14" Beams S.14" " 18" "
Ringbolt
Covering Board 8"x16" Notched around stan.
Plank sheer 6"x8"
Salt Stop
3"x6" Lead Scuppers
3" Air Spaces Between Hanger Knees
T.D. Ceiling 4⅞" clinch bolts ea. frame 1'-1" Edge bolt 2½ times width of strake every other frame.
Waterways 1⅛" clinch bolt 2 each to frame. Two 1⅛" drift & 2 Clinch Bolts to each frame
Ring bolts to be located on every 5th beam about as shown. And to be fitted before shell is put on. Bolts to be clinched over 6" Dia. Iron Washers. Rings. to be 1¼" Dia. R. Iron and have 5" clear opening. Bolts 1" Dia. R. Iron.
T.D. Ceiling 8"x14" Not over 6 Pcs. to strake. Flat scarphs 5'-0" Long
1st. Waterways 12"x12"
2nd. Waterway 12"x14"
Beam to Clamp 2-1" Clinch Bolts
Ring Bolt
T.D. Knees S-10" as shown
Aircourse
14"
L.D. Clamp 12"x14"
T.D. Beam chocks between all beams 9"x14"
T.D. Clamp 4-1⅛" Clinch Bolts edge bolted as above.
Beam Caps Iron Bark or spotted gum 6"x14"x36" notched 2" for stanchion.
T.D. Beams S.14"x M.16" - 2" Crown in top. Under side straight under each middle beam Hatch Beams & Fore & Afters S.18" x M.16"
Wales, & Topsides above this point 6"x8"
Salt Stop
Knees as above
Knees. 16 Bolts all clinch except 2 ea. End & 2 throat bolts 1⅛" Arms Bolts 1"
Frames double sawn S.12" M.24" on ℄ tapered to 10" at plank sheer sound fir spaced 32" C. to C. Ext ending above deck single, for bulwarks. Double for end erections. Fastened with 1" Drift bolts and 1¼" fir tree nails at Main Deck, Floors long & short arm. Overlap 5'-0" short arm end 7'-0" from C.L. Fillers between floors under keelson 24" Long.
14"x14" Stanchion on every beam
Ceiling 10"x14" Flat Scarphs 5'-0" Long
6"x10"
3" Augur Holes between knees for air course.
Ring Bolt
18"
I Beam Keelson, Web ¾"x22" top flange 1x12" angles 4"x4"x½" bottom flange 1"x20" angles 6"x4"x½"
Ceiling 4-1" Clinch Bolts each frame 1-1" Edge bolt every other frame 2½ times width of strake
Bilge strakes 12"x14" tapered to 9"x10" at ends not over 5 pcs. to strake flat, scarphs 6'-0" Long
6"x11"
Steel plate 7/16"x4" on one timber of each frame for half length amidships
4"x10"
23"x24"
17"x24"
Through and edge bolts in keelson 1¼"
24"x24"
20"x24"
14"x14"
6"x12"
12'-6"
Apx. Gross Tonnage
260x45x22x.75 / 100 = 1940 Tons
Stop Waters
Limbers 2½"x3½"
24"
6"x14"
5½"x14"
5½"x16"
Dead Rise 36"
5"x18"
5"x16"
7"x18"
6½"x18"
Swash Board
9"x18"
8"x18"
1-1⅜" Bolt to each floor
Half Moulded Beam 22'-0"
Keel 20"x30" Lenghts apx. 60'-0" 96'-0" & 106'-0" Scarphs 150'-0" Long
Iron Bark Shoe 4"x20"
L.O.A 279'-4"
Length Rule 260'-0"
Length L.W.L. 267'-8"
Beam Moulded 44'-0"
Beam Extreme 45'-0"
Moulded Depth 25'-0"
Depth Hold Assumed 22'-0"
Equipment
Anchors 2 Bowers 4700 lb. each stockless
1 Steam 1900 lb.
1 Kedge 950 lb.
1 Kedge 500 lb.
Chain 200 fathoms 2" Stud Link

MIDSHIP SECTION

WOODEN MOTOR SHIP

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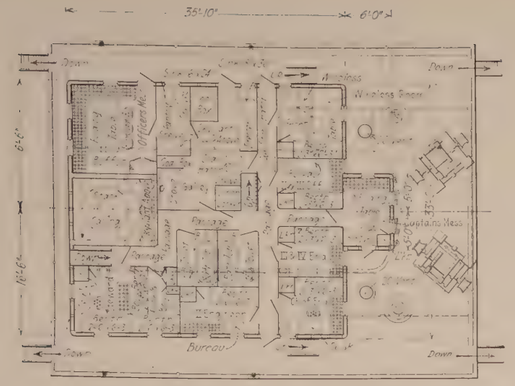
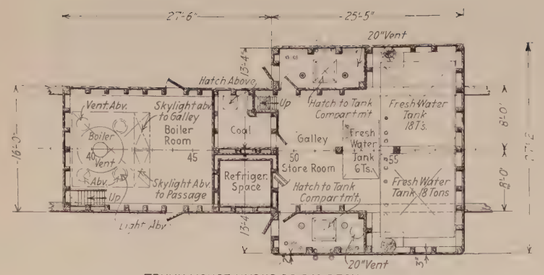
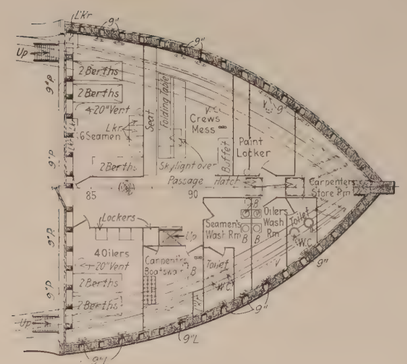


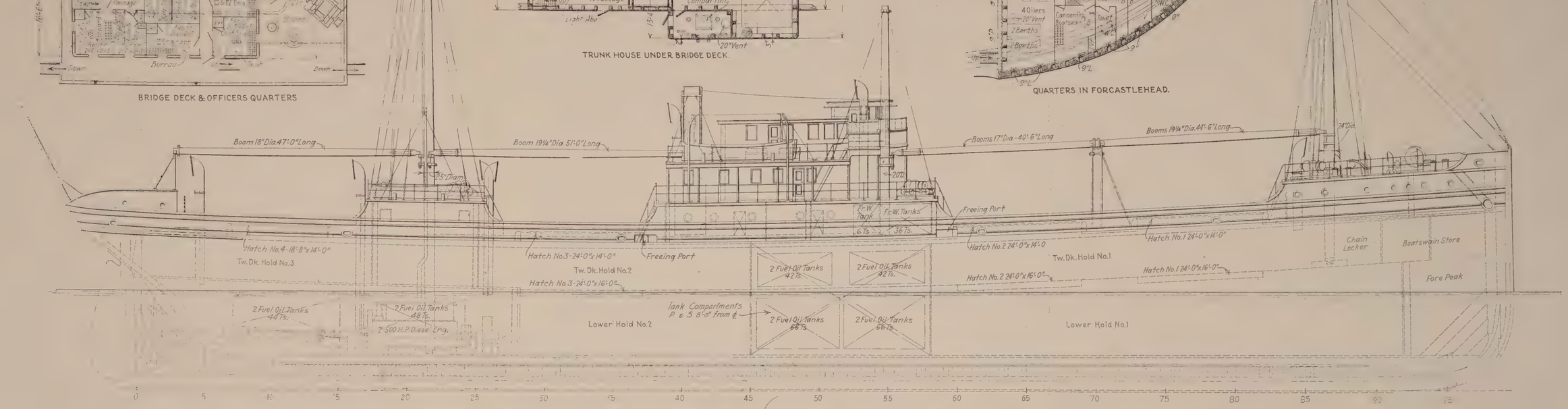
BRIDGE DECK & OFFICERS QUARTERS

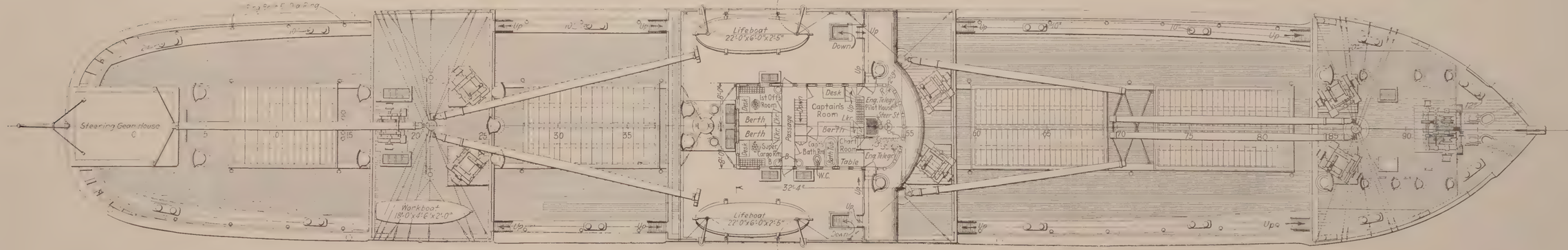


TRUNK HOUSE UNDER BRIDGE DECK.



QUARTERS IN FORCASTLEHEAD.


Boom 18" Dia. 47'-0" Long
Boom 19¼" Dia. 51'-0" Long
Booms 17" Dia. 40'-6" Long
Booms 19¼" Dia. 44'-6" Long
35' Diam.
20" Vent
Fr. W. Tank 6 Ts.
Fr. W. Tanks 36 Ts.
Freeing Port
Hatch No. 4 18'-8" x 14'-0"
Tw. Dk. Hold No. 3
Hatch No. 3 24'-0" x 14'-0"
Tw. Dk. Hold No. 2
Hatch No. 3 24'-0" x 16'-0"
Hatch No. 2 24'-0" x 14'-0"
Tw. Dk. Hold No. 1
Hatch No. 1 24'-0" x 14'-0"
Hatch No. 2 24'-0" x 16'-0"
Hatch No. 1 24'-0" x 16'-0"
Chain Locker
Boatswain Store
Fore Peak
2 Fuel Oil Tanks 42 Ts.
2 Fuel Oil Tanks 44 Ts.
2 Fuel Oil Tanks 48 Ts.
2 500 H.P. Diesel Eng.
Tank Compartments p & S 8'-0" from ℄
2 Fuel Oil Tanks 66 Ts.
Lower Hold No. 2
Lower Hold No. 1



Principal Dimensions

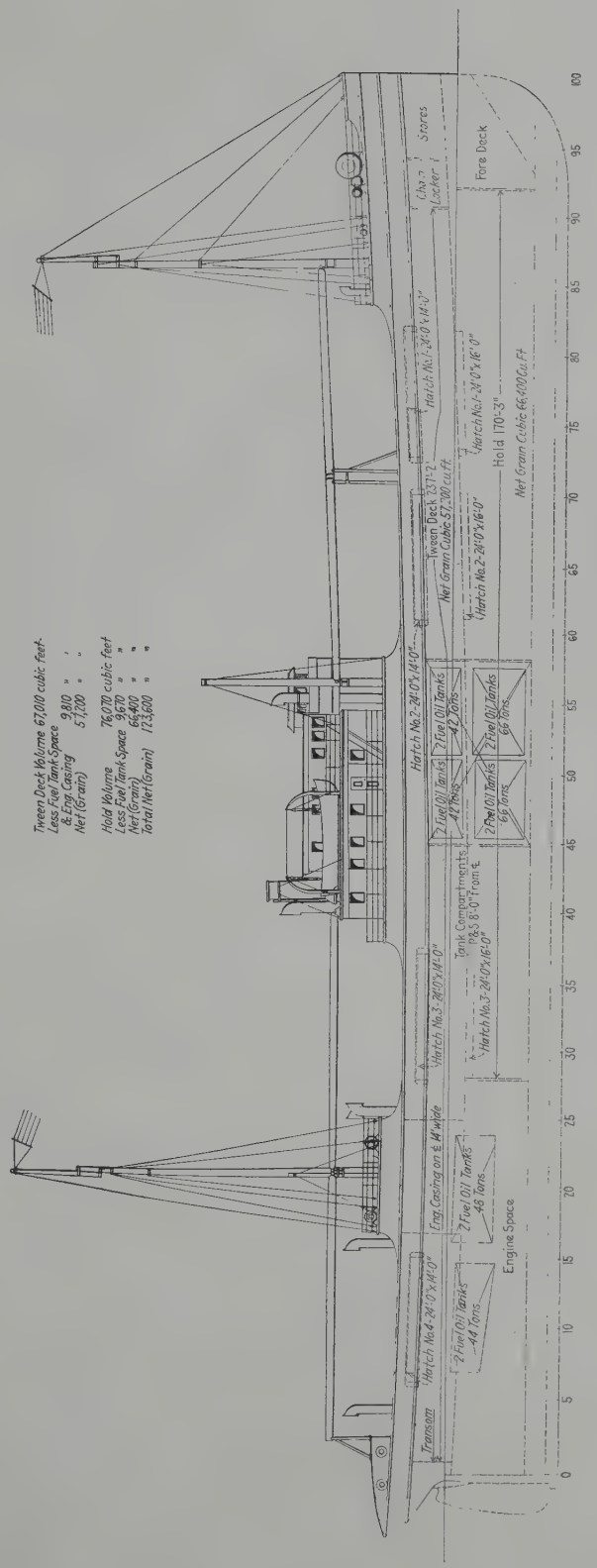
L. O. A.	279'—4"
Length Rule	260'—0"
Length L. W. L.	267'—8"
Beam Molded	44'—0"
Beam Extreme	45'—0"
Molded Depth	25'—0"

OUTBOARD PROFILE AND GENERAL ARRANGEMENT PLAN
WOODEN MOTOR SHIP

Designed by Cox and Stevens, New York City

PLATE XXIII

Dead Weight L Tons	Ext. Mean Draft in Feet & Inch.	Displacement L Tons	Tons per Inch Imm.
3000		5300	
	XXIII		24.9
900		200	
800		100	
700	XXII	5000	
600		900	
2500		800	
400	XXI	700	
300		600	
			24.5
200		4500	
100	XX	400	
2000		300	
900		200	
800	XIX	100	
700		4000	
600		900	
1500	XVIII	800	24.0
400		700	
300		600	
200	XVII	3500	
100		400	
1000		300	
900	XVI	200	
800		100	
700		3000	
	XV		23.5
600		900	
500		800	
400	XIV	700	
300		600	
200		2500	23.0
100	XIII	400	
0		300	
		200	
	XII	100	



LOADING TABLE AND CARGO CAPACITY, WOODEN MOTOR SHIP

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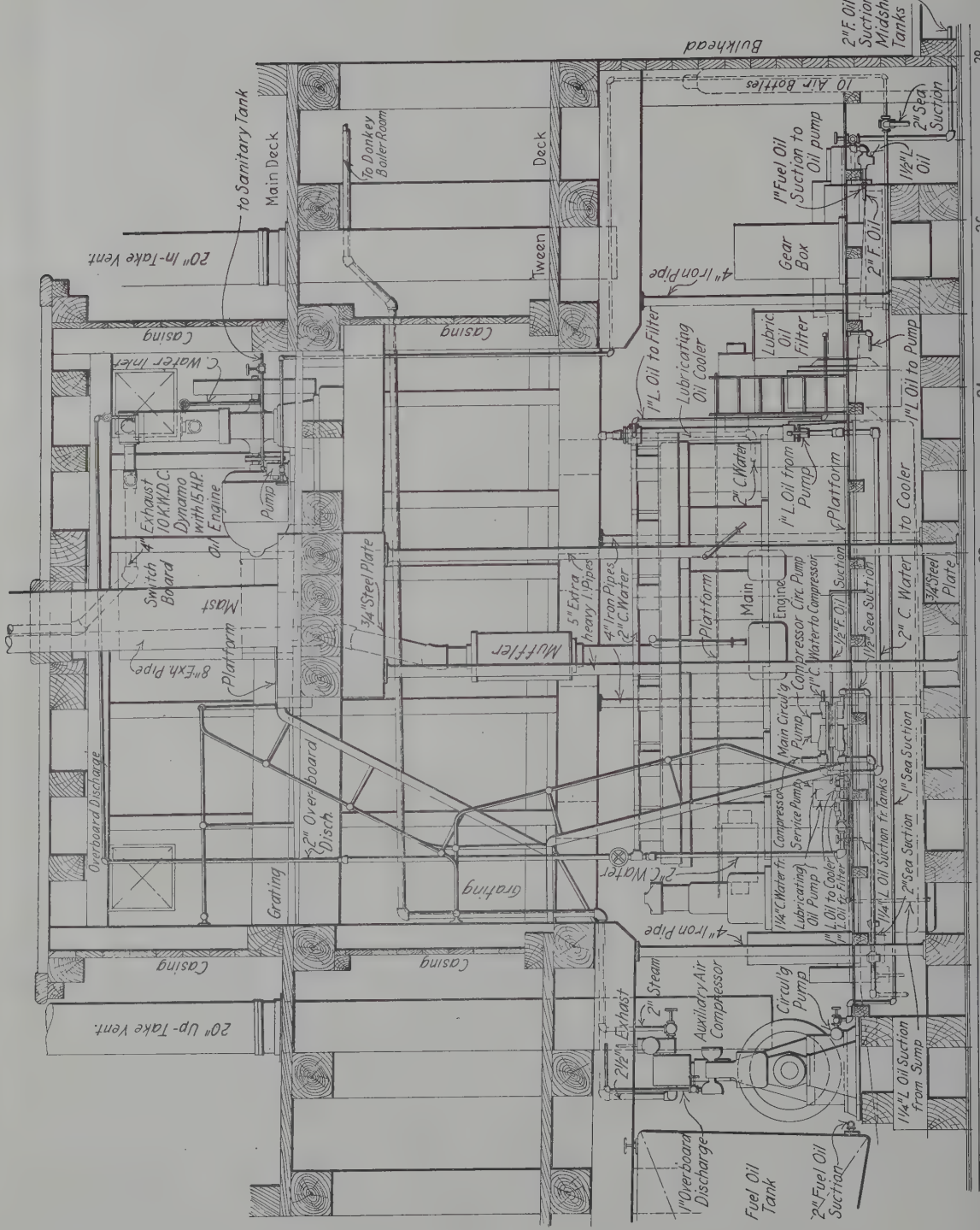
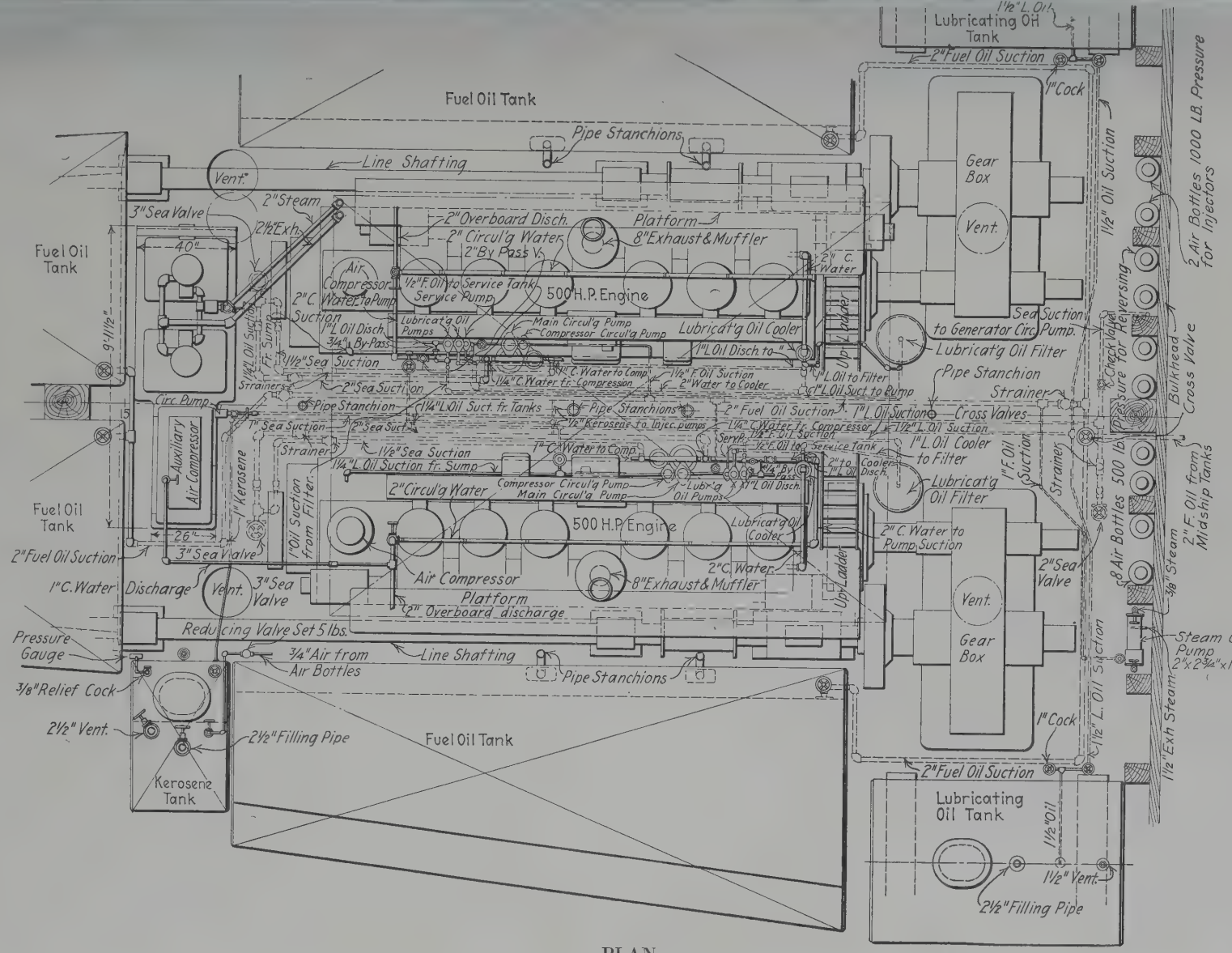


ELEVATION
WOODEN MOTOR SHIP
Designed by Cox & Stevens, New York City



PLAN

WOODEN MOTOR SHIP
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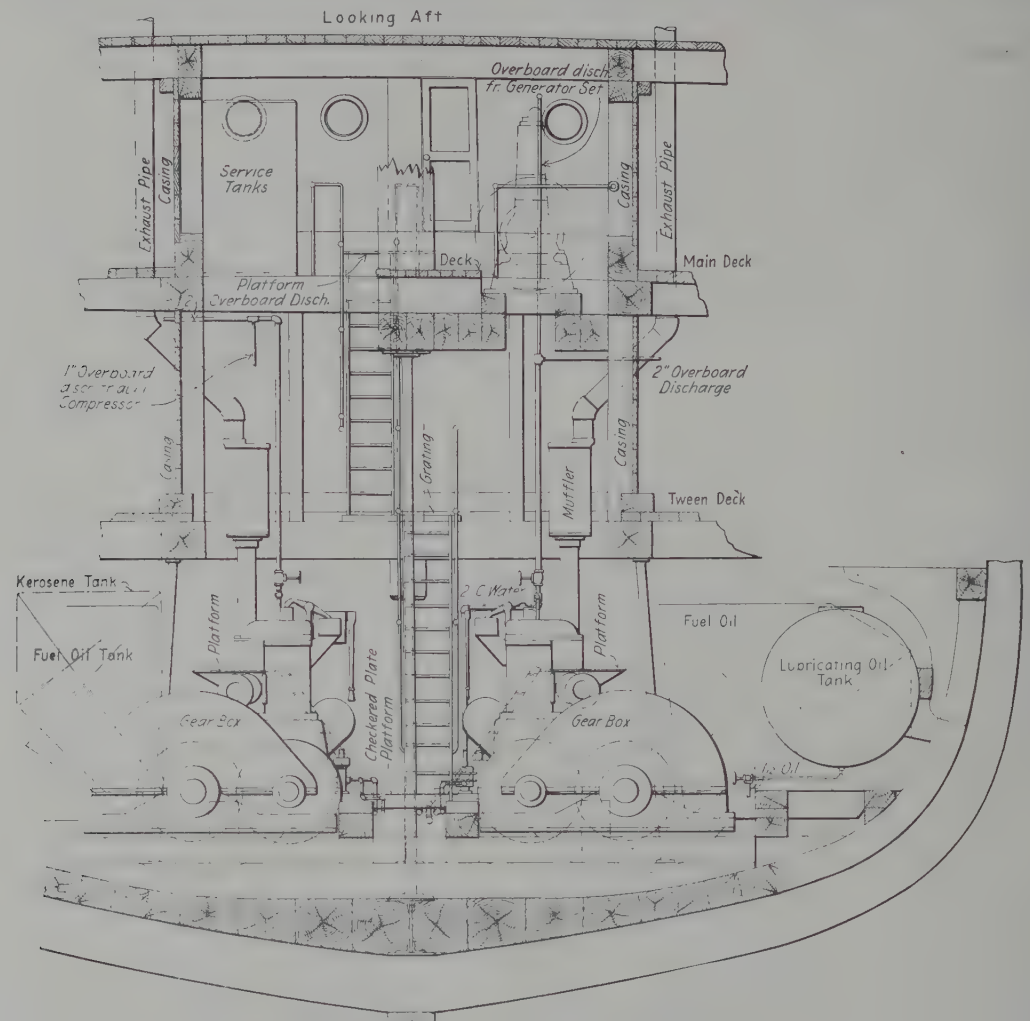

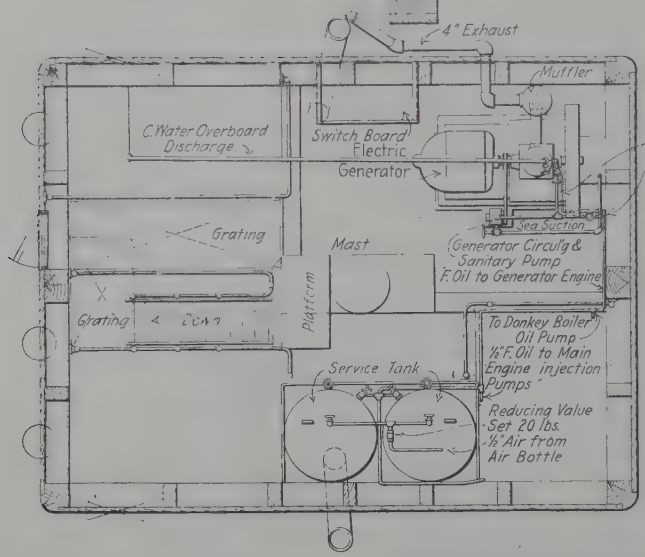

Note

½ Ton tackle & hooks to be provided in engine room for lifting engine parts.
Exhaust gas pipes to be properly lagged & insulated inway of wood work with asbestos.
Exhaust gas pipes, steam & exhaust steam pipes black iron.
Fuel oil suction kerosene & lubricating oil pipes galvanized iron.
½" Fuel oil & kerosene pipes: copper
Sea suction & circulating water pipes: brass
Valve on fuel oil, kerosene & lubricating oil pipes to have iron bodies & brass fittings.

WOODEN MOTOR SHIP
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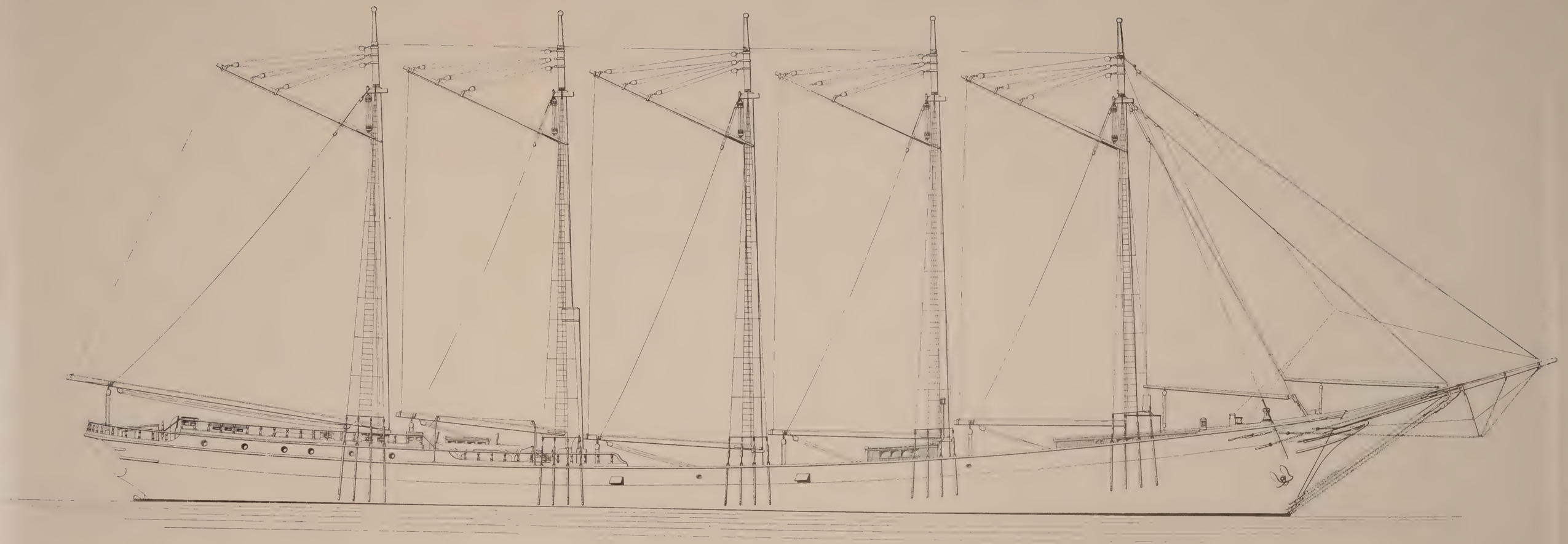
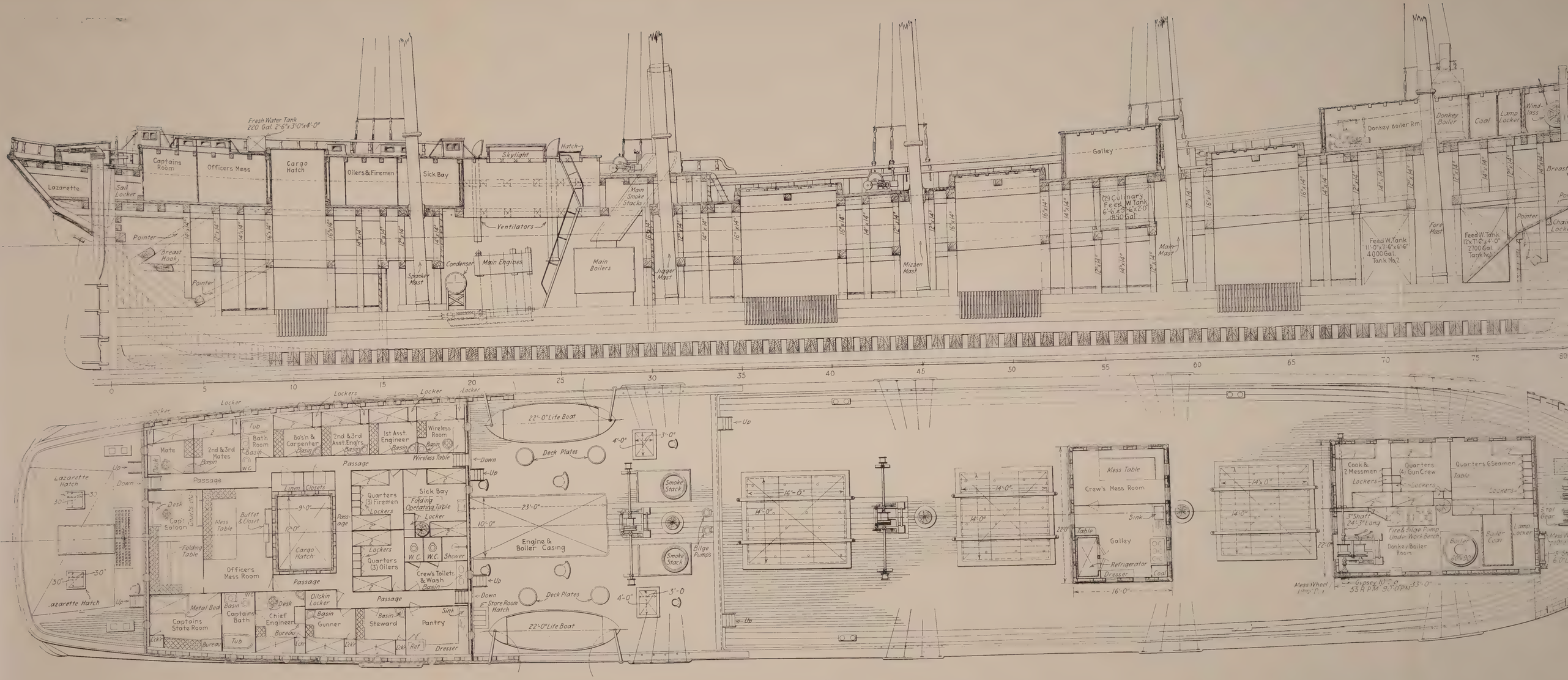


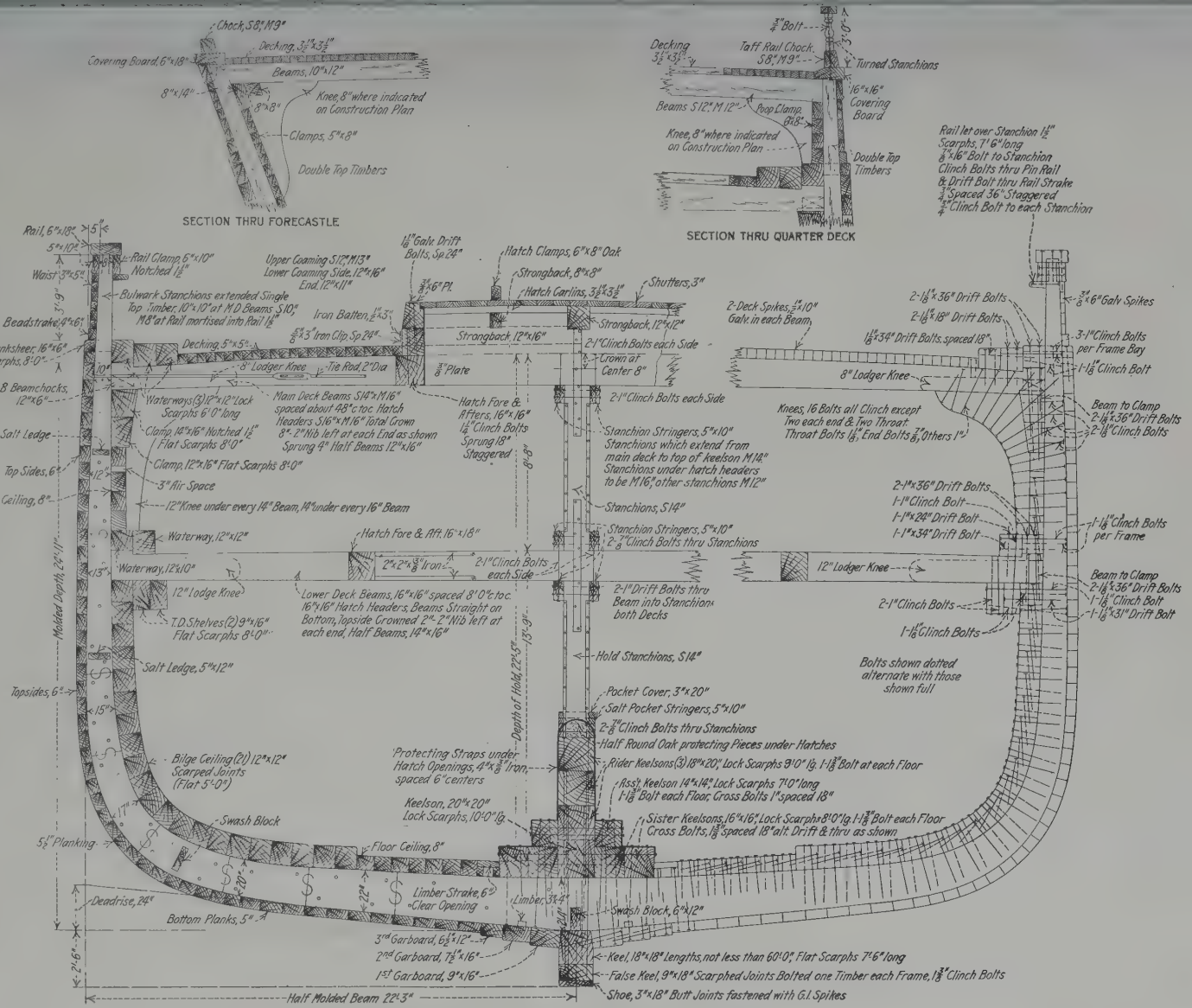
Principal Dimensions

Length O. A.	280′— 0″
Length B. P.	249′— 7″
Beam Ext.	45′— 6″
Depth Ml'd.	24′—11″
Draft Loaded	23′— 0″

OUTBOARD PROFILE
AUXILIARY FIVE MASTED SCHOONER
Designed by Cox and Stevens, New York City



INBOARD PROFILE AND MAIN DECK
AUXILIARY FIVE MASTED SCHOONER
Designed by Cox and Stevens, New York City


SECTION THRU FORECASTLE
SECTION THRU QUARTER DECK
Chock, S8", M9"
Decking, 3½"x3½"
Covering Board, 6"x18"
Beams, 10"x12"
8"x14"
Knee, 8" where indicated on Construction Plan
Clamps, 5"x8"
Double Top Timbers
¾" Bolt
Taff Rail Chock, S8", M9"
Turned Stanchions
16"x16" Covering Board
Beams S12", M12"
Knee, 8" where indicated on Construction Plan
Double Top Timbers
Rail let over Stanchion 1½"
Scarphs, 1'6" long
⅝"x16" Bolt to Stanchion
Clinch Bolts thru Pin Rail
¾" Drift Bolt thru Rail Strake
¾" Spaced 36" Staggered
¾" Clinch Bolt to each Stanchion
Rail, 6"x18"
Waist, 3"x5"
Bulwark Stanchions extended Single Top Timber, 10"x10" at M D Beams, S10", M8" at Rail mortised into Rail 1½"
Beadstrake, 4"x6"
Planksheer, 16"x6" Scarphs, 8'-0"
M B Beamchocks, 12"x16"
Salt Ledge
Top Sides, 6"
Ceiling, 8"
Molded Depth, 22'-11"
Topsides, 6"
Deadrise, 24"
Bottom Planks, 5"
5½" Planking
Rail Clamp, 6"x10" Notched 1½"
Upper Coaming S12", M13"
Lower Coaming Side, 12"x16"
End, 12"x11"
Iron Batten, 1"x3½"
Decking, 5"x5"
8" Lodger Knee
Tie Rod, 2" Dia
Waterways (3) 12"x12" Lock Scarphs 6'0" long
Clamp 14"x16" Notched 1½" Flat Scarphs 8'0"
Clamp, 12"x16" Flat Scarphs 8'0"
3" Air Space
12" Knee under every 14" Beam, 14" under every 16" Beam
Waterway, 12"x12"
Waterway, 12"x10"
12" Lodge Knee
T.D. Shelves (2) 9"x16" Flat Scarphs 8'0"
Salt Ledge, 5"x12"
Bilge Ceiling (2) 12"x12" Scarped Joints (Flat 5'-0")
Swash Block
Floor Ceiling, 8"
Limber Strake, 6" Clear Opening
Limber, 3"x4"
3rd Garboard, 6½"x12"
2nd Garboard, 7½"x16"
1st Garboard, 9"x16"
Half Molded Beam 22'-3"
1⅛" Galv. Drift Bolts, Sp 24"
¾"x6" Pl.
Strongback, 8"x8"
Hatch Carlins, 3½"x3½"
Strongback, 12"x12"
Strongback 12"x16"
⅝" Plate
Hatch Clamps, 6"x8" Oak
Shutters, 3"
2-1" Clinch Bolts each Side
Crown at Center 8"
Main Deck Beams S14"x M16" spaced about 48" c. to c. Hatch Headers S16"x M16" Total Crown 8". 2" Nib left at each End as shown
Sprung 9" Half Beams 12"x16"
Hatch Fore & Afters, 16"x16" 1¼" Clinch Bolts Sprung 18" Staggered
Stanchion Stringers, 5"x10"
Stanchions which extend from main deck to top of Keelson M14"
Stanchions under hatch headers to be M16", other stanchions M12"
Stanchions, S14"
Stanchion Stringers, 5"x10"
2-⅞" Clinch Bolts thru Stanchions
Hatch Fore & Aft, 16"x18"
2"x2"x⅜" Iron
2-1" Clinch Bolts each Side
Lower Deck Beams, 16"x16" spaced 8'0" c. to c. 16"x16" Hatch Headers, Beams Straight on Bottom, Topside Crowned 2". 2" Nib left at each end, Half Beams, 14"x16"
2-1" Drift Bolts thru Beam into Stanchion both Decks
Hold Stanchions, S14"
Pocket Cover, 3"x20"
Salt Pocket Stringers, 5"x10"
2-⅞" Clinch Bolts thru Stanchions
Half Round Oak protecting Pieces under Hatches
Rider Keelsons (3) 18"x20", Lock Scarphs 9'0" lg. 1-1⅜" Bolt at each Floor
Ass't Keelson 14"x14", Lock Scarphs 7'0" long
1-1⅜" Bolt each Floor, Cross Bolts 1" spaced 18"
Sister Keelsons, 16"x16", Lock Scarphs 8'0" lg. 1-1⅜" Bolt each Floor
Cross Bolts, ⅞" spaced 18" alt. Drift & thru as shown
Protecting Straps under Hatch Openings, 4"x⅜" Iron, spaced 6" centers
Keelson, 20"x20" Lock Scarphs, 10'0" lg.
Swash Block, 6"x12"
Keel, 18"x18" Lengths, not less than 60'0", Flat Scarphs 7'6" long
False Keel, 9"x18" Scarphed Joints Bolted one Timber each Frame, 1⅜" Clinch Bolts
Shoe, 3"x18" Butt Joints fastened with G.I. Spikes
Depth of Hold, 22'-5"
13'-9"
8'-8"
2-Deck Spikes, ⅝"x10" Galv. in each Beam
2-1⅛" x 36" Drift Bolts
2-1½" x 18" Drift Bolts
1⅛" x 34" Drift Bolts, spaced 18"
8" Lodger Knee
Knees, 16 Bolts all Clinch except Two each end & Two Throat. Throat Bolts 1⅛", End Bolts ⅞", Others 1"
2-1" x 36" Drift Bolts
1-1" Clinch Bolt
1-1" x 20" Drift Bolt
1-1" x 34" Drift Bolt
12" Lodger Knee
2-1" Clinch Bolts
1-1⅛" Clinch Bolts
Bolts shown dotted alternate with those shown full
¾" x 6" Galv. Spikes
3-1" Clinch Bolts per Frame Bay
1-1⅛" Clinch Bolt
Beam to Clamp
2-1⅛" x 36" Drift Bolts
2-1⅛" Clinch Bolts
Beam to Clamp
2-1⅛" x 36" Drift Bolts
1-1⅛" Clinch Bolt
1-1⅛" x 31" Drift Bolt

AUXILIARY FIVE MASTED SCHOONER

Designed by Cox & Stevens, New York City

See Next Page

AUXILIARY FIVE MASTED SCHOONER

For Plan of Midship Section
See Page 445

SCANTLINGS

Stem: S18″ M26″ butt fir, in one piece.

Apron: S20″ M30″ butt fir, in one piece.

False Stem: Iron bark M8″ face to match stem.

Knightheads: S-14″ x M 30″ to forecastle head.

Hawse Timbers: 4 tiers, 14″ timber parallel to stem.

Deadwoods: 20″ thick fitted diagonally molded to house cants and ceiling.

Pointers and Hooks: Pointers 14″ thick M 12 at heel and 10″ at top end, kneed with 12″ knees, breast hook knees 14″ thick.

Stern Post: Butt Fir in one piece M 32″ S 36″ at top, 18″ at bottom.

Rudder Stock: 22″ iron bark not less than 30′ long, shaped into rudder in one piece.

Transom: Main transom timber 18″ x 18″, upper timber 10″ x 10″.

Tie Rods: Six of 2″ dia. to be located between main deck beam set upon ¾″ steel plate.

Bow Ports: Located just above load water line, clear opening 28″ x 28″, 12″ sill timbers and breast hooks top and bottom.

Hatches: Four. Two—14′ x 14′, one—14′ x 16′, one—10′ x 12′.

Masts: Foremast 26″ dia. Others 25″ dia.

Lumber: In general of Douglas fir.

EQUIPMENT

2 Bower Anchors	4,760#	Stockless
1 " Anchor	3,950#	"
1 Stream Anchor	1,620#	Including Stock
1 Kedge Anchor	810#	" "

240 Fathoms of 1⅞″ Stud Link Chain.
90 " " 12″ Hemp Tow Line.
90 " " 9½″ Stream Anchor Hawser.
270 " " 6½″ Hemp Hawsers.

PRINCIPAL DIMENSIONS

Length over all	280′—0″
Length between Per'ps	249′—7″

PRINCIPAL DIMENSIONS—Continued

Beam extreme	45′—6″
Depth of hold	22′—5″
Depth molded	24′—11″
Draft loaded	23′—0″
Freeboard amidships top of main deck	4′—6½″

FASTENINGS

Garboard to frame 4-1″ x 24″ gal. drift bolts
2nd and 3rd garboard 2-1″ x 24″ galv. drift bolts and 2 treenails.

Remainder of planking 2 spikes or drift bolts, ¾″ x 16″ and 2 treenails; planking over 10″ wide 3 treenails.

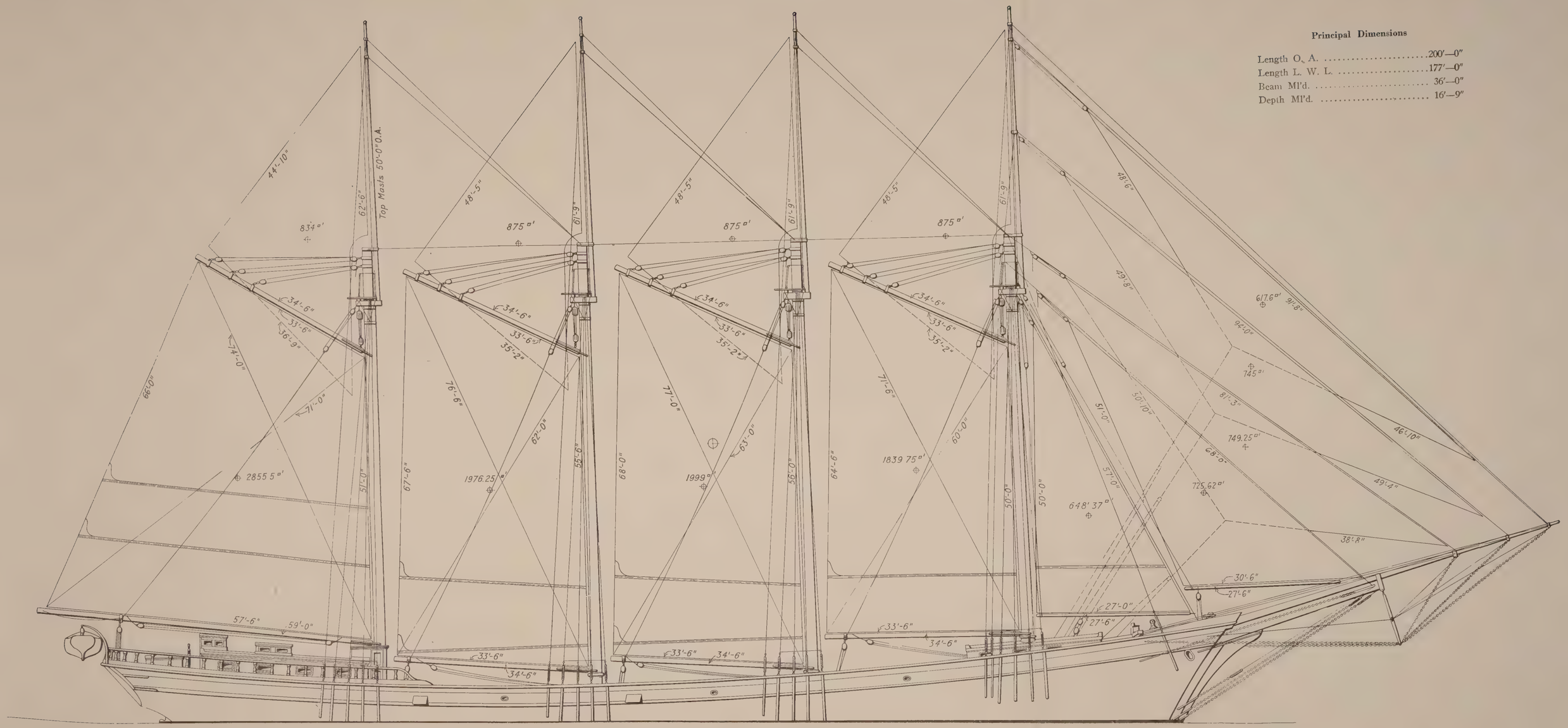
Treenails hardwood or locust not less than ⅔ to go thru and be wedged on inside of ceiling.

All ceiling to be edge bolted in every strake with bolts alternating every other frame space; bolts to be ⅞″ for 8″ ceiling, 1″ for ceiling 8″ to 11″ and 1⅛″ for 11″ ceiling and over. Length not less than 2 strake width and 4″ additional. Drift bolts to frames same dia. as corresponding edge bolts; bolts thru floors ceiling 20″ long; bolts thru bilge and side ceiling to extend within 1″ of finish surface of frame. Two bolts per strake to each timber of frames.

Bolt and spike heads where exposed to the weather to be set in and plugged with white pine plug dipped in white lead.

Iron strapping for about ⅔ length amidships ¾″ x 8″ belts connected by treble riveted butt laps fastened to each frame by 1″ x 10″ countersunk head blunt bolts staggered. Diagonal straps ½″ x 4″ at 45 degrees let into frame and to meet top belt in every other frame space connected with 2-⅞″ rivets. 1″ rivet at crossing 1-1″ x 10″ bolt to each frame. Diagonal straps overlap floor timbers.

Frames double sawn spaced 36″ C-to-C-sided throughout 12″ molded as shown. Floors long and short arm alternately. Top timbers 10″ x 12″; timbers secured together with 1¼″ treenails, one drift bolt to keel thru each floor.
To overlap not less than 3′-6″.

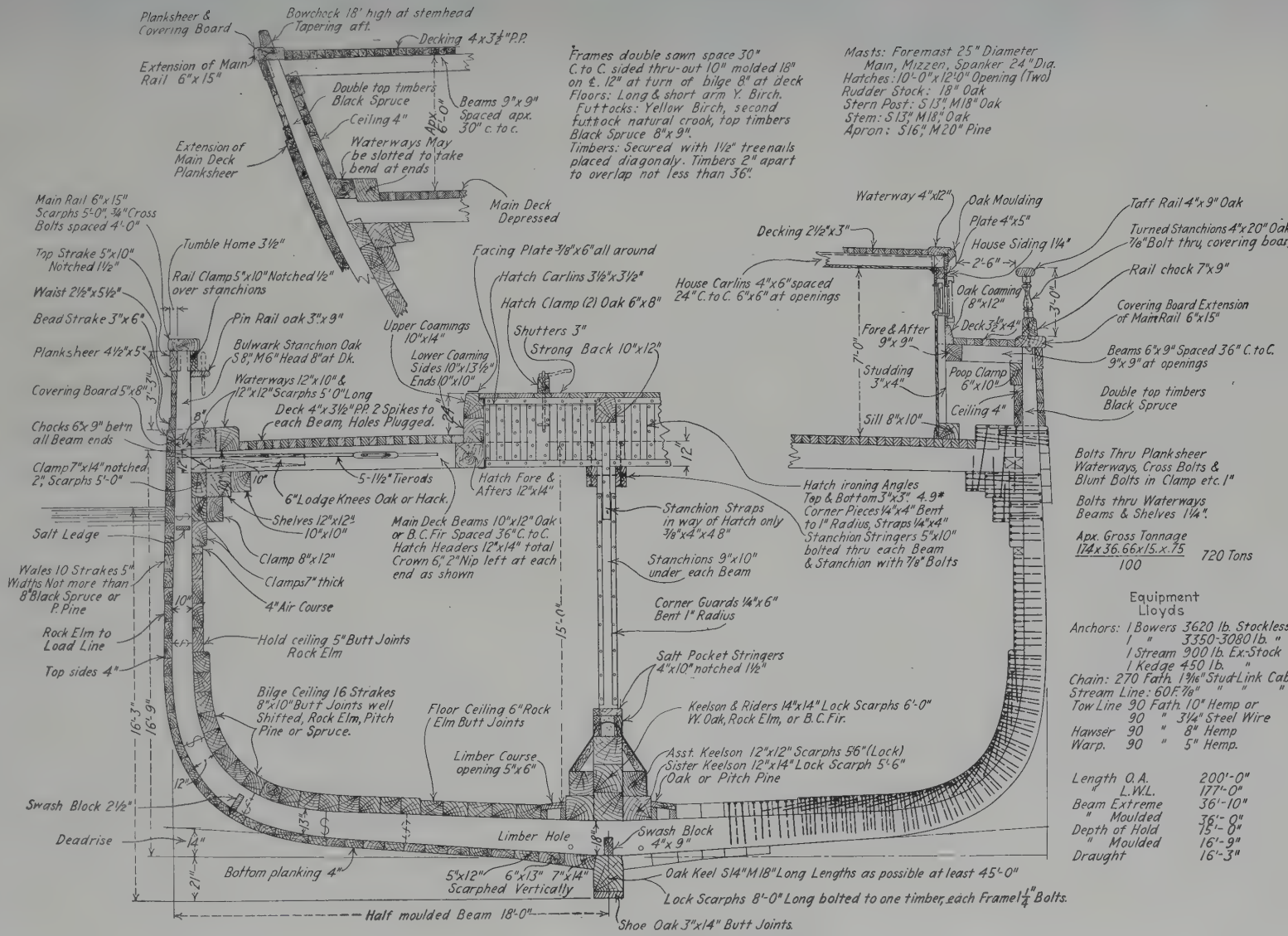


Principal Dimensions

Length O. A.	200'—0"
Length L. W. L.	177'—0"
Beam Ml'd.	36'—0"
Depth Ml'd.	16'—9"

PROFILE AND SAIL PLAN
FOUR MASTED WOODEN SCHOONER
Designed by Cox and Stevens, New York City

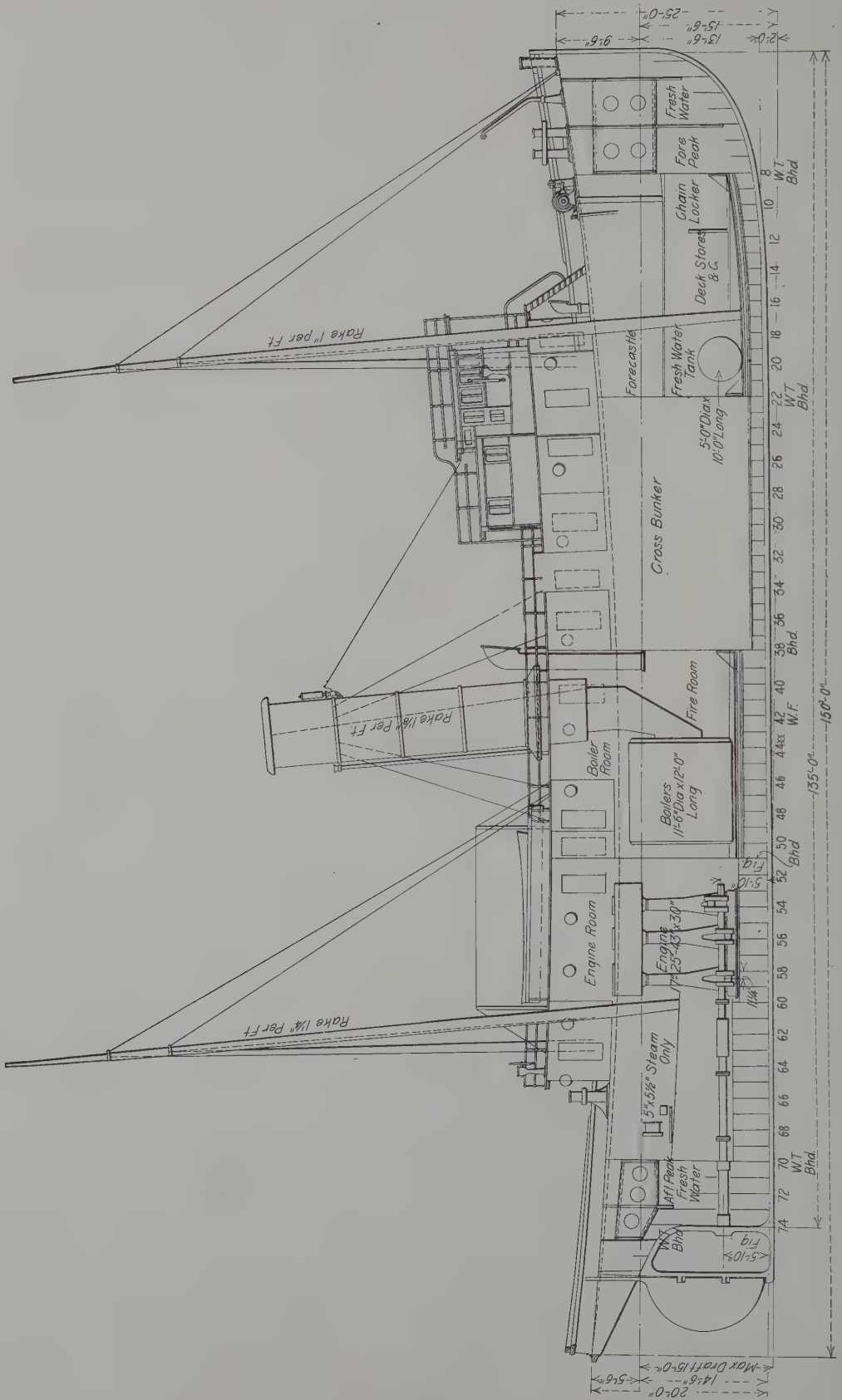
PLATE XXVI


Plankshear & Covering Board
Bowchock 18' high at stemhead Tapering aft.
Decking 4"x3½" P.P.
Extension of Main Rail 6"x15"
Double top timbers Black Spruce
Ceiling 4"
Beams 9"x9" Spaced apx. 30" c. to c.
Apx. 6'-0"
Extension of Main Deck Plankshear
Waterways May be slotted to take bend at ends
Main Deck Depressed
Frames double sawn space 30" C. to C. sided thru-out 10" molded 18" on ℄. 12" at turn of bilge 8" at deck
Floors: Long & short arm Y. Birch.
Futtocks: Yellow Birch, second futtock natural crook, top timbers Black Spruce 8"x9".
Timbers: Secured with 1½" treenails placed diagonaly. Timbers 2" apart to overlap not less than 36".
Masts: Foremast 25" Diameter
Main, Mizzen, Spanker 24" Dia.
Hatches: 10'-0"x12'0" Opening (Two)
Rudder Stock: 18" Oak
Stern Post: S13", M18" Oak
Stem: S13", M18", Oak
Apron: S16", M20" Pine
Main Rail 6"x15" Scarphs 5'-0", ¾" Cross Bolts spaced 4'-0"
Tumble Home 3½"
Top Strake 5"x10" Notched 1½"
Rail Clamp 5"x10" Notched ½" over stanchions
Waist 2½"x5½"
Bead Strake 3"x6"
Pin Rail oak 3"x9"
Plankshear 4½"x5"
Bulwark Stanchion Oak S 8", M 6" Head 8" at Dk.
Covering Board 5"x8"
Waterways 12"x10" & 12"x12" Scarphs 5'0" Long
Deck 4"x3½" P.P. 2 Spikes to each Beam, Holes Plugged.
Chocks 6"x9" bet'n all Beam ends
Clamp 7"x14" notched 2", Scarphs 5'-0"
6" Lodge Knees Oak or Hack.
5-1½" Tierods
Shelves 12"x12" 10"x10"
Salt Ledge
Clamp 8"x12"
Clamps 7" thick
Wales 10 Strakes 5" Widths Not more than 8" Black Spruce or P. Pine
4" Air Course
Rock Elm to Load Line
Top sides 4"
Hold ceiling 5" Butt Joints Rock Elm
Bilge Ceiling 16 Strakes 8"x10" Butt Joints well Shifted, Rock Elm, Pitch Pine or Spruce.
Swash Block 2½"
Deadrise
Bottom planking 4"
Facing Plate ⅞"x6" all around
Hatch Carlins 3½"x3½"
Hatch Clamp (2) Oak 6"x8"
Upper Coamings 10"x14"
Lower Coaming Sides 10"x13½" Ends 10"x10"
Shutters 3"
Strong Back 10"x12"
Hatch Fore & Afters 12"x14"
Main Deck Beams 10"x12" Oak or B.C. Fir Spaced 36" C. to C. Hatch Headers 12"x14" total Crown 6", 2" Nip left at each end as shown
Floor Ceiling 6" Rock Elm Butt Joints
Limber Course opening 5"x6"
Limber Hole
Swash Block 4"x9"
5"x12" 6"x13" 7"x14" Scarphed Vertically
Oak Keel S14" M18" Long Lengths as possible at least 45'-0"
Lock Scarphs 8'-0" Long bolted to one timber, each Frame 1¼" Bolts.
Half moulded Beam 18'-0"
Shoe Oak 3"x14" Butt Joints.
Waterway 4"x12"
Oak Moulding
Plate 4"x5"
Decking 2½"x3"
House Siding 1¼"
2'-6"
Taff Rail 4"x9" Oak
Turned Stanchions 4"x20" Oak
⅞" Bolt thru covering board.
Rail chock 7"x9"
House Carlins 4"x6" spaced 24" C. to C. 6"x6" at openings
Oak Coaming 8"x12"
Deck 3½"x4"
3'-0"
Covering Board Extension of Main Rail 6"x15"
Fore & After 9"x9"
7'-0"
Beams 6"x9" Spaced 36" C. to C. 9"x9" at openings
Studding 3"x4"
Poop Clamp 6"x10"
Ceiling 4"
Double top timbers Black Spruce
Sill 8"x10"
Hatch ironing Angles Top & Bottom 3"x3"x.4.9# Corner Pieces ¼"x4" Bent to 1" Radius, Straps ¼"x4" Stanchion Stringers 5"x10" bolted thru each Beam & Stanchion with ⅞" Bolts
Stanchion Straps in way of Hatch only ⅜"x4"x4'8"
Stanchions 9"x10" under each Beam
Corner Guards ¼"x6" Bent 1" Radius
Salt Pocket Stringers 4"x10" notched 1½"
Keelson & Riders 14"x14" Lock Scarphs 6'-0" W. Oak, Rock Elm, or B.C. Fir.
Asst. Keelson 12"x12" Scarphs 56" (Lock) Sister Keelson 12"x14" Lock Scarph 5'-6" Oak or Pitch Pine
Bolts Thru Plankshear Waterways, Cross Bolts & Blunt Bolts in Clamp etc. 1"
Bolts thru Waterways Beams & Shelves 1¼".
Apx. Gross Tonnage 174x36.66x15.x.75 / 100 = 720 Tons
Equipment Lloyds
Anchors: 1 Bowers 3620 lb. Stockless } 3 Anchors
1 " 3350-3080 lb. "
1 Stream 900 lb. Ex-Stock
1 Kedge 450 lb. "
Chain: 270 Fath. 1 3/16" Stud-Link Cable
Stream Line: 60 F. 7/8" " " "
Tow Line 90 Fath. 10" Hemp or 90 " 3¼" Steel Wire
Hawser 90 " 8" Hemp
Warp. 90 " 5" Hemp.
Length O.A. 200'-0"
" L.W.L. 177'-0"
Beam Extreme 36'-10"
" Moulded 36'-0"
Depth of Hold 15'-0"
" Moulded 16'-9"
Draught 16'-3"

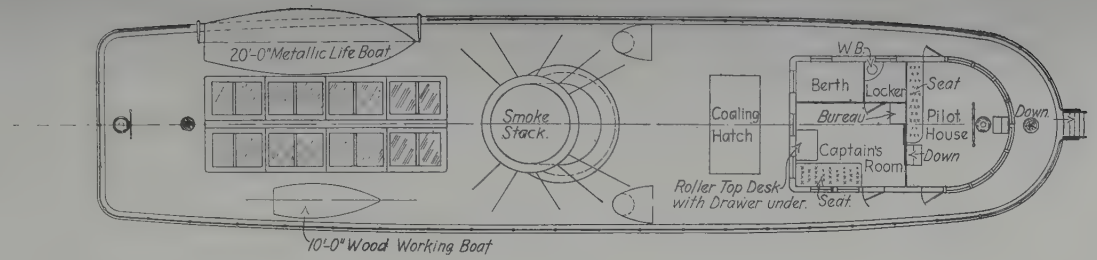
FOUR MASTED SCHOONER

Designed by Cox & Stevens, New York City

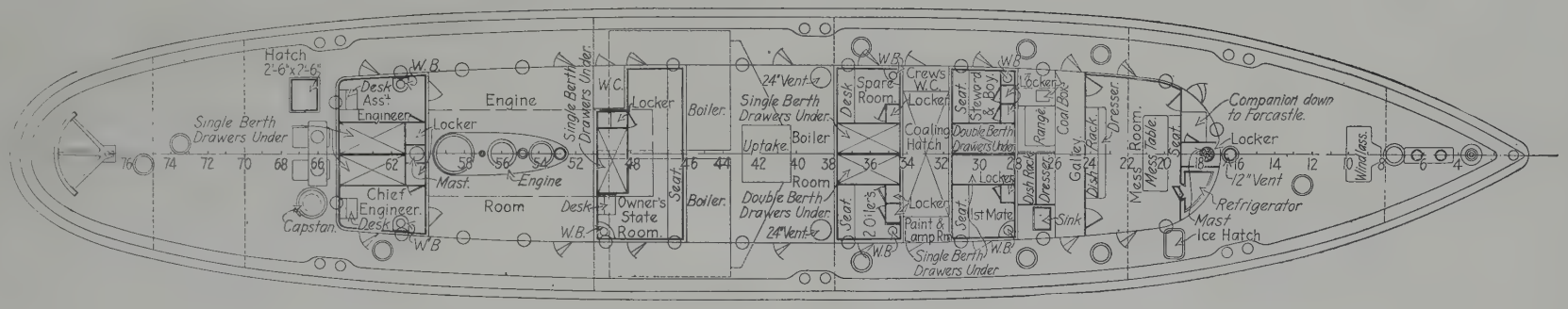
INBOARD PROFILE



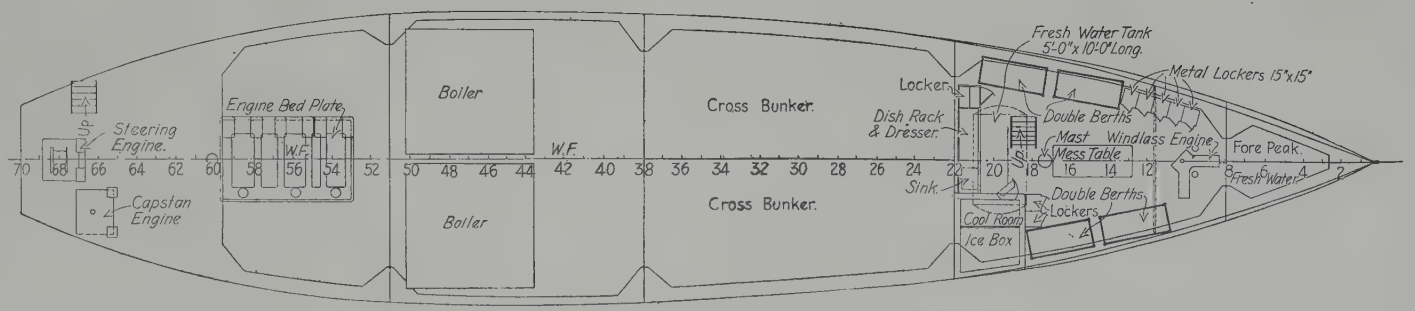
STEEL SEA GOING TUG
Staten Island Shipbuilding Co., Staten Island, N. Y.
See Opposite Page



TOP OF HOUSE



MAIN DECK

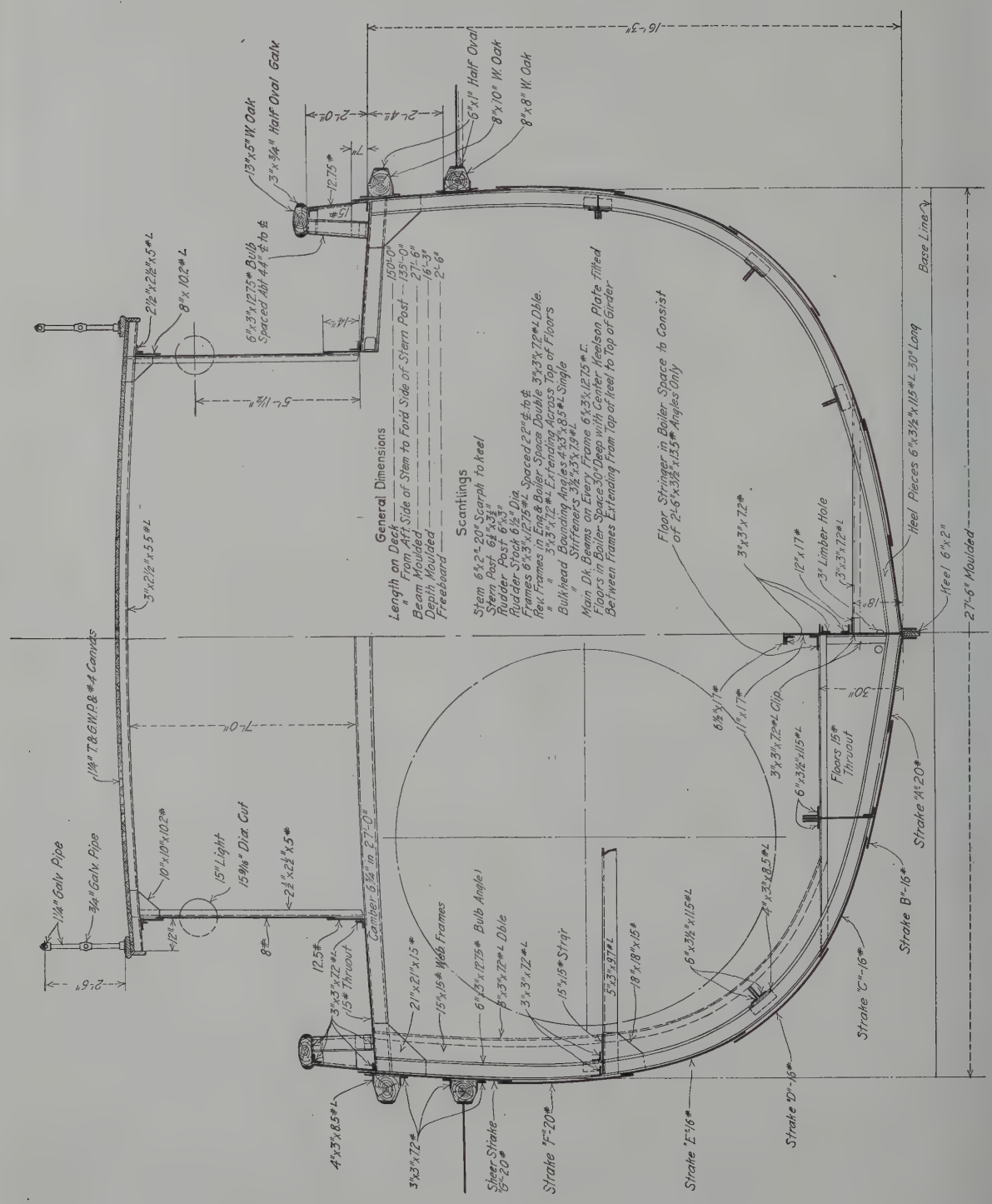


HOLD

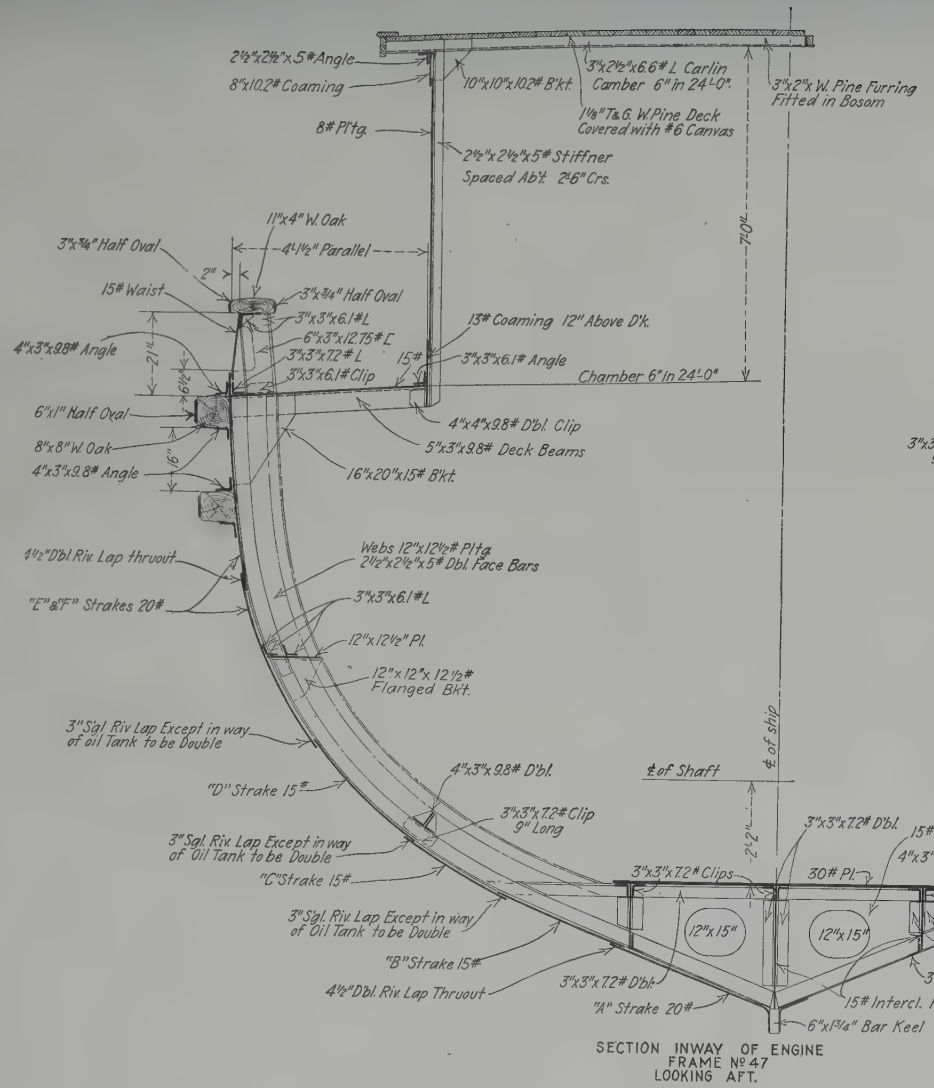
STEEL SEA GOING TUG

Staten Island Shipbuilding Co., Staten Island, N. Y.

See Opposite Page



STEEL SEA GOING TUG
Staten Island Shipbuilding Co., Staten Island, N. Y.

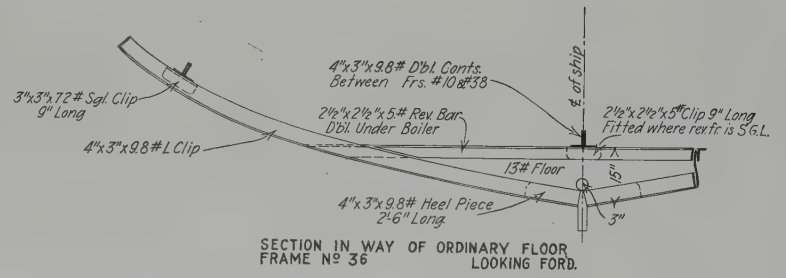


SECTION INWAY OF ENGINE
FRAME № 47
LOOKING AFT.

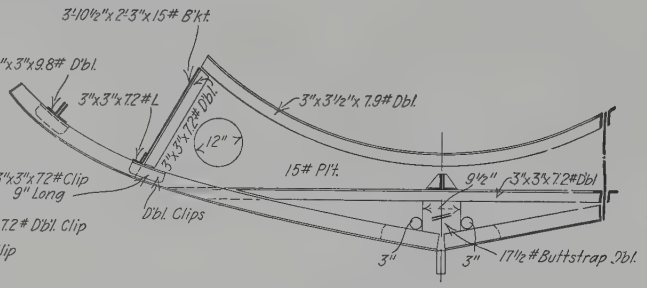
General Dimensions

Length O.A.	100'-2"
" between Perp's.	94'-10"
Breadth Moulded	24'-0"
Depth Moulded	12'-9"

Stem 6"x2"
Stern Frame 6"x2½"
Rudder - 6½" Stock - 12# Pl't - 9" L Frame
Frames 4"x3"x9.8# Spaced 14" For'd. #26 & #20 Aft
Web Frames one in Engine Space & one in Boiler Space
Forecastle Deck Beams 3"x2½"x6.6# L 12"x12"x10.2# B'k't.
W.T. B'h'd.
Pl'tg. 10.2# - 13# Floor - Stiffner 3"x2½"x5.5# B. Bar 4"x3"x9.8#
O.T. B'h'd.
Pl'tg. 12.5# - 15# Floor Vert. Stiff. 4"x3"x7.2# Hor. Stiff 5"x3"x9.8#
B. Bar 3½"x3½"x8.5# D'bl.
Deck Stringer 15# Pl'tg. 12#



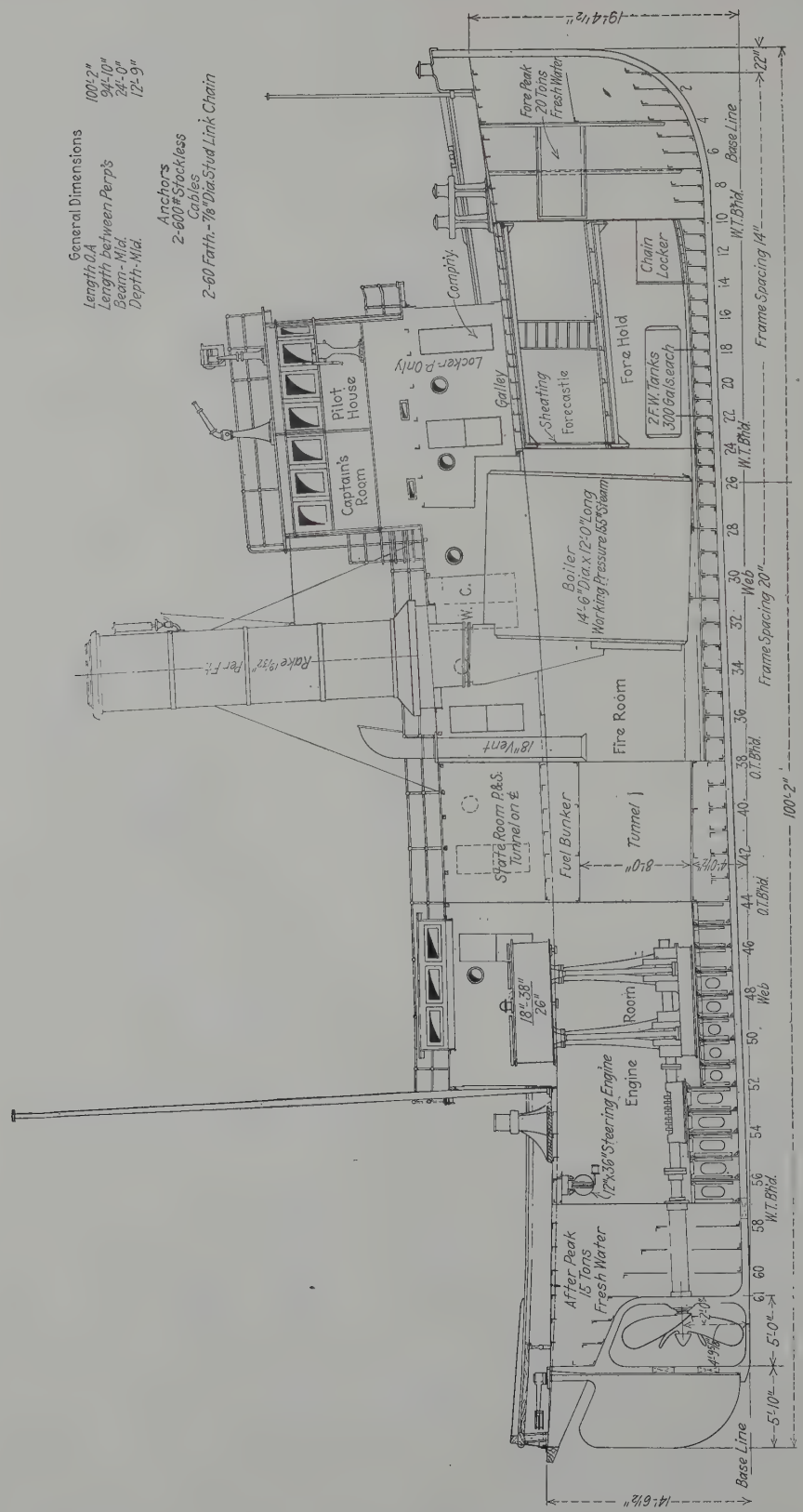
SECTION IN WAY OF ORDINARY FLOOR
FRAME № 36
LOOKING FOR'D.



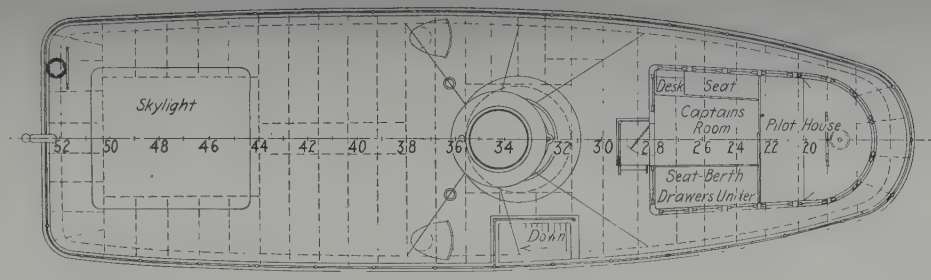
SECTION AT BOILER SADDLE
FRAME № 31
LOOKING FOR'D.

STEEL HARBOR TUG

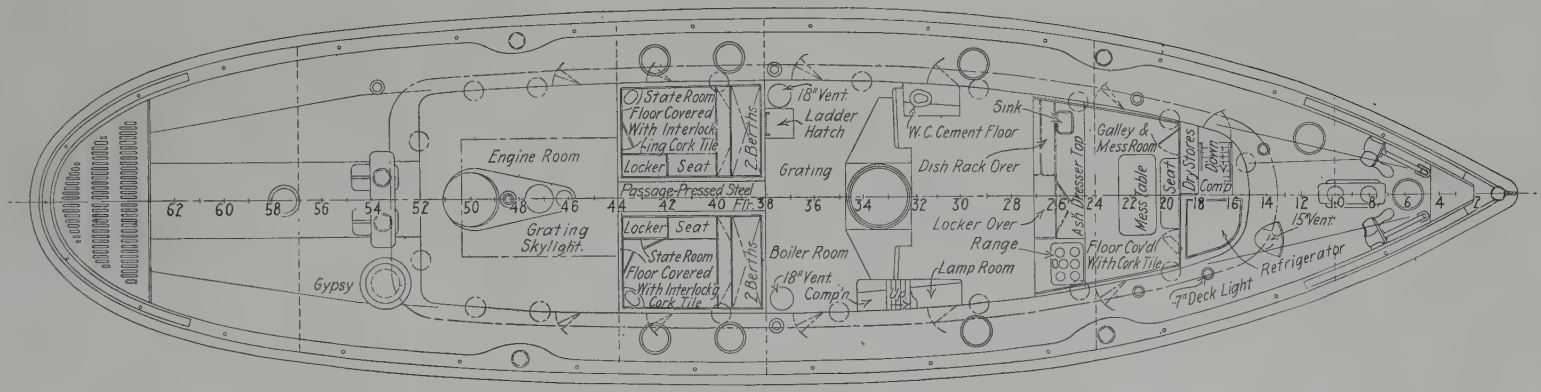
Staten Island Shipbuilding Co., Staten Island, N. Y.



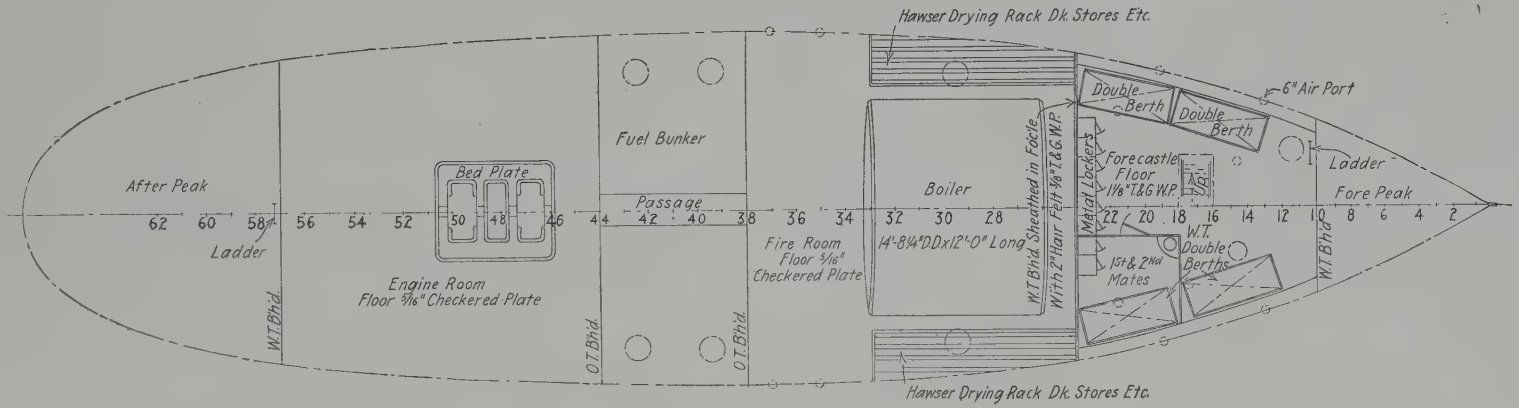
STEEL HARBOR TUG
Staten Island Shipbuilding Co., Staten Island, N. Y.
See Opposite Page



DECK HOUSE TOP



MAIN DECK

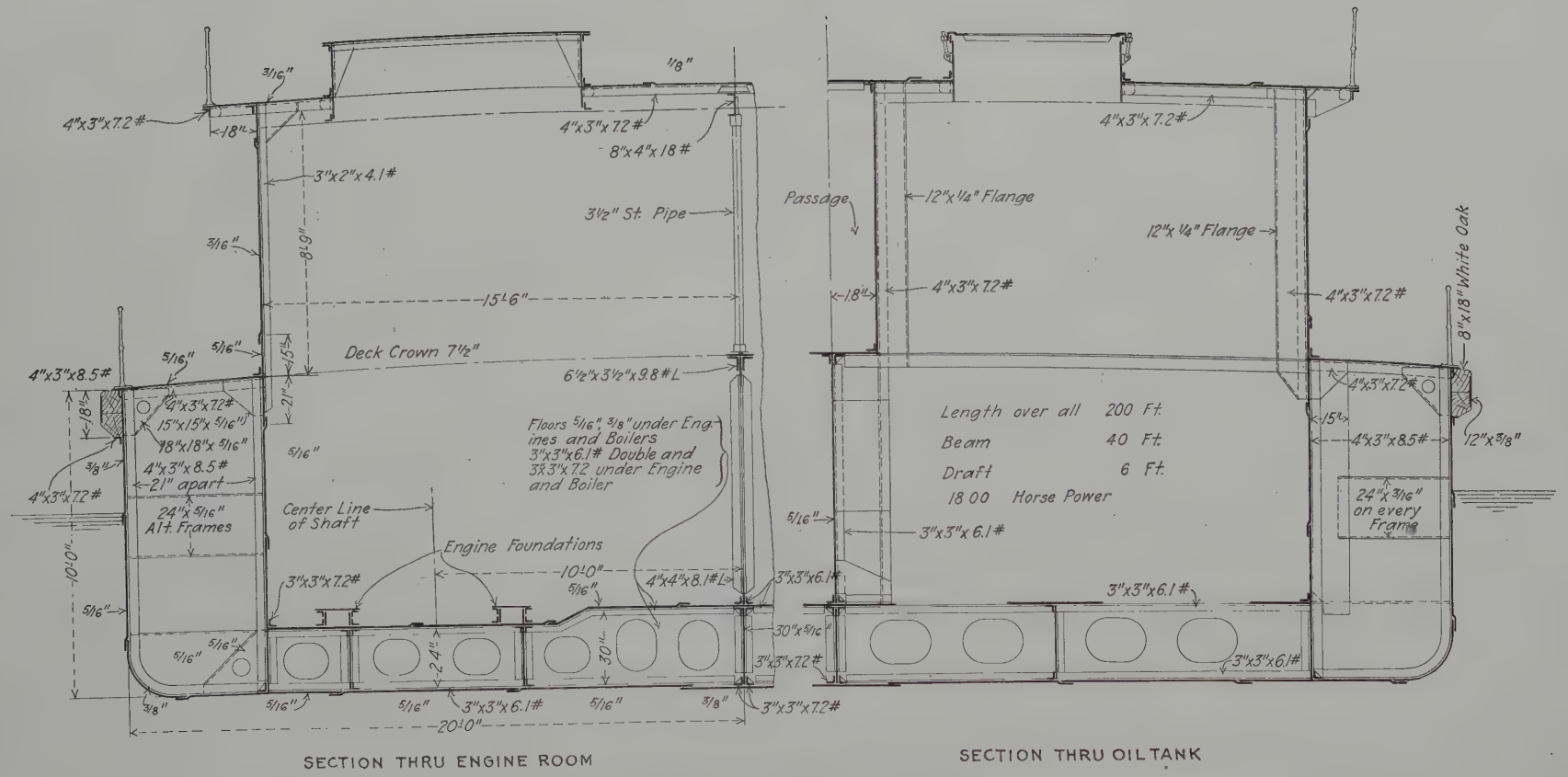


HOLD

STEEL HARBOR TUG

Staten Island Shipbuilding Co., Staten Island, N. Y.

See Opposite Page



SECTION THRU ENGINE ROOM

SECTION THRU OIL TANK

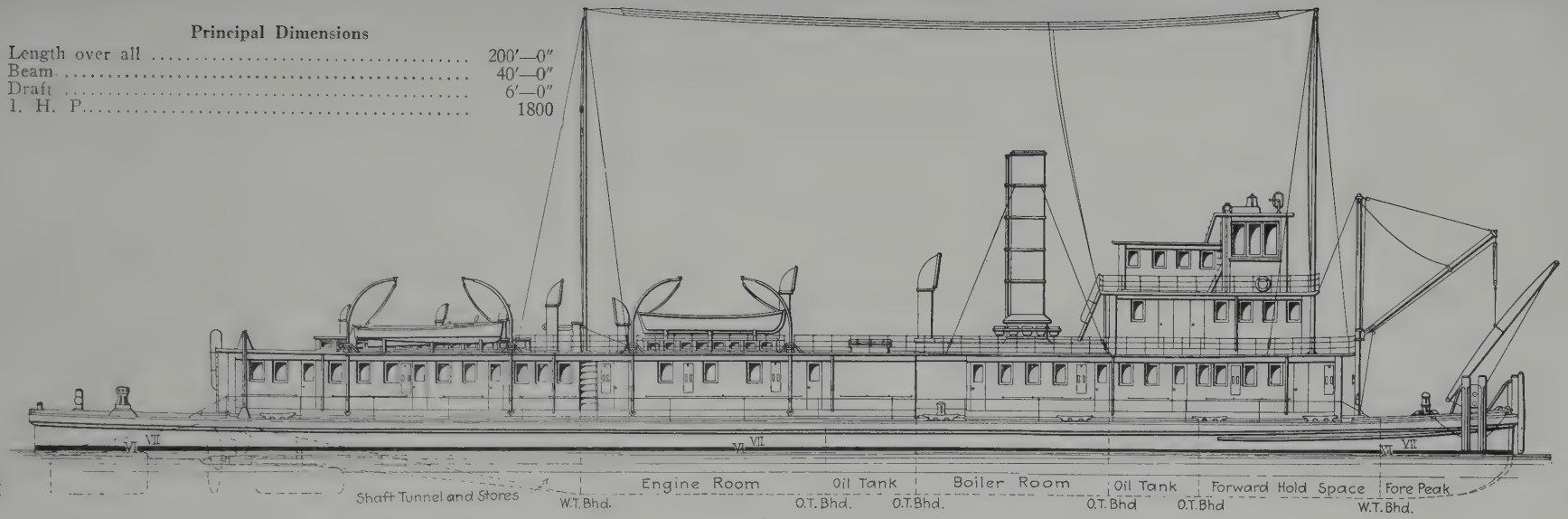
TUNNEL STERN RIVER TOW BOAT

Designed by Cox & Stevens, New York City

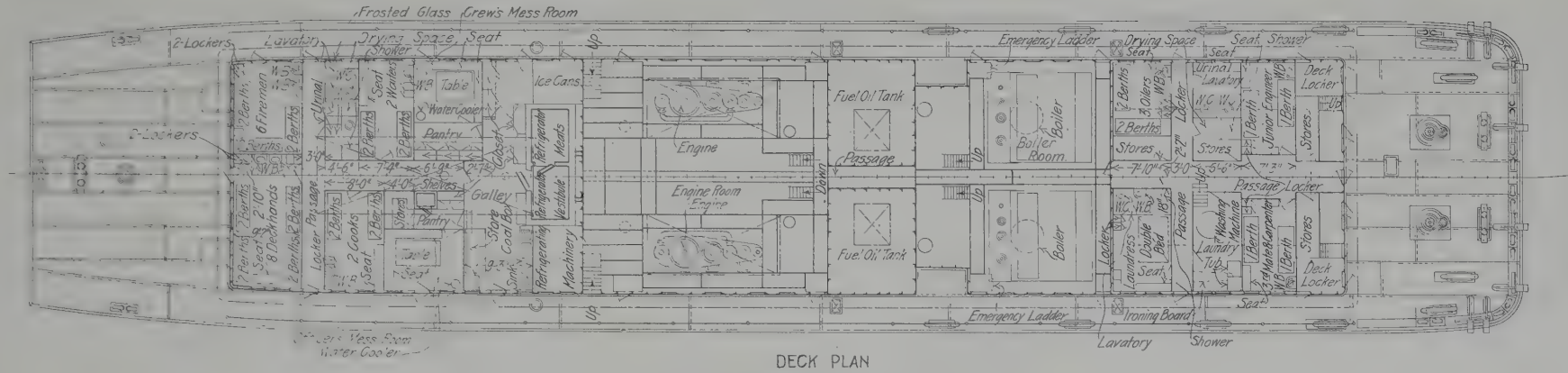
See Opposite Page

Principal Dimensions

Length over all	200′—0″
Beam	40′—0″
Draft	6′—0″
I. H. P.	1800



PROFILE



DECK PLAN

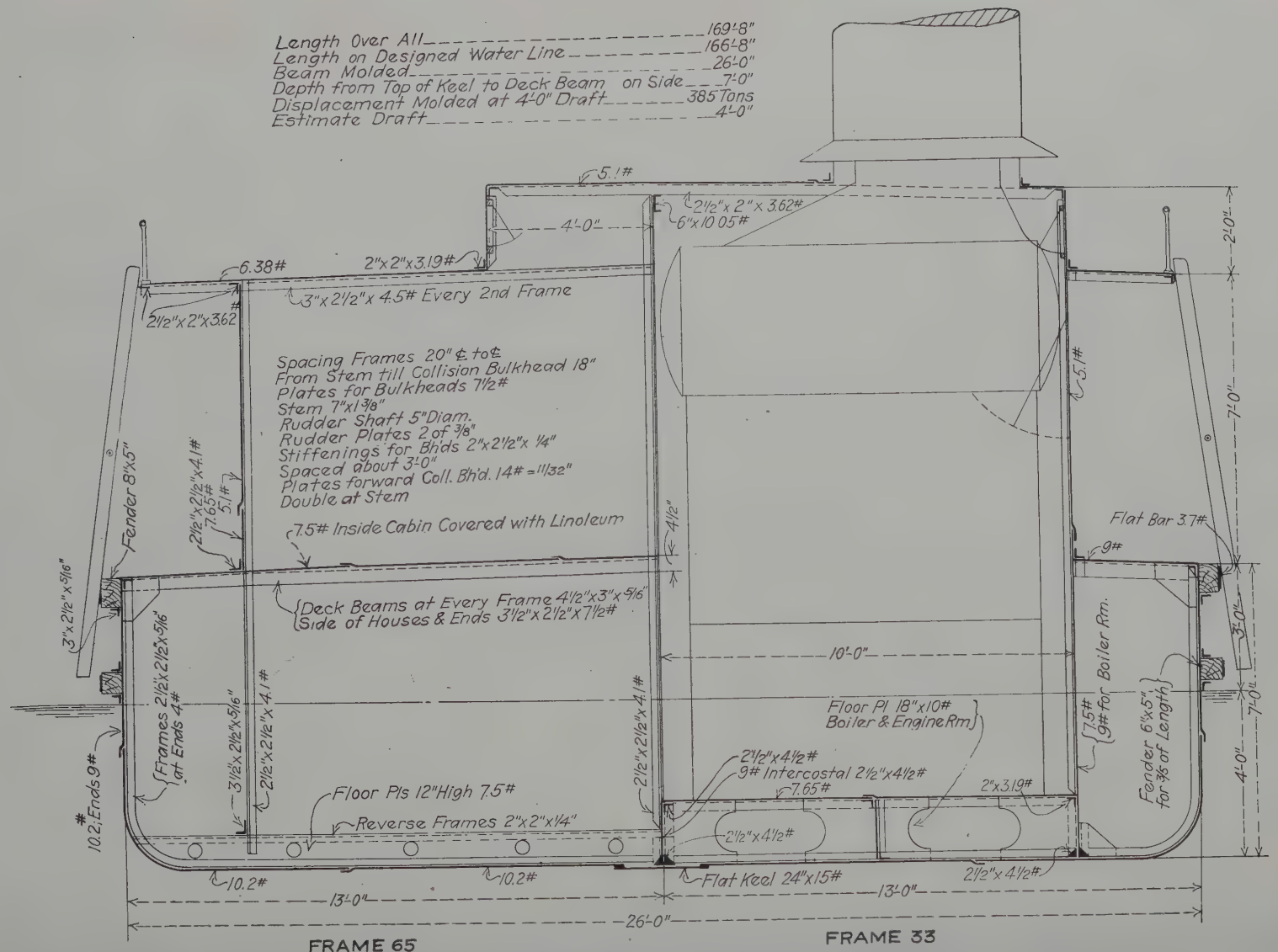
TUNNEL STERN RIVER TOW BOAT

Designed by Cox and Stevens, New York City

See Opposite Page

General Description

Length Over All	169'-8"
Length on Designed Water Line	166'-8"
Beam Molded	26'-0"
Depth from Top of Keel to Deck Beam on Side	7'-0"
Displacement Molded at 4'-0" Draft	385 Tons
Estimate Draft	4'-0"

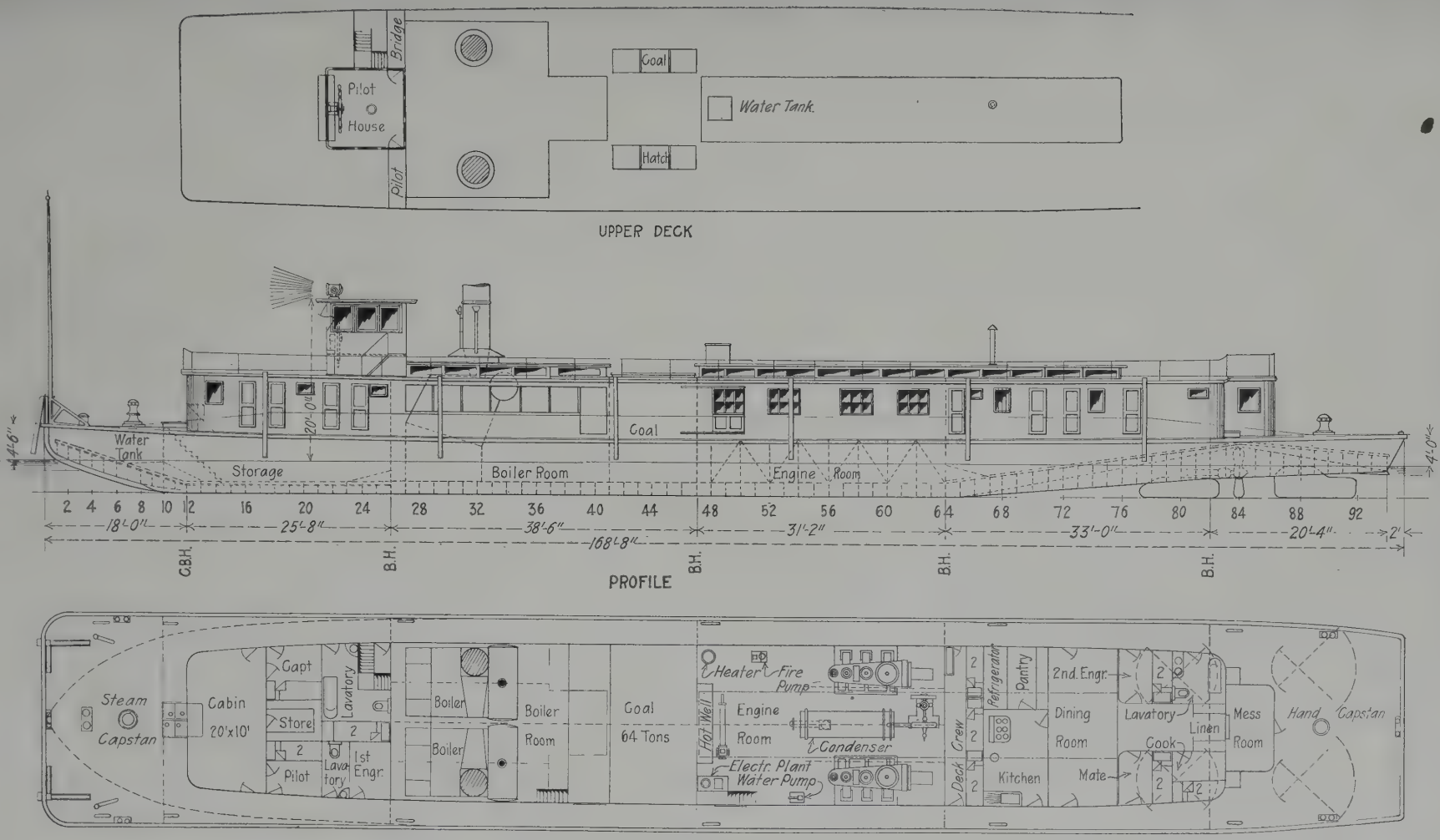


MIDSHIP SECTION

TWIN SCREW STEEL TOW BOAT

The Charles Ward Engineering Works, Charleston, W. Va.

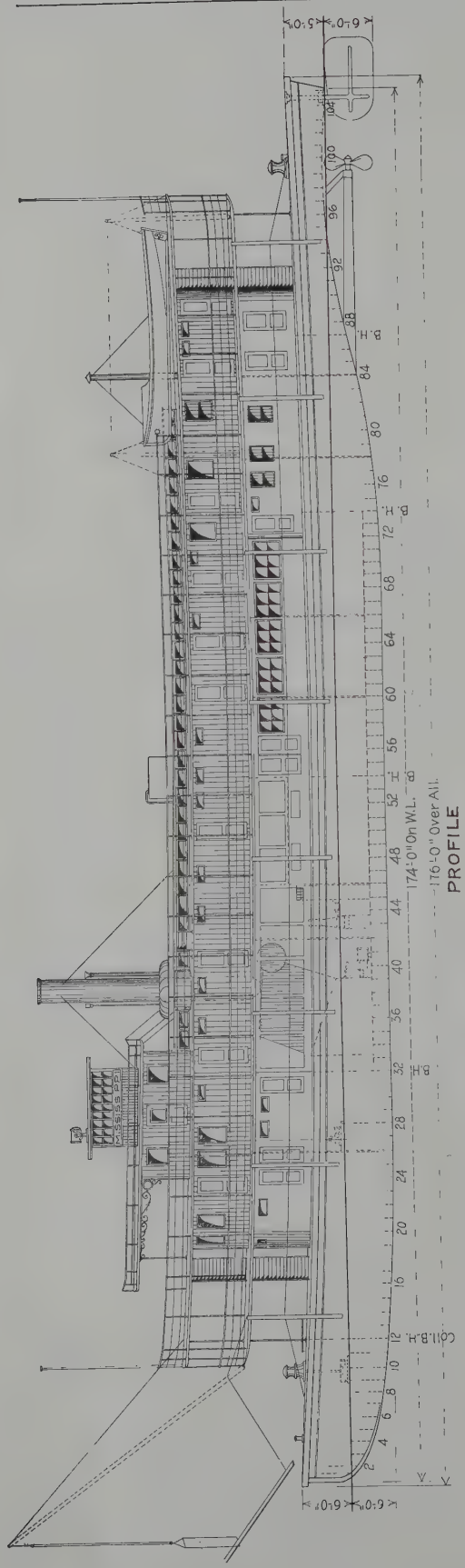
See Opposite Page



TWIN SCREW STEEL TOW BOAT

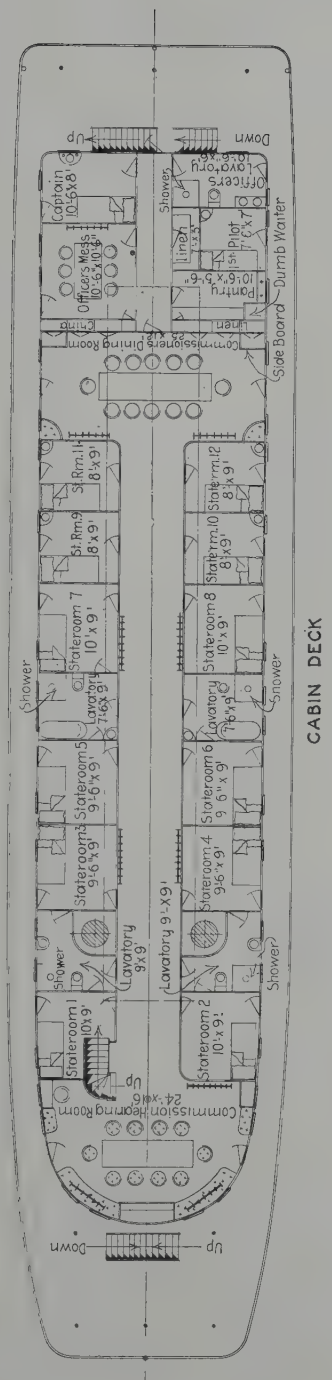
The Charles Ward Engineering Works, Charleston, W. Va.

See Opposite Page

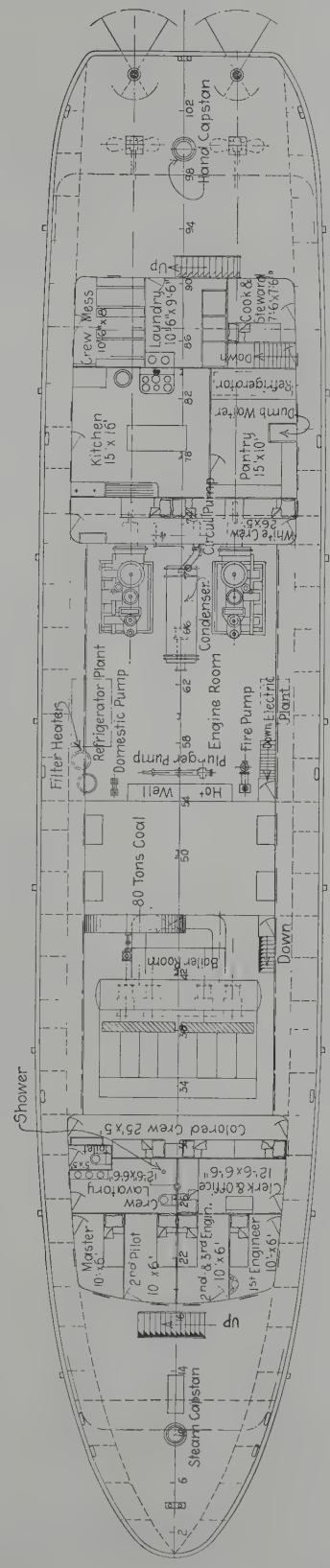


OBSERVATION DECK
TWIN SCREW STEEL STEAMER
The Charles Ward Engineering Works, Charleston, W. Va.

See Opposite Page

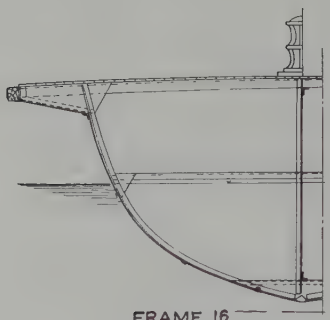


CABIN DECK

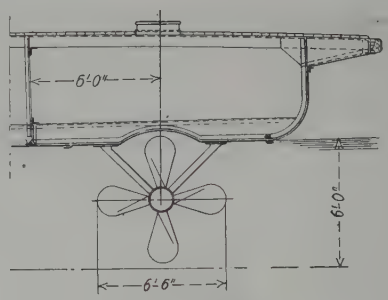


MAIN DECK

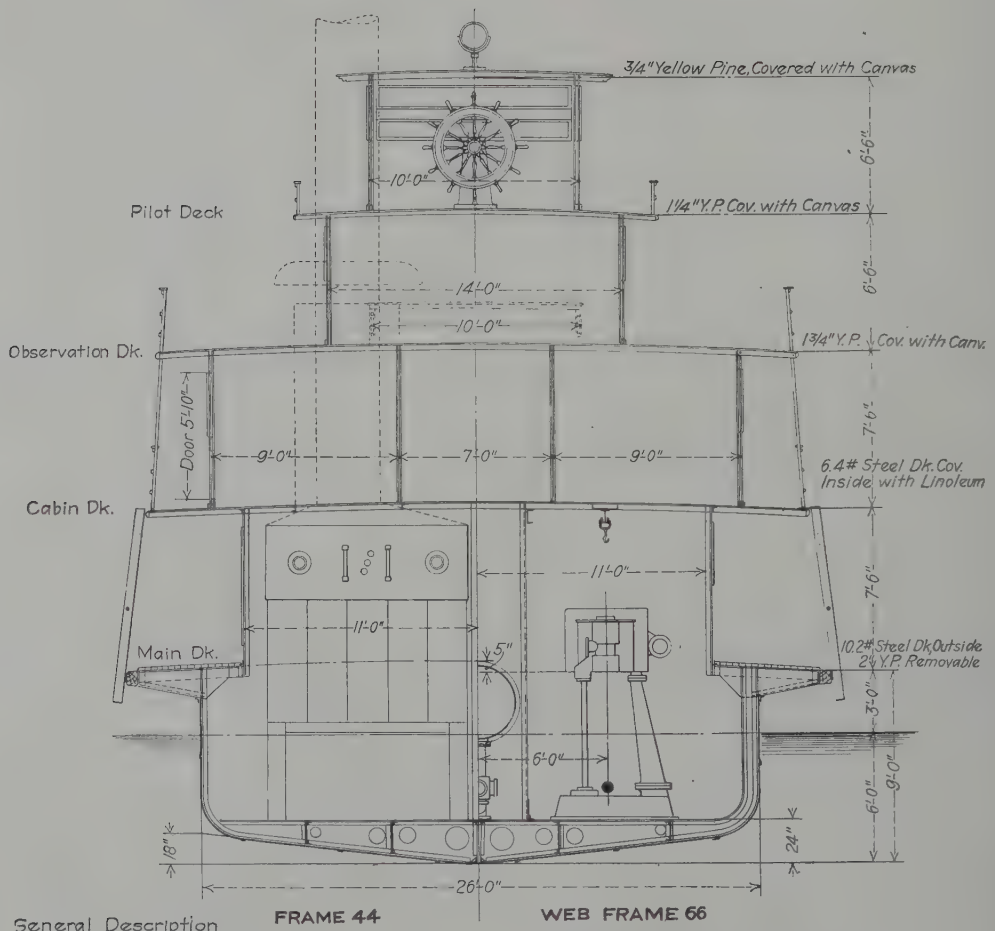
TWIN SCREW STEEL STEAMER
The Charles Ward Engineering Works, Charleston, W. Va.
See Opposite Page



FRAME 16



FRAME 100



FRAME 44 WEB FRAME 66

General Description

Length Over All ..... 176'-0"
" on W. L. ..... 174'-0"
Beam Molded ..... 26'-0"
" Over All ..... 33'-0"
Depth from Top of Keel to Main Dk. Beam at Side ..... 9'-0"
Displacement Molded at 6'-0 Draft 425 Tons
2 Engines at I. H. P. 1000
2 Boilers ..... (Water Tube)

Spacing Frames; 20" Forward 18" and 16". Angle Bar Frames, 2 1/2" x 2 1/2" x 5# Ends 4# Reverse Frames, 2 1/4", 3 1/2#, Floor Plates; 12" high, 11#, at Ends 10#. Engine and Boiler Room, 24" high, 14# Hull; Bilge and Bottom 15# at Ends 12#, Side 13#, Ends 11# Plate Keel; 20# Ends 16#. Bulkheads, 12 & 9# Stiffenings; 2 1/2" x 2 1/2", 4 1/2# Stem, Flat Bar; 7" x 1 1/2", Rudder Shaft, 6", Plate 5/8" Decks; 10, 2#, and 6.4#. Beams; Main Deck: 6 x 3", 12# and 7#. Cabin Deck: 5# Girder 6" High ⊔ 13# Stanchion ⊔ 4", 6.25#, fore and after L 4 1/2" x 3" x 7.7#. Middle Keel Angles: 2 1/2" x 2 1/2" x 4# Middle Keel; Intercostal 12 and 10#. Main Deck Crown 5".

TWIN SCREW STEEL STEAMER

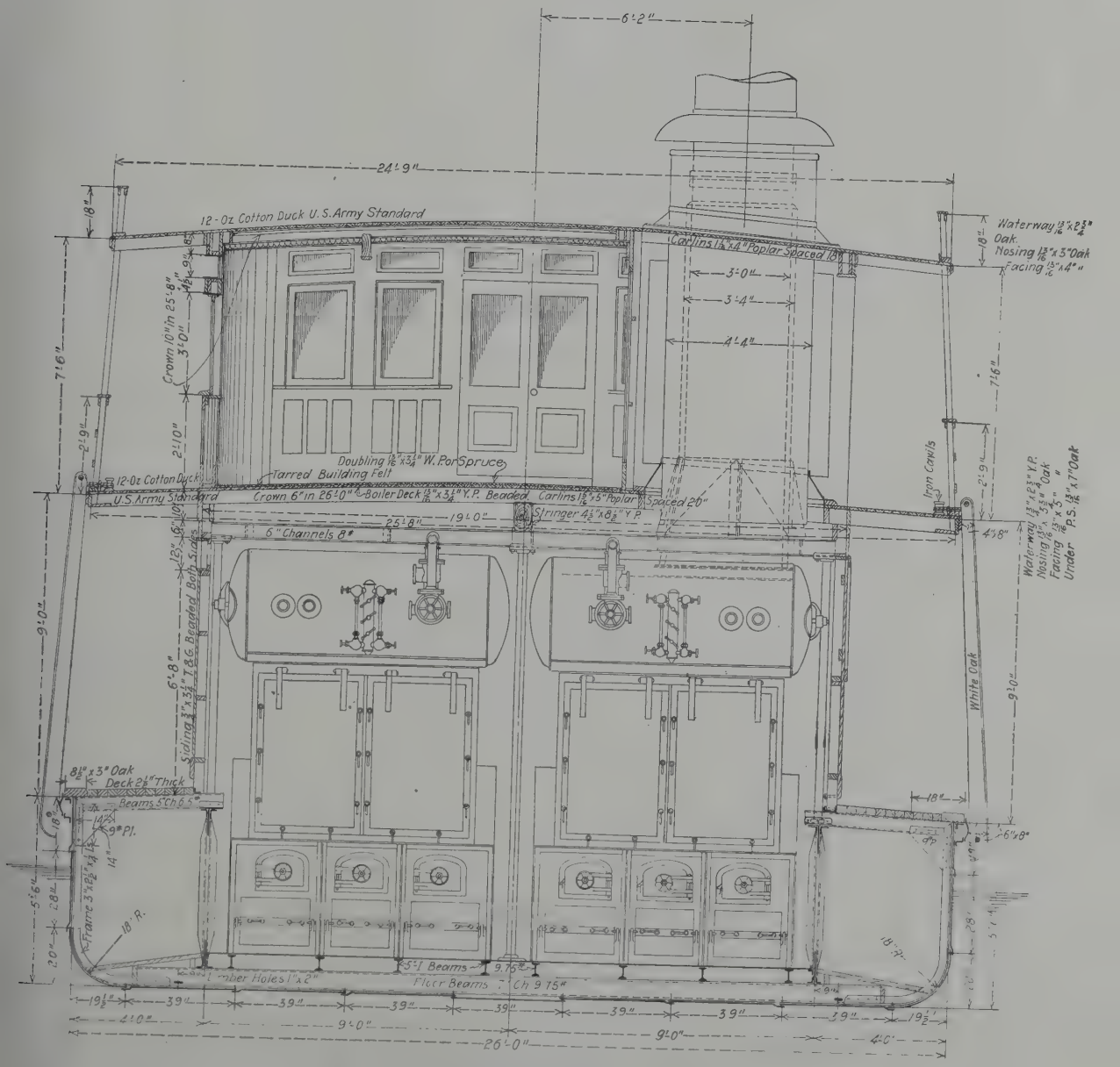
The Charles Ward Engineering Works, Charleston, W. Va.

See Pages 458 and 459

SECTION THRU BOILER ROOM

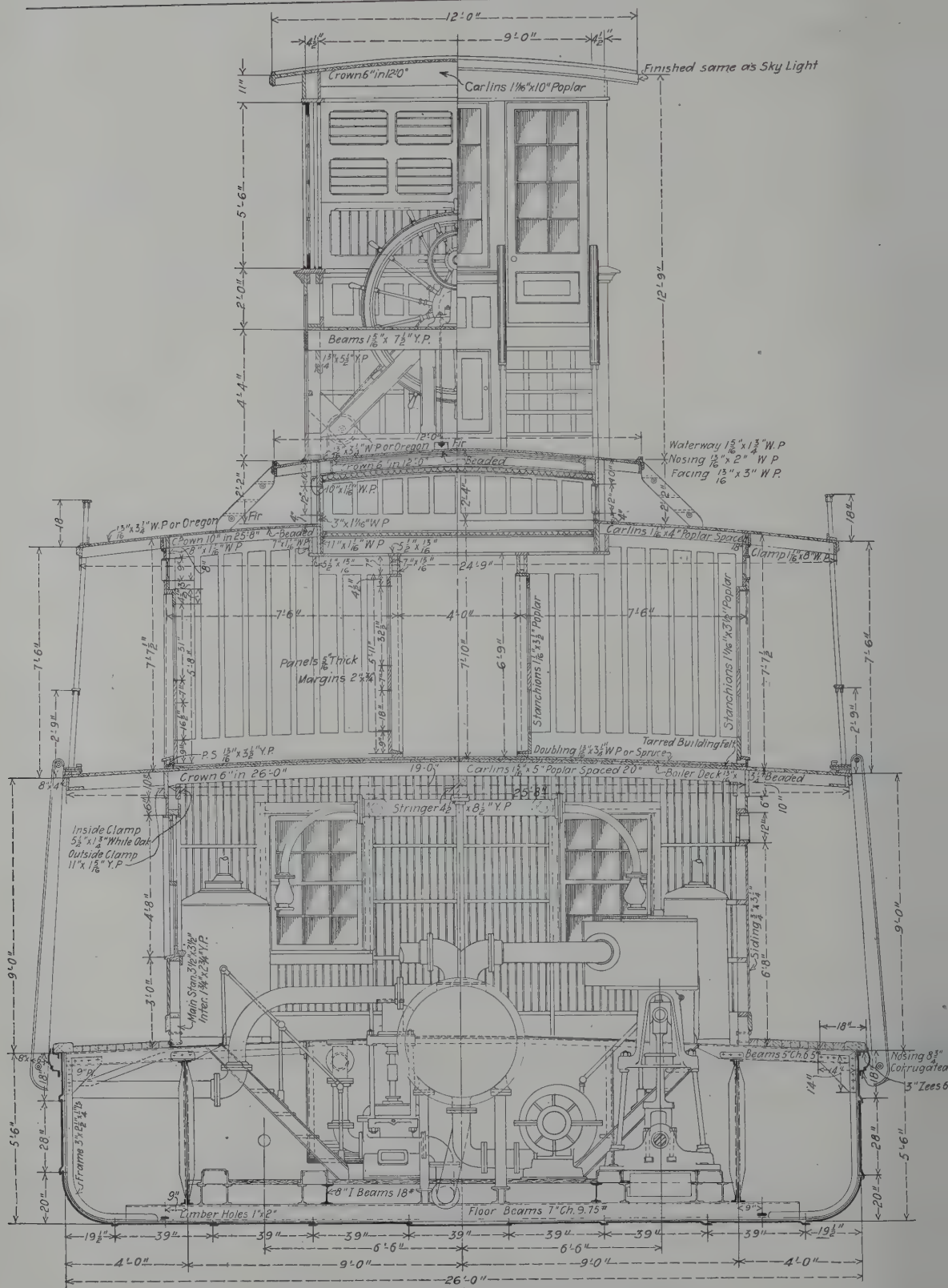
General Dimensions

Length Between Perp.	144'0"
Beam Molded	26'0"
Depth Molded	5'6"
Sheer Forward	2'6"
Sheer Aft	2'0"
Crown of Deck	0'6"
Draft Loaded (mean)	3'6"
Displacement (In Gross Tons)	258



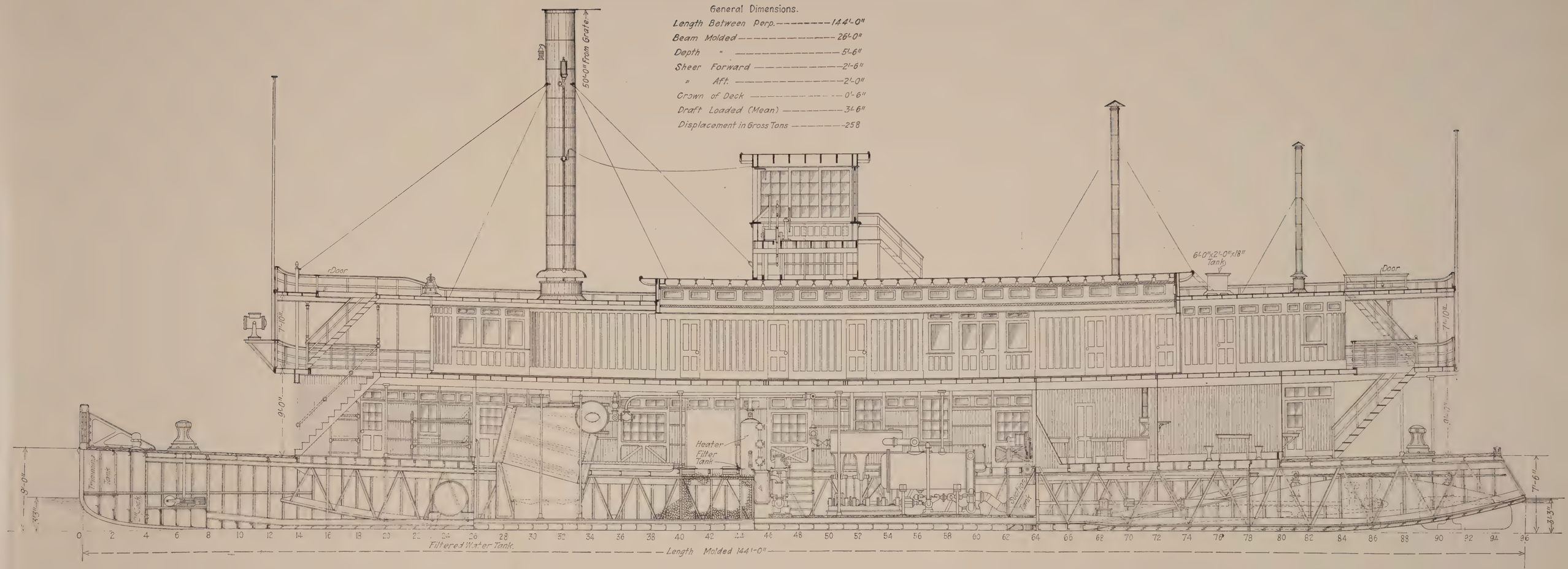
TWIN SCREW RIVER STEAMBOAT "INSPECTOR"
The Charles Ward Engineering Works, Charleston, W. Va.
See Page 462

SECTION THRU ENGINE ROOM


12'-0"
9'-0"
Finished same as Sky Light
Crown 6" in 12'0"
Carlins 1 1/16" x 10" Poplar
Beams 1 5/16" x 7 1/2" Y.P.
Waterway 1 5/16" x 1 3/4" W.P
Nosing 1/16" x 2" W.P
Facing 13/16" x 3" W.P.
Crown 6" in 12'-0"
Beaded
Carlins 1 1/16" x 4" Poplar Spaced
Clamp 1 1/16" x 8" W.P.
Panels 5/8" Thick
Margins 2 3/4"
Stanchions 1 1/16" x 3 1/2" Poplar
Tarred Building Felt
Doubling 13/16" x 3 1/4" W.P or Spruce
Crown 6" in 26'-0"
19'-0"
Carlins 1 1/2" x 5" Poplar Spaced 20"
Boiler Deck 13/16"
Beaded
Stringer 4 1/2" x 8 1/2" Y.P
Inside Clamp 5 1/2" x 1 3/4" White Oak
Outside Clamp 11" x 1 5/8" Y.P
Stating 4" x 3 1/4"
Beams 5" Ch. 6.5#
Nosing 8 3/4"
Corrugated
3" Zees 6
Frames 3 1/2" x 2 1/2" x 1/4"
8" I Beams 18#
Timber Holes 1" x 2"
Floor Beams 7" Ch. 9.75#
19 1/2"
39"
6'-6"
4'-0"
9'-0"
26'-0"

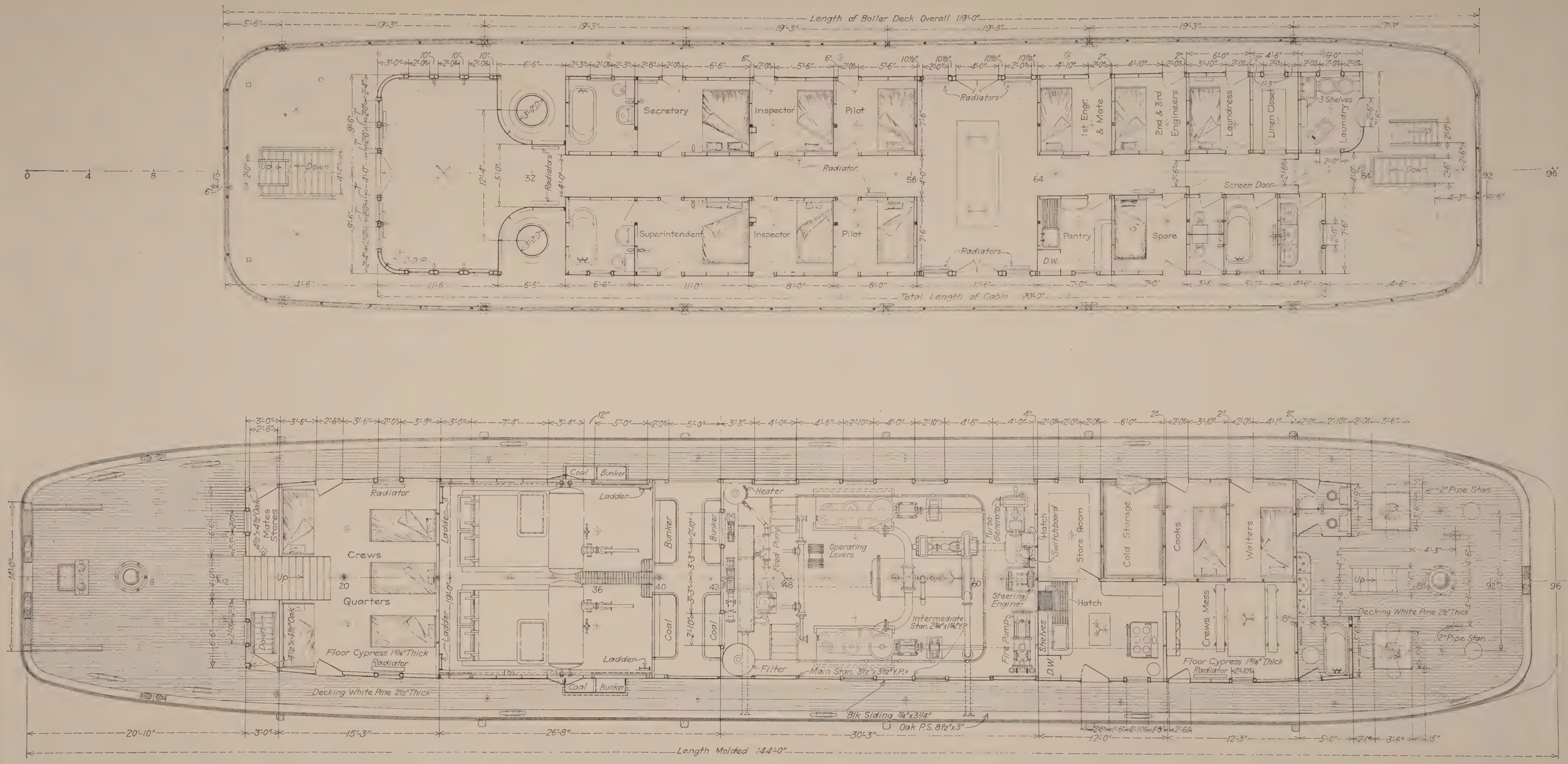
TWIN SCREW RIVER STEAMBOAT, "INSPECTOR"
The Charles Ward Engineering Works, Charleston, W. Va.

See Page 461


General Dimensions.
Length Between Perp. ---------- 144'-0"
Beam Molded ---------- 26'-0"
Depth " ---------- 5'-6"
Sheer Forward ---------- 2'-6"
" Aft. ---------- 2'-0"
Crown of Deck ---------- 0'-6"
Draft Loaded (Mean) ---------- 3'-6"
Displacement in Gross Tons ---------- 258
50'-0" From Grate
Door
Door
6'-0"x2'-0"x18" Tank
7'-10"
7'-10"
9'-0"
9'-0"
3'-6"
7'-6"
3'-3"
Heater
Filter
Tank
Discharge Tank
Trimming Tank
Keel
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50 52 54 56 58 60 62 64 66 68 70 72 74 76 78 80 82 84 86 88 90 92 94 96
Filtered Water Tank.
Length Molded 144'-0"

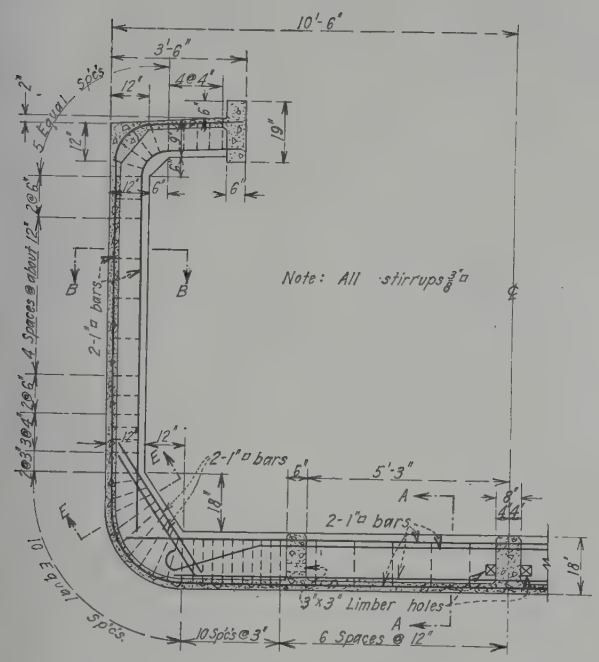
INBOARD PROFILE
TWIN SCREW RIVER STEAMBOAT "INSPECTOR"
The Charles Ward Engineering Works, Charleston, W. Va.

PLATE XXVII

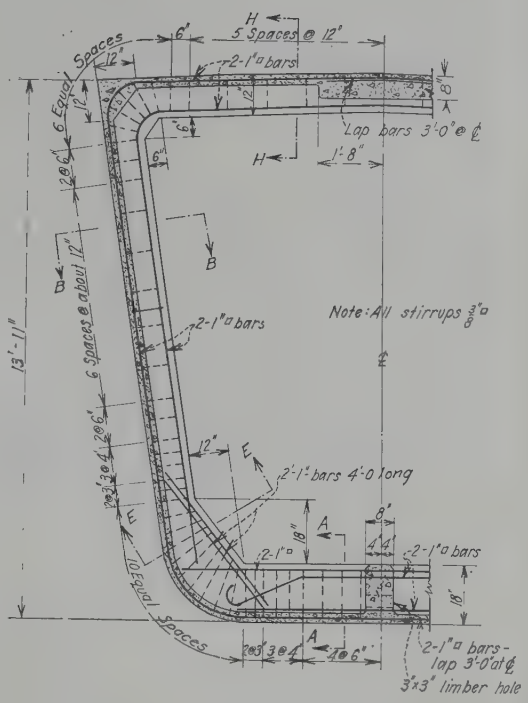


DECK PLANS, TWIN SCREW STEAMBOAT "INSPECTOR"
The Charles Ward Engineering Works, Charleston W. Va.

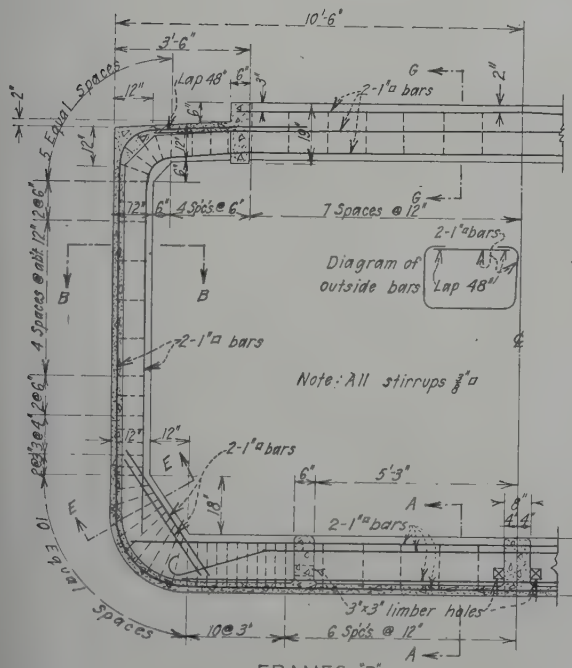
PLATE XXVIII



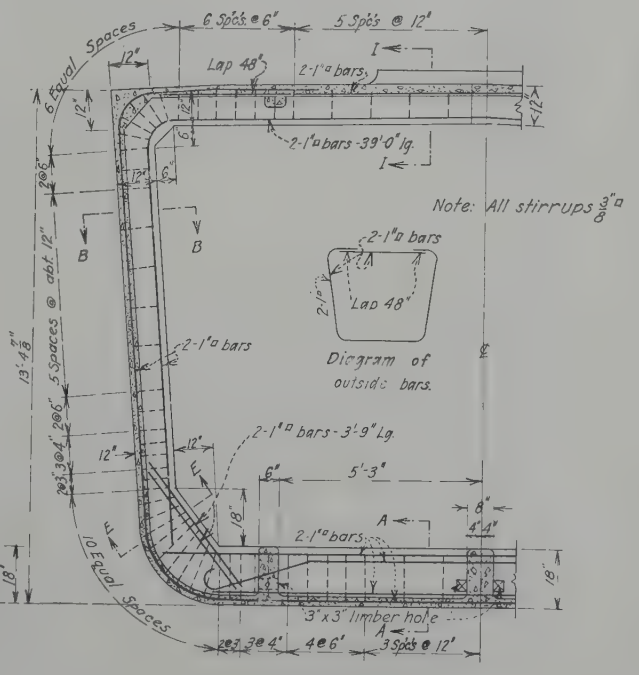
FRAMES "C"



FRAME Nº 1

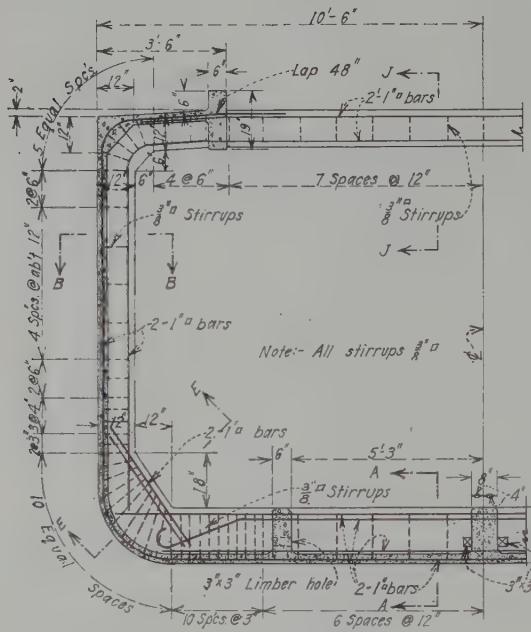


FRAMES "D"

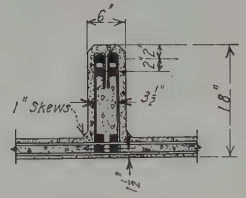


FRAME Nº 2

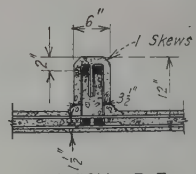
500-TON D. W. CONCRETE CANAL BARGE



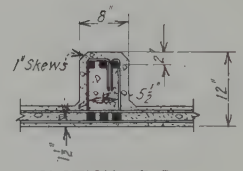
FRAMES "A"



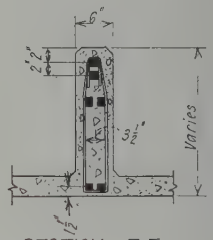
SECTION A-A



SECTION B-B



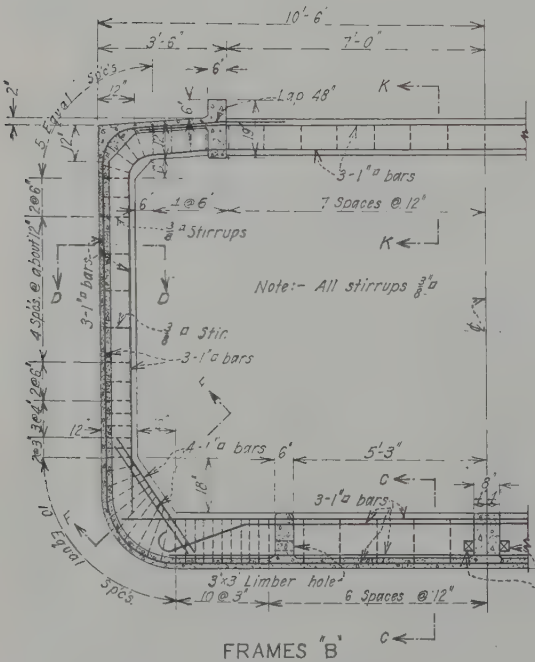
SECTION D-D



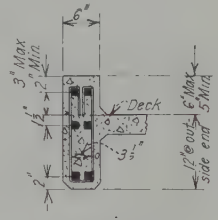
SECTION E-E

GENERAL NOTES

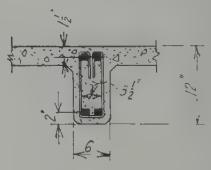
3"x3" limber holes where shown, keep these holes 1" above reinforcing steel. Make camber of deck 3" total (2" at 3'-0" from outboard deck line. "Class A" or "Class B"



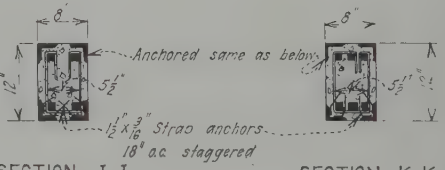
FRAMES "B"



SECTION G-G



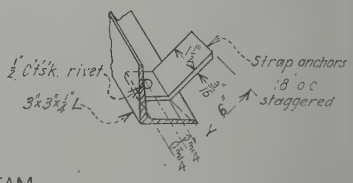
SECTION H-H



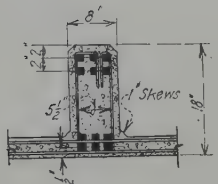
SECTION J-J

SECTION K-K

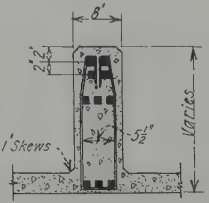
TYPICAL HATCH BEAM CORNER GUARD



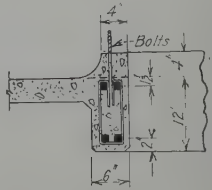
DETAIL OF L GUARD



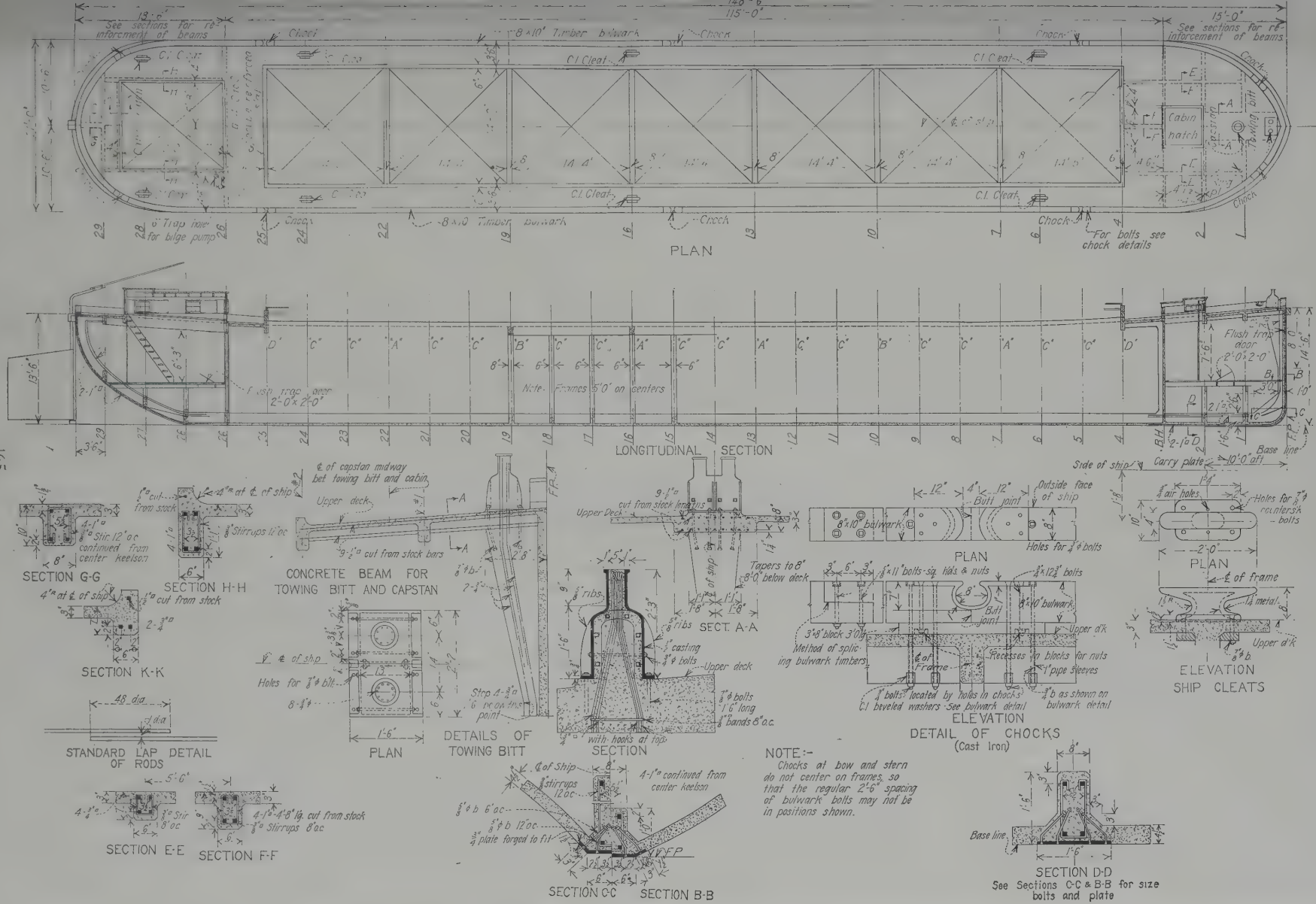
SECTION C-C



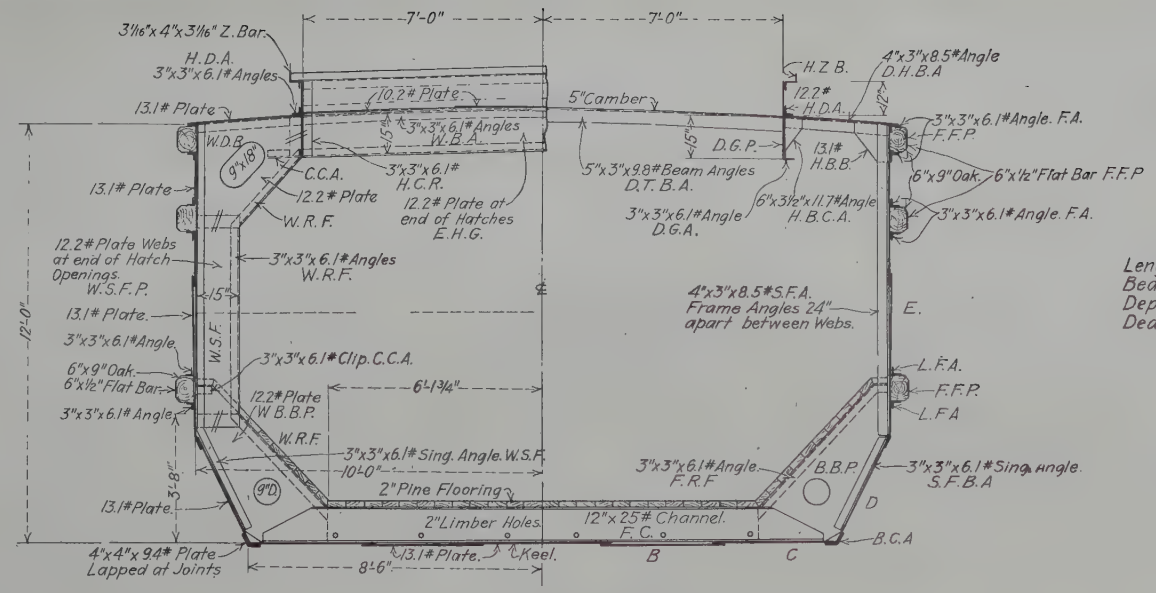
SECTION F-F



SECTION I-I

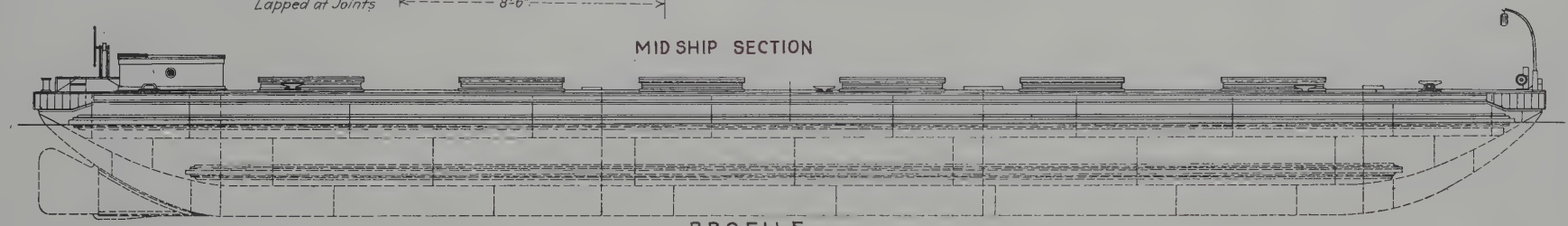


500-TON D. W. CONCRETE CANAL BARGE



MID SHIP SECTION

Length Over All ..... 150 Ft.
Beam ..... 20 Ft.
Depth ..... 12 Ft.
Deadweight Capacity ..... 550 S.Tons

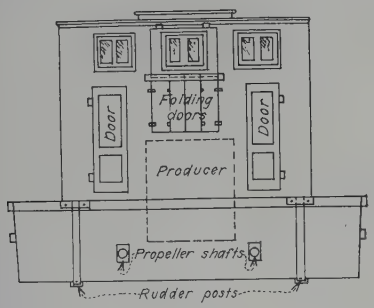


PROFILE

DECK PLAN

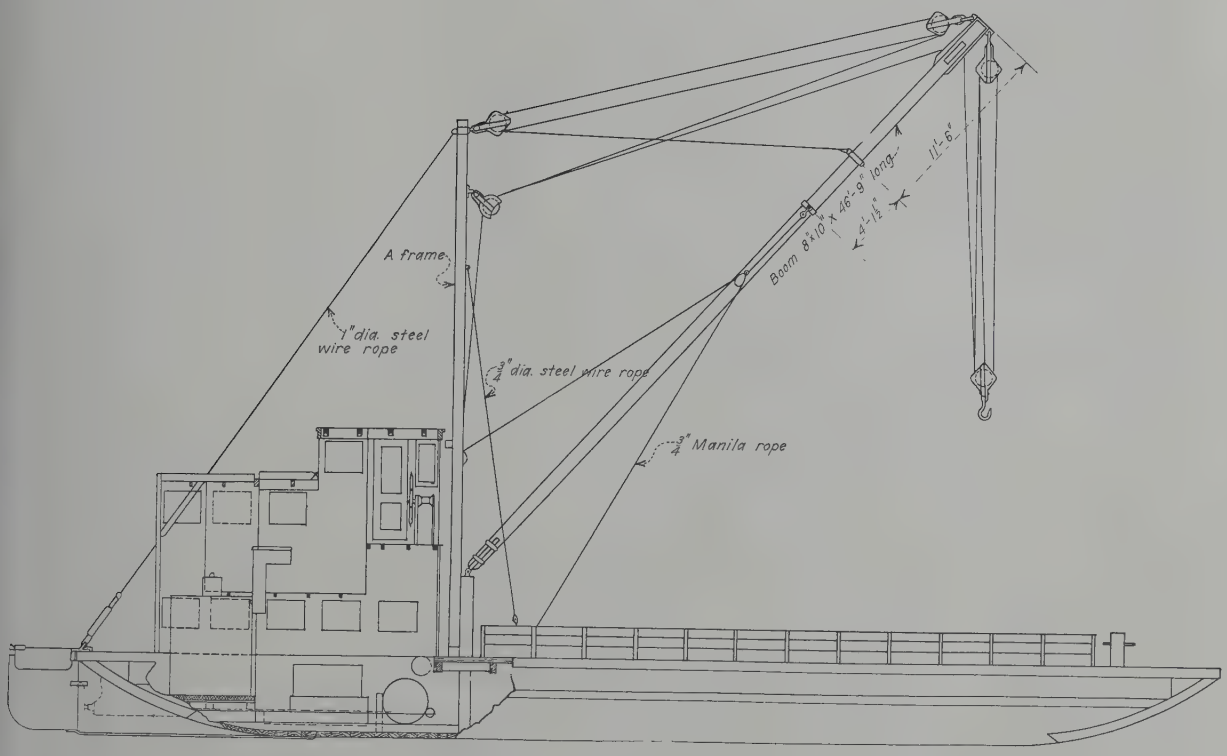
CANAL AND HARBOR STEEL BARGE
Designed by Cox & Stevens, New York City

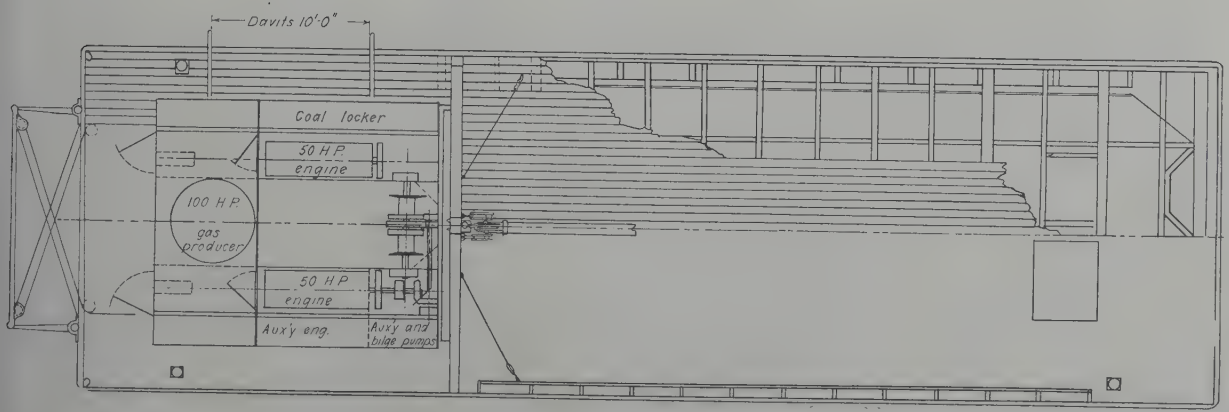
SELF-PROPELLED LIGHTER, GAS PRODUCER INSTALLATION



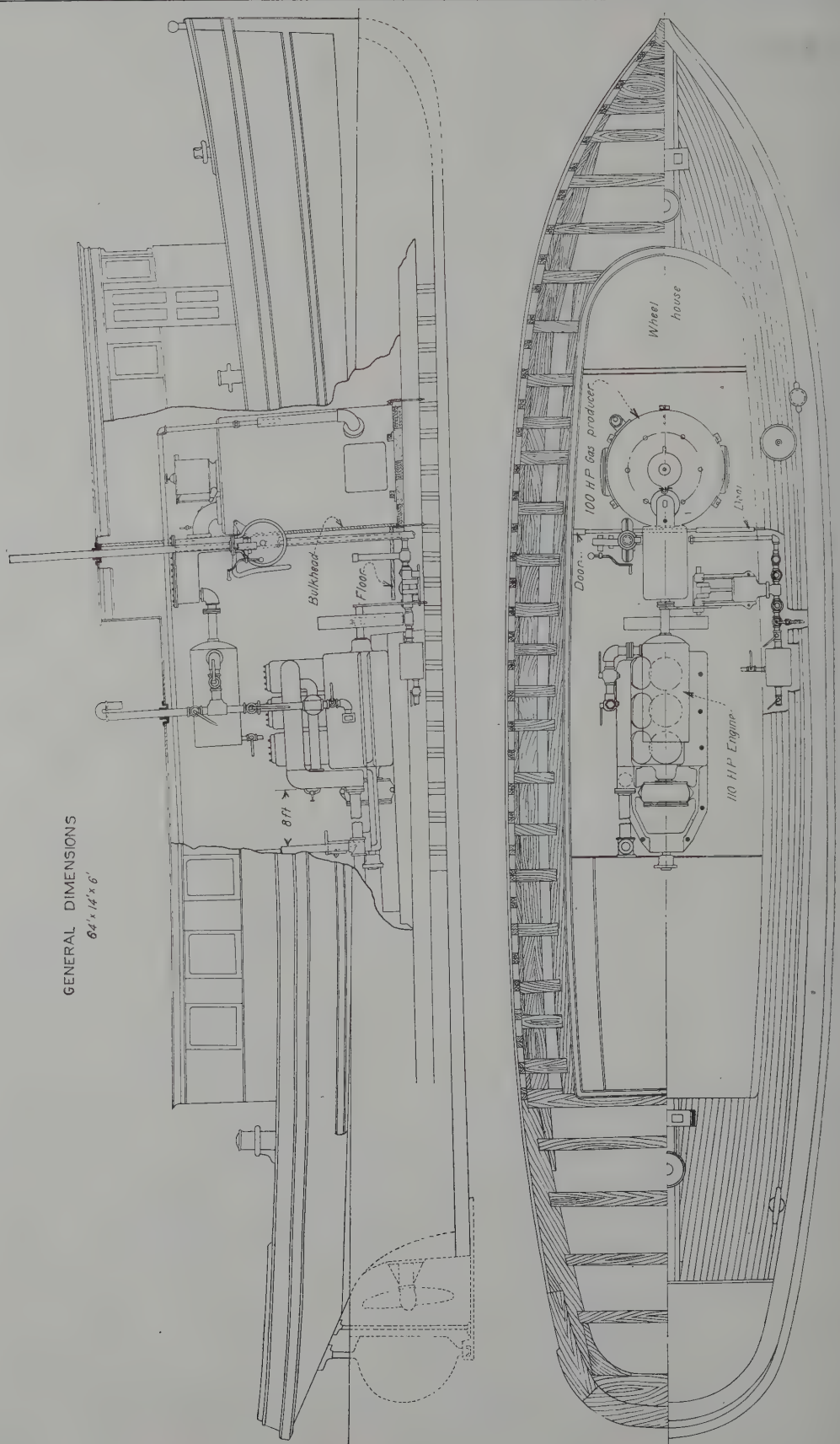
GENERAL DIMENSIONS

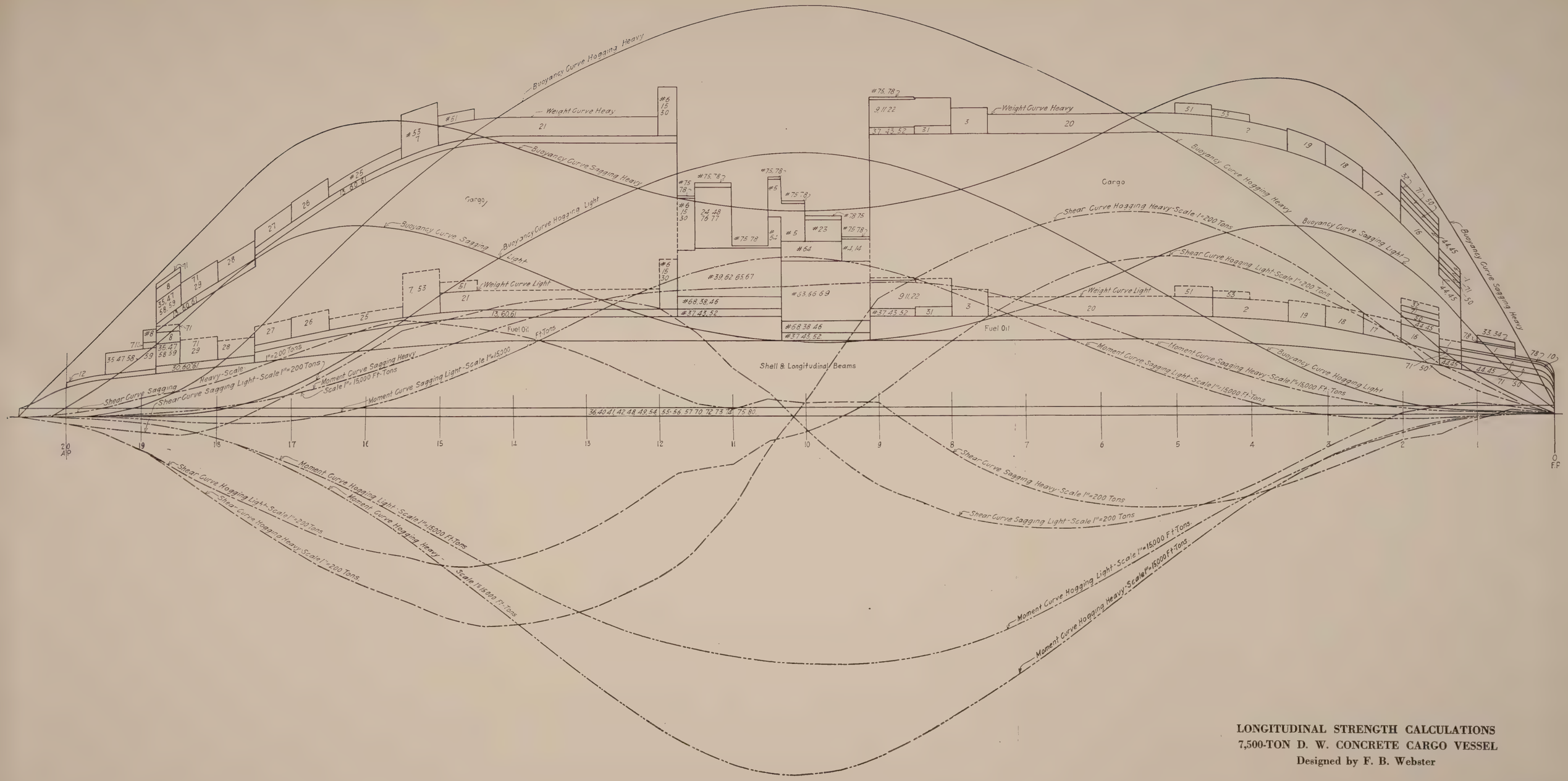
Length overall	70'-0"
Breadth at deck	21'-0"
" " bottom	20'-0"
Depth - bottom to upper side of deck	5'-2"
" of hold	4'-0"





ARRANGEMENT OF HARBOR TUG WITH GAS PRODUCER INSTALLATION




Buoyancy Curve Hogging Heavy
Weight Curve Heavy
Buoyancy Curve Sagging Heavy
Buoyancy Curve Sagging Light
Buoyancy Curve Hogging Light
Weight Curve Light
Cargo
Fuel Oil
Ft-Tons
Shell & Longitudinal Beams
Shear Curve Hogging Heavy-Scale 1"=200 Tons
Shear Curve Hogging Light-Scale 1"=200 Tons
Moment Curve Hogging Heavy-Scale 1"=15000 Ft-Tons
Moment Curve Hogging Light-Scale 1"=15000 Ft-Tons
Shear Curve Sagging Heavy-Scale 1"=200 Tons
Shear Curve Sagging Light-Scale 1"=200 Tons
Moment Curve Sagging Heavy-Scale 1"=15000 Ft-Tons
Moment Curve Sagging Light-Scale 1"=15000 Ft-Tons
Heavy-Scale 1"=200 Tons
Scale 1"=15,000 Ft-Tons
Scale 1"=15000 Ft-Tons
36 40 41 42 48 49 54 55 56 57 70 72 73 75 80
20 AP
0 FP

LONGITUDINAL STRENGTH CALCULATIONS
7,500-TON D. W. CONCRETE CARGO VESSEL
Designed by F. B. Webster

PLATE XXIX

7,500-TON D. W. CONCRETE CARGO VESSEL

For Longitudinal Strength Diagram
See Plate XXIX Opposite Page 468

TABLE OF WEIGHTS

No.	Weight	For'd	Aft	Tons
1	Bulkhead at frame No. 1	184.5	....	22.47
2	Bulkhead at frame No. 6	120.75	....	52.47
3	Bulkhead at frame No. 12	44.25	....	36.64
4	Bulkhead at frame No. 14	18.75	....	20.80
5	Bulkhead at frame No. 16	....	6.75	53.55
6	Bulkhead at frame No. 18	....	36.5	53.55
7	Bulkhead at frame No. 24	....	113.0	50.62
8	Bulkhead at frame No. 30	....	185.25	17.94
9	Longitudinal bulkhead No. 12 to No. 14	31.5	....	14.75
10	Flat between No. 0 and No. 1	193.0	....	9.19
11	Flat between No. 12 and No. 14	31.5	....	38.74
12	Flat between No. 30 and stern	....	195.5	16.10
13	Shaft tunnel	....	120.0	100.00
14	Cofferdam at bulkhead No. 14	16.75	....	2.63
15	Cofferdam at bulkhead No. 18	....	36.5	2.63
16	Frame No. 2	171.75	....	24.7
17	Frame No. 3	159.0	....	27.6
18	Frame No. 4	146.25	....	29.7
19	Frame No. 5	133.5	....	30.2
20	Frame No. 7 to No. 11	82.5	....	159.5
21	Frame No. 19 to No. 23	....	74.75	159.5
22	Frame No. 13	31.5	....	31.9
23	Frame No. 15	6.0	....	31.9
24	Frame No. 17	....	23.75	31.9
25	Frame No. 25	....	125 75	30.0
26	Frame No. 26	....	138.50	28.6
27	Frame No. 27	....	151.25	26.7
28	Frame No. 28	....	164.0	25.3
29	Frame No. 29	....	176.75	23.8
30	Bulkhead aft of bridge deck	....	36.50	12.95
31	Bulkhead for'd end of bridge deck	31.50	....	12.95
32	Bulkhead aft end of forecastle deck	171.73	....	10.03
33	Chain locker bulkheads transverse	190.5	....	5.69
34	Chain locker bulkheads longitudinal	187.5	....	1.90
35	Stern frame and stern post	....	205.0	17.0
36	Lower deck planking and sparring	....	.94	105.0
37	Bridge deck	....	4.0	38.2
38	Foundations	....	9.3	25.0
39	Miscellaneous foundations	....	20.0	20.0
40	Paint	....	....	25.0
41	Carpentry and joiners' work	....	30.0	40.0
42	Bulwark	....	133.0	15.7
43	Bridge deck sides	....	2.5	26.0
44	Forecastle deck	186.0	....	24.3
45	Forecastle deck sides	191.0	....	17.6
46	Enclosure engine and boiler	....	8.0	8.0
47	Steering appliances	....	198.0	28.0
48	Pumping and drainage	....	15.1	30.0
49	Ventilation	....	....	10.0
50	Anchor and cable handling	187.5	....	30.0
51	Warping and towing gear	....	....	45.0
52	Boat handling	2.4	....	6.0
53	Masts and spars	4.0	....	20.0
54	Hand rails	....	18.2	5.0
55	Air ports, etc	....	25.6	10.0
56	Doors, hatches, etc	....	3.15	22.0

TABLE OF WEIGHTS—Continued

No.	Weight	For'd	Aft	Tons
57	Miscellaneous fittings	....	....	20.0
58	Stern tube	....	192.0	6.7
59	Propeller	....	200.0	8.93
60	Shafting	....	110.0	40.20
61	Steady bearing	....	110.0	4.69
62	Main engine foundations	....	22.0	11.15
63	Boiler foundations	4.0	....	11.15
64	Smoke stack	....	....	55.80
65	Marine engine	....	23.0	120.5
66	Water tube boilers	4.0	....	123.0
67	Main condenser	....	28.0	13.4
68	Miscellaneous machinery	....	....	54.48
69	Reserve feed water	6.0	....	93.0
70	Electric and other leads	....	....	2.0
71	Ground tackle	147.4	....	45.0
72	Rigging and lines	6.0	....	16.6
73	Canvas and bunting	112.0	....	2.0
74	Miscellaneous equipment	....	....	8.4
75	Outfit and complement	....	....	23.0
76	Water	....	27.0	37.0
77	Provisions	....	26.0	5.0
78	Miscellaneous stores	45.0	....	20.0
79	Fuel oil	....	....	900.0
80	Margin	....	....	114.0

GENERAL NOTES

Heavy Condition: Ready for sea with 6,322 tons of cargo stores, fuel oil, etc.

Light Condition: Same as Heavy Condition except for absence of 6,322 tons of cargo.

Buoyancy: Moment and shear curves are shown for each of the four following conditions: Hogging heavy, hogging light, sagging heavy, and sagging light.

Area under weight curve heavy=260.00 sq. in.

Displacement=13,000 tons.

1 inch of weight and Buoyancy curves=13,000÷260=50 tons.

Length of diagram=40 inches.

Length of ship between perpendiculars=420′—0″.

1 inch Horizontal=420÷40=10.5′.

1 inch Vertical of weight and buoyancy curves=50÷10.5=4.76 tons.

Let 1 inch vertical of shear curves=4 sq. in. of weight and buoyancy curves=50x5=200 tons.

Then 1 sq. in. of shear curves=200x10.5=2,100 ft. tons.

Let 1″ vertical of moment curves=7.15 sq. in. of shear curves=2,100x7.15=15,000 ft. tons.

Hogging (heavy).

Max. moment=146,000 ft. tons.

K=13,000x420/146,000=37.4.

Max. shear=1,146 tons.

Sagging (light).

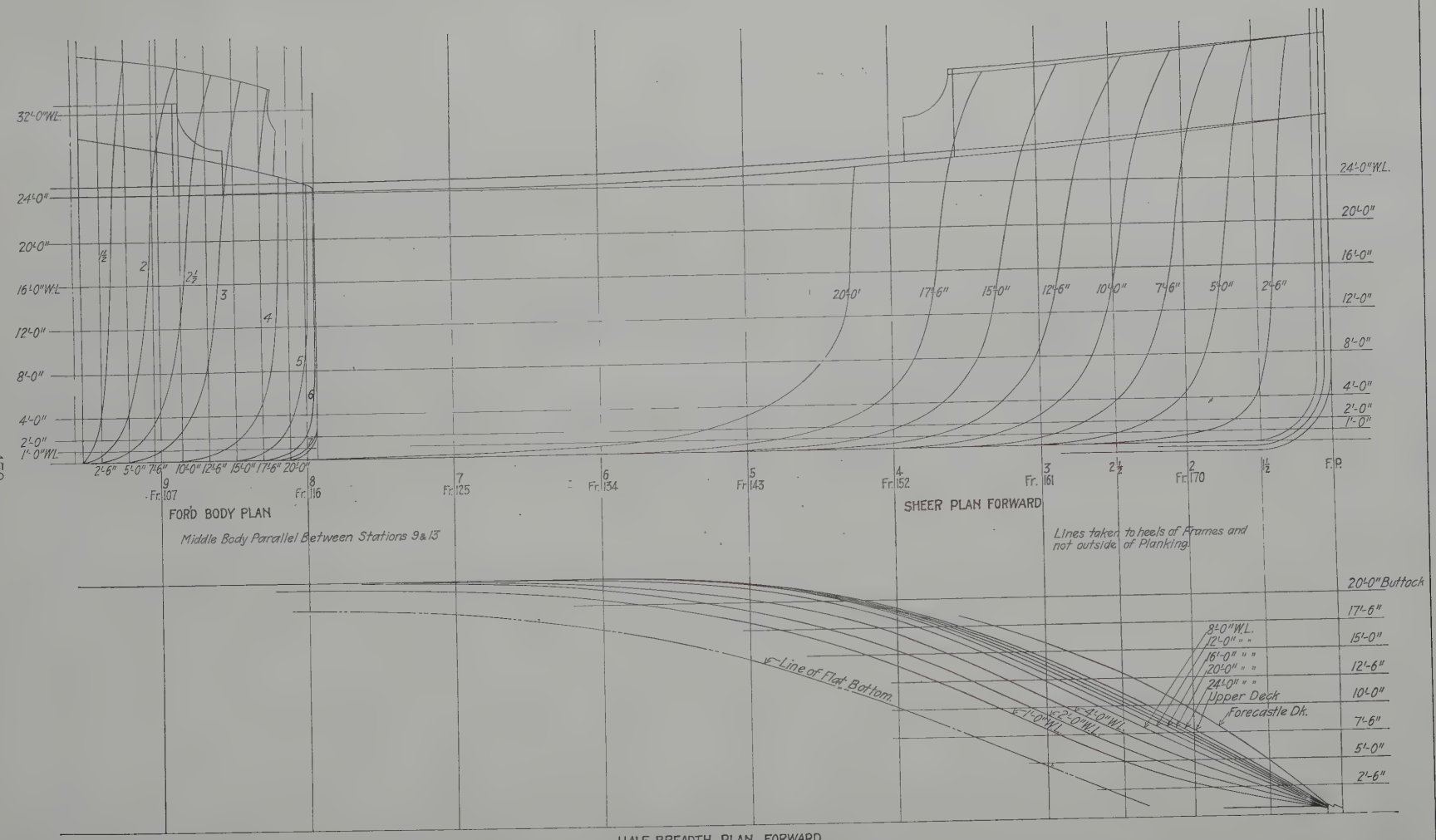
Max. moment=65,500 ft. tons.

K=13,000x420/65,500=83.3.

Max. shear=648 tons.

Principal Dimensions

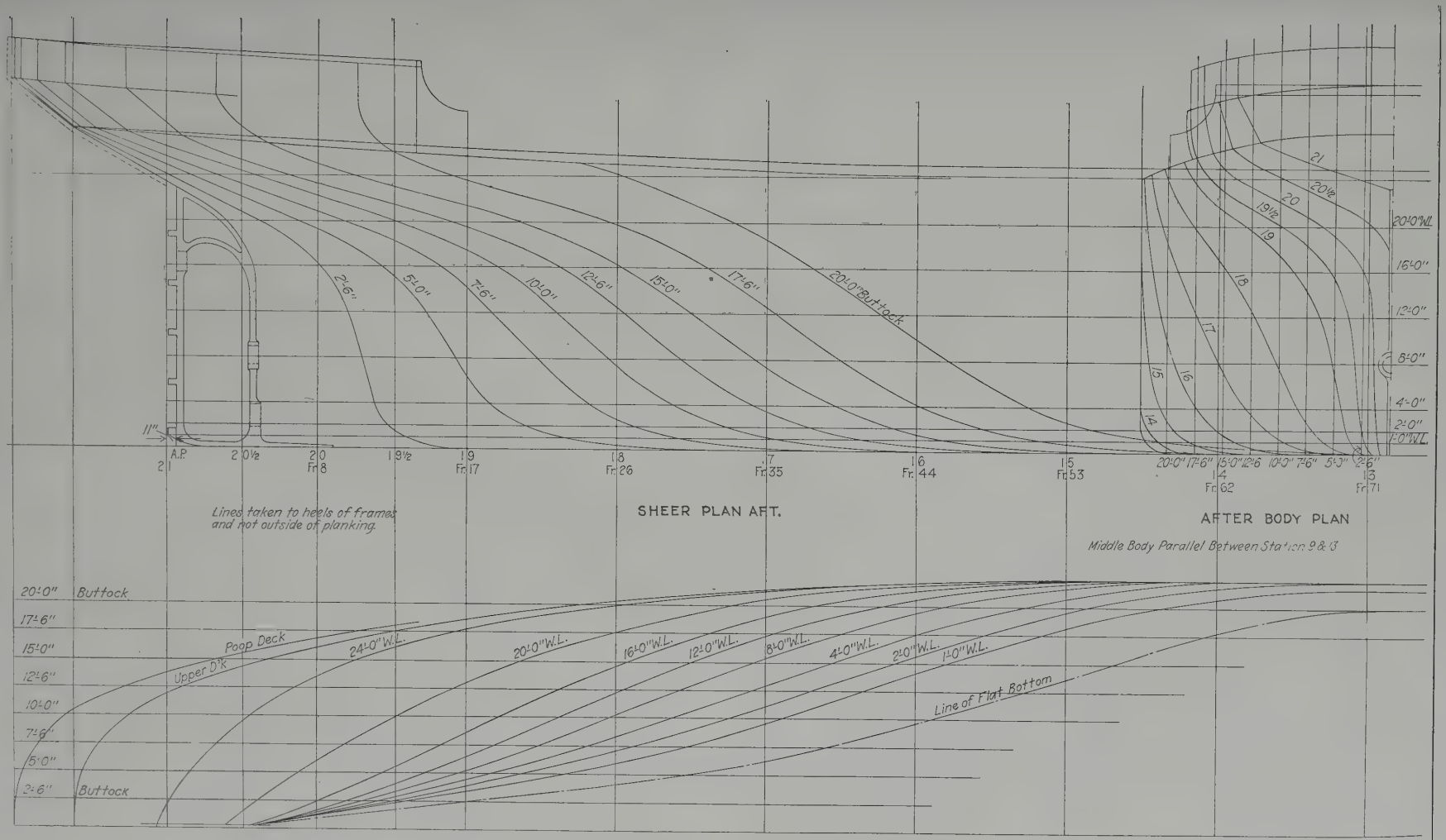
Length between perpendiculars	420′—0″
Length overall	434′—3″
Molded depth at side	36′—0″
Beam	54′—0″
Designed load draft	26′—0″
Camber of Deck	12″ Str.
Displacement, heavy	13,000 tons
Displacement, ready for sea	6,678 tons



HALF BREADTH PLAN FORWARD

3,500-TON D. W. COMPOSITE FREIGHTER

For After Body See Opposite Page

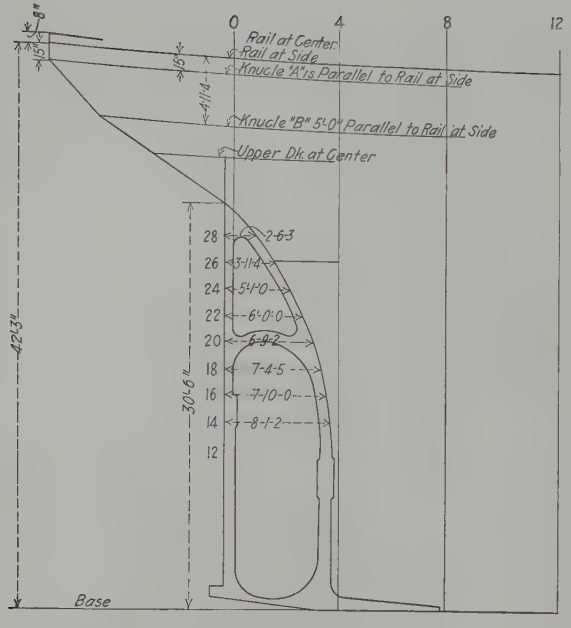


HALF BREADTH PLAN AFT.

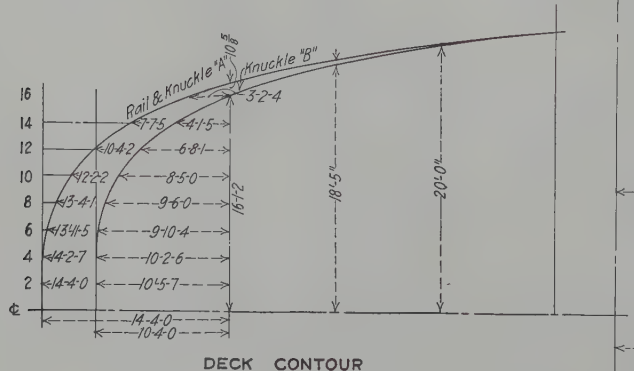
3,500-TON D. W. COMPOSITE FREIGHTER

For Forward Body See Opposite Page

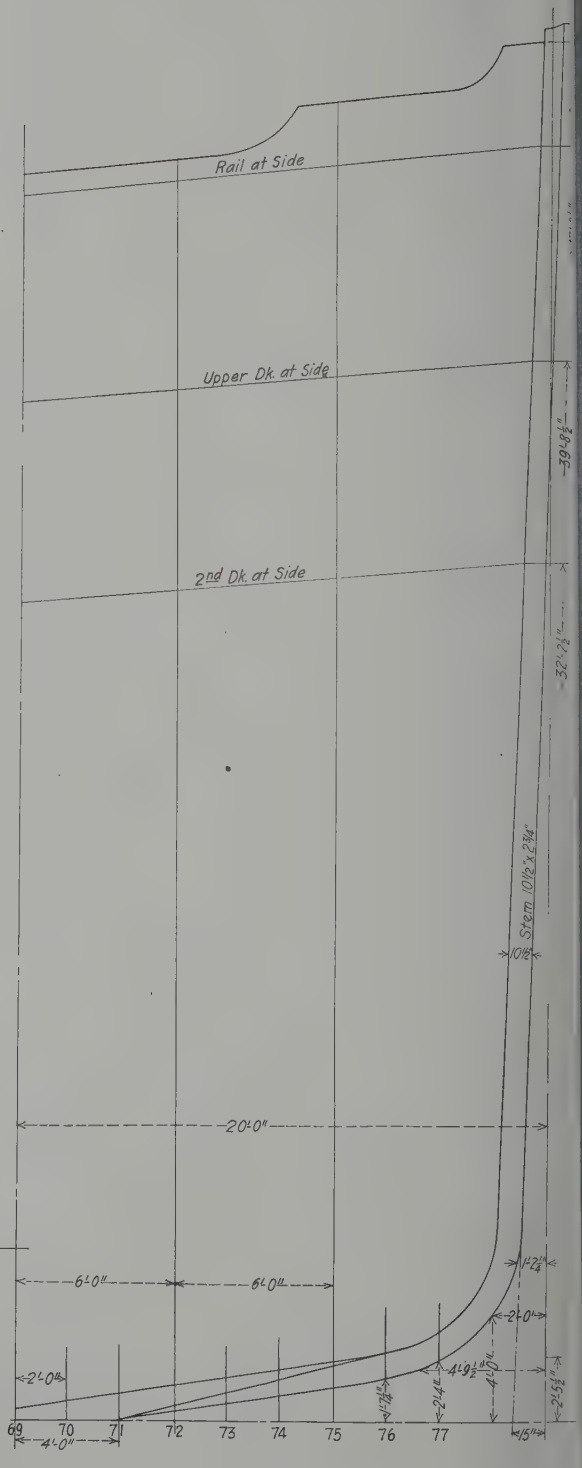
TYPICAL STEM AND STERN PROFILES



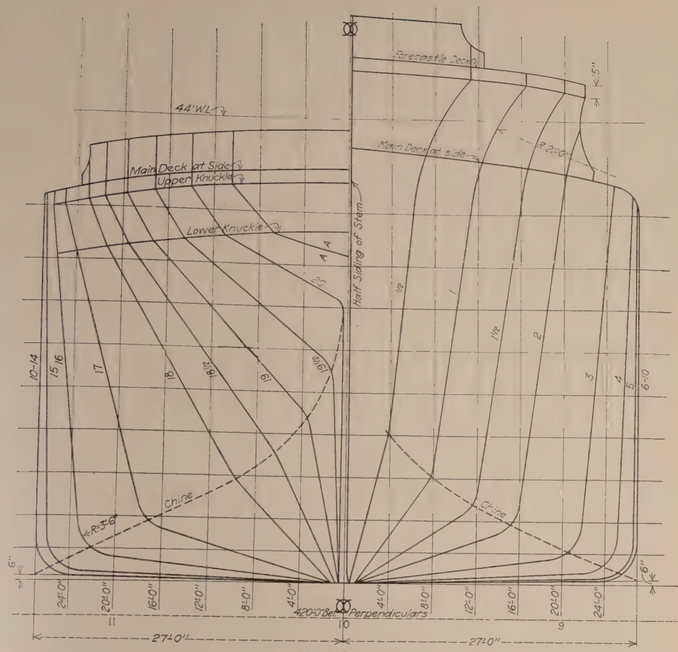
STERN PROFILE



DECK CONTOUR

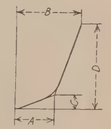


STEM PROFILE



BODY PLAN

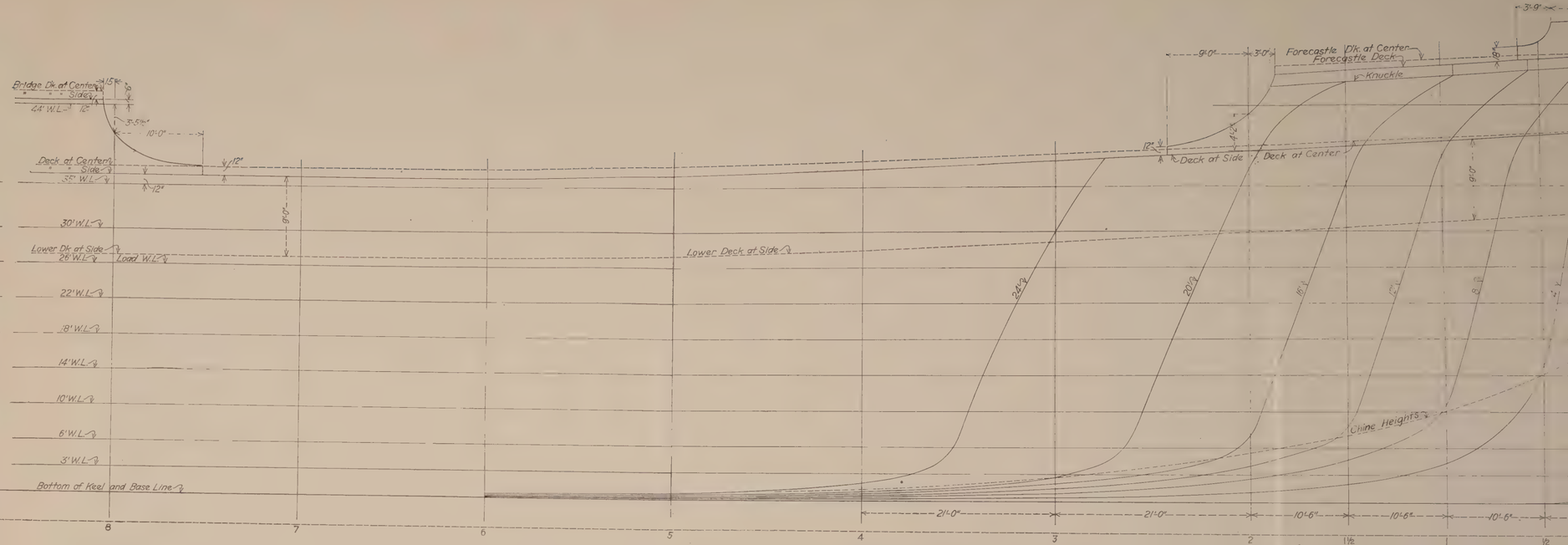
Stations	Half Breadths					Heights				
	Chine "A"	35' W.L. "B"	Lower Knuckle "C"	Upper Kn. & Main Deck "D"	Forecastle Deck "E"	Chine "C"	Lower Knuckle D	Upper Knuckle	Main Deck	Forecastle Deck
11	0-3-0							48-6-0	41-3-0	49-9-0
10	3-1-0	5-11-4		7-0-6	11-2-5	14-2-1		47-10-0	40-7-0	49-1-0
9	7-11-4	11-4-0		12-4-0	16-5-6	10-2-0		47-3-6	39-11-6	48-5-6
8	12-0-2	15-11-5		16-8-3	20-0-6	7-4-2		46-8-3	39-5-0	47-11-0
7	15-9-2	19-8-7		20-3-3		5-4-4			38-10-4	
6	21-7-5	24-5-7		24-9-4		2-8-4			37-10-4	
5	25-1-6	26-4-7		26-6-0		1-3-0			36-11-5	
4	26-8-0	26-10-6		26-11-0		0-7-1			36-3-3	
3	27-3-0	27-0-0		27-0-0		0-6-0			36-0-0	
2	27-3-0			27-0-0		0-6-0	30-3-0		36-0-0	
1½	26-0-2			26-9-7		1-0-5	30-4-4		36-1-4	
1	22-1-4			26-2-5		2-7-4	30-6-3		36-3-3	
½	17-5-6		23-11-0	25-1-0		5-4-6	30-9-2	35-3-2	36-6-2	
0	9-8-3		21-3-0	23-0-2		9-7-1	31-2-6	35-8-6	36-1-6	
0½	6-3-5		19-5-2	21-6-4		12-3-4	31-6-0	36-0-0	37-3-0	
-1	3-4-2		17-3-1	19-7-0		15-9-2	31-10-0	36-4-0	37-7-0	
-1½	1-2-7		14-7-3	17-2-5		20-6-7	32-2-3	36-8-6	37-11-6	
-2			10-11-4	15-11-7			32-8-3	37-2-0	38-5-0	
-2½			6-7-4	10-5-0			33-0-2	37-6-2	38-3-2	



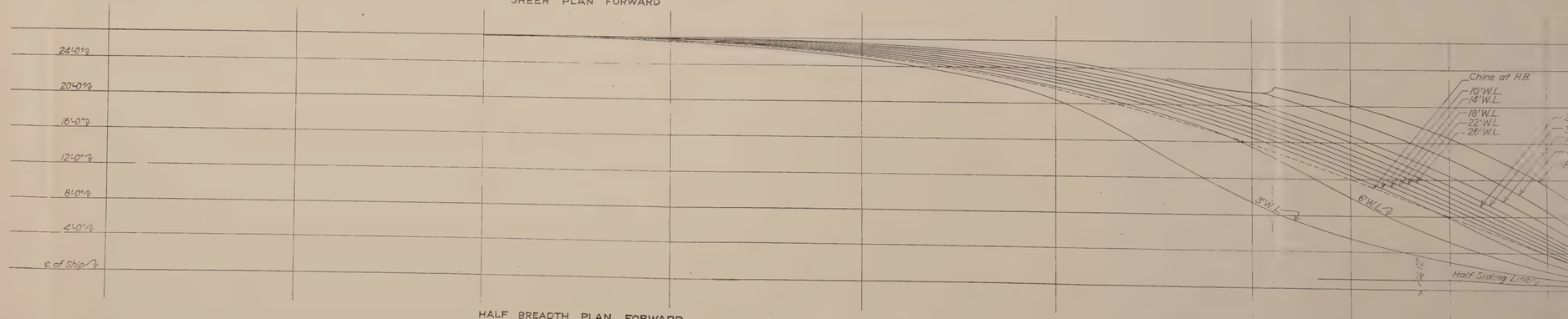
General Notes:-

Length Between Perpendiculars	420'0"
" Overall	434'3"
Molded Depth of Side	35'0"
Beam	54'0"
Designed Load Draft	26'0"
Camber of Deck	12"

A Bilge Radius of 3'6" is to be used for the Entire Length of the ship.



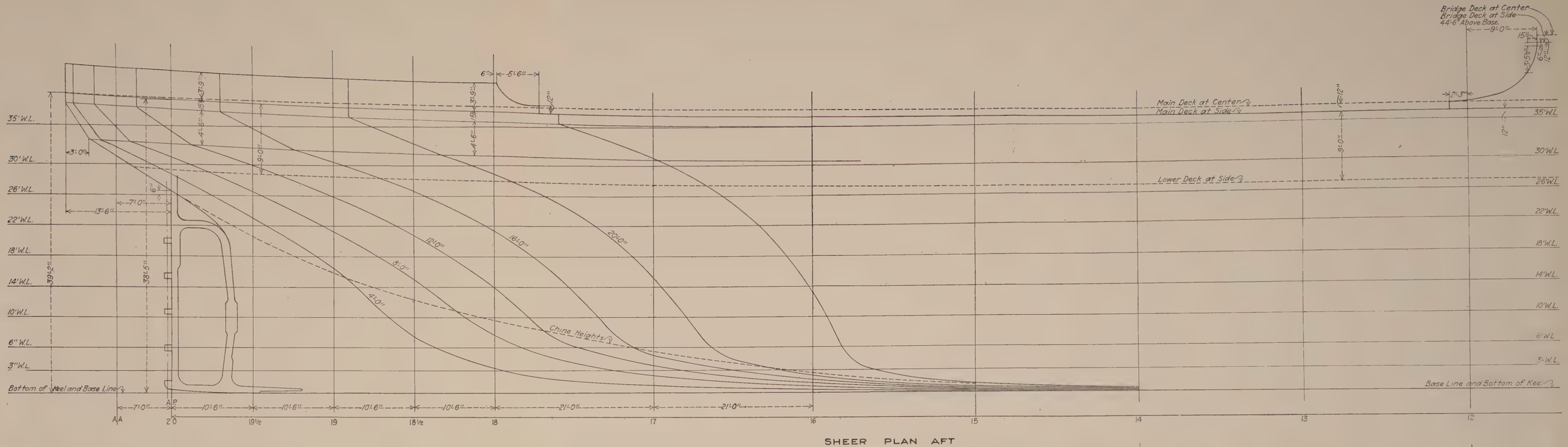
SHEER PLAN FORWARD



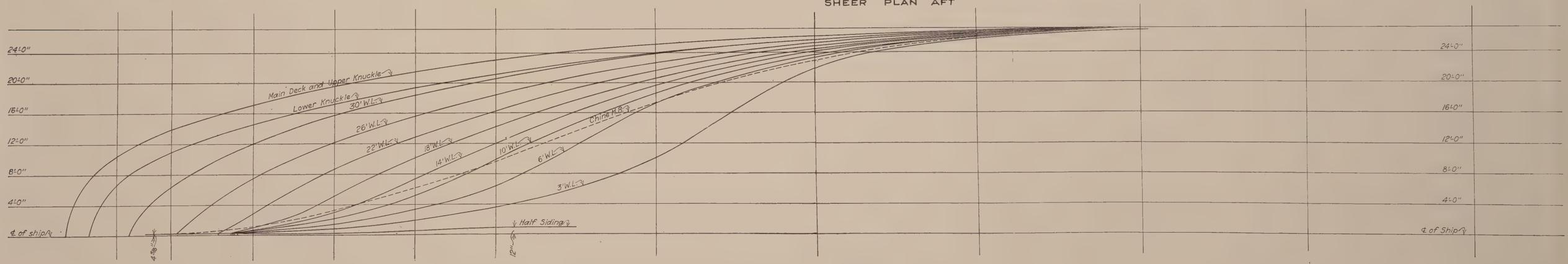
HALF BREADTH PLAN FORWARD

LINES OF FORWARD BODY

7,500-TON D. W. CONCRETE TANKER



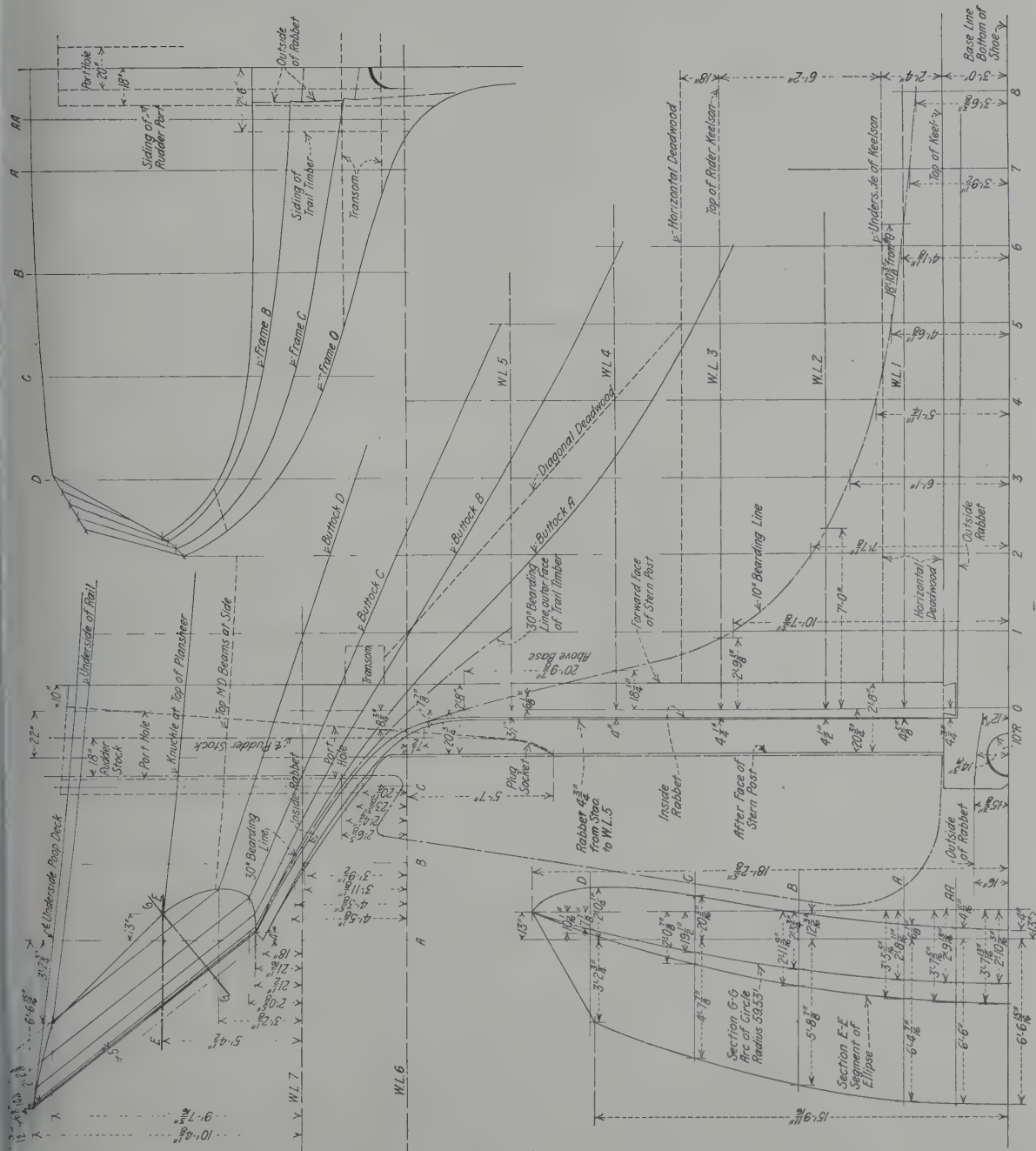
SHEER PLAN AFT



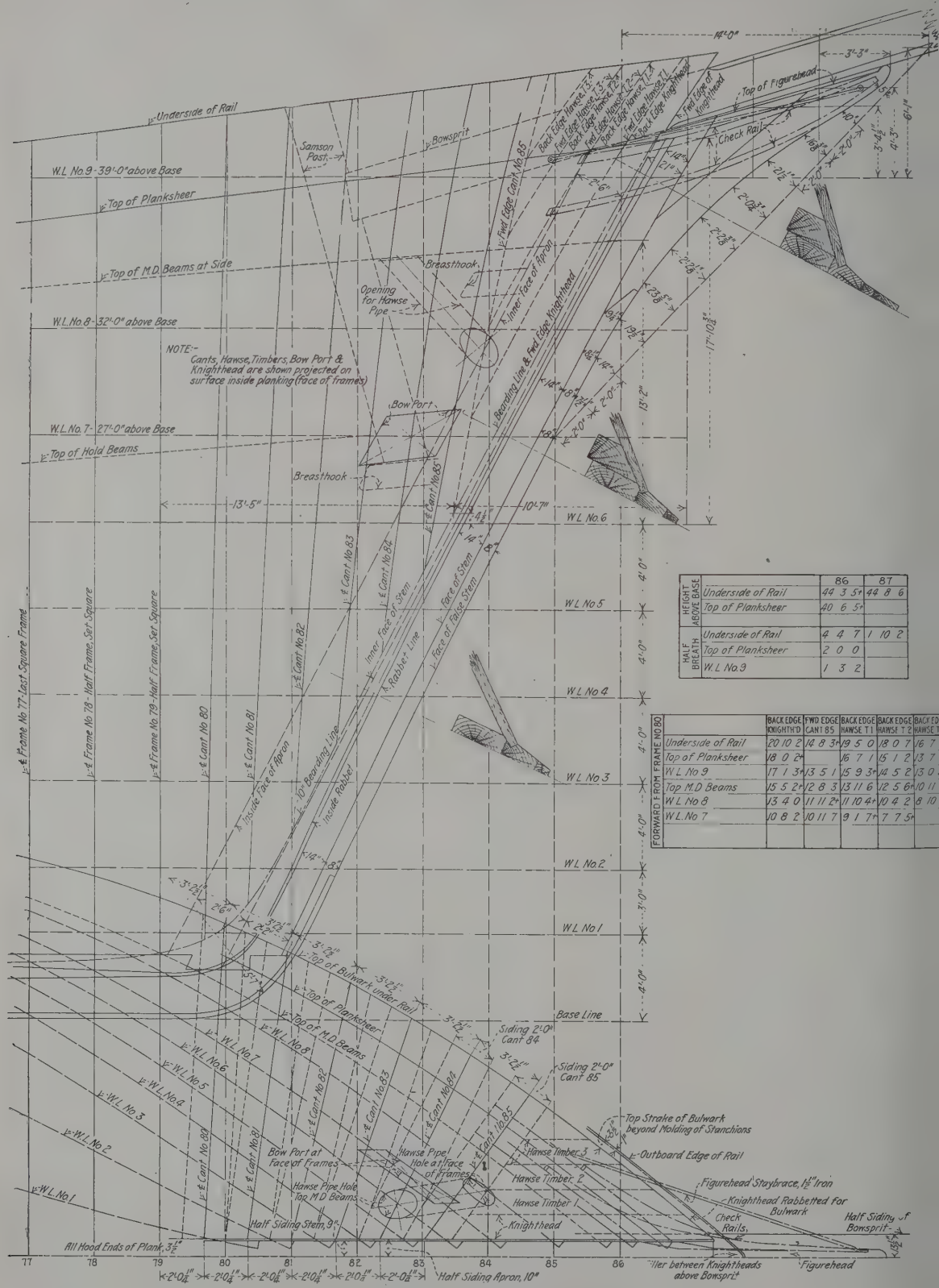
HALF BREADTH PLAN AFT

LINES OF AFTER BODY
7,500-TON D. W. CONCRETE OIL TANKER

PLATE XXXI



AUXILIARY FIVE MASTED SCHOONER
Designed by Cox & Stevens, New York City



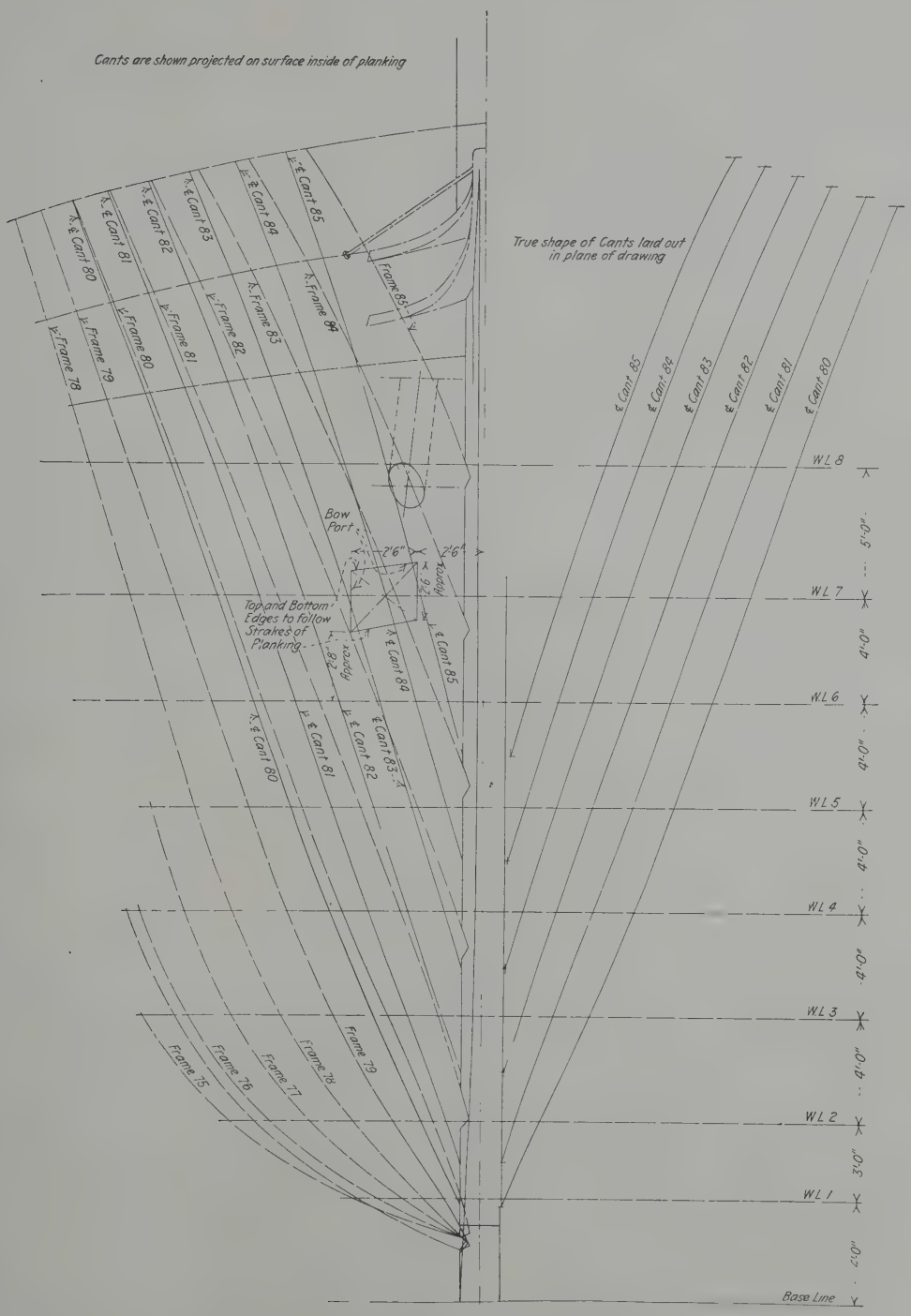
		86	87
HEIGHT ABOVE BASE	Underside of Rail	44 3 5+	44 8 6
	Top of Planksheer	40 6 5+	
HALF BREATH	Underside of Rail	4 4 7	1 10 2
	Top of Planksheer	2 0 0	
	W.L. No. 9	1 3 2	

FORWARD FROM FRAME NO. 80	BACK EDGE KNIGHTH'D	FWD EDGE CANT 85	BACK EDGE HAWSE T1	BACK EDGE HAWSE T 2	BACK ED HAWSE T
Underside of Rail	20 10 2	14 8 3+	19 5 0	18 0 7	16 7
Top of Planksheer	18 0 2+		16 7 1	15 1 2	13 7
W.L. No. 9	17 1 3+	13 5 1	15 9 3+	14 5 2	13 0
Top M.D. Beams	15 5 2+	12 8 3	13 11 6	12 5 6+	10 11
W.L. No. 8	13 4 0	11 11 2+	11 10 4+	10 4 2	8 10
W.L. No. 7	10 8 2	10 11 7	9 1 7+	7 7 5+	

AUXILIARY FIVE MASTED SCHOONER

Designed by Cox & Stevens, New York City

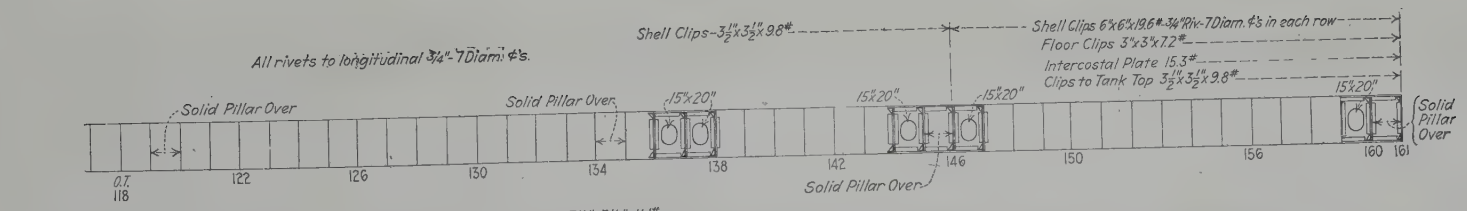
See Opposite Page

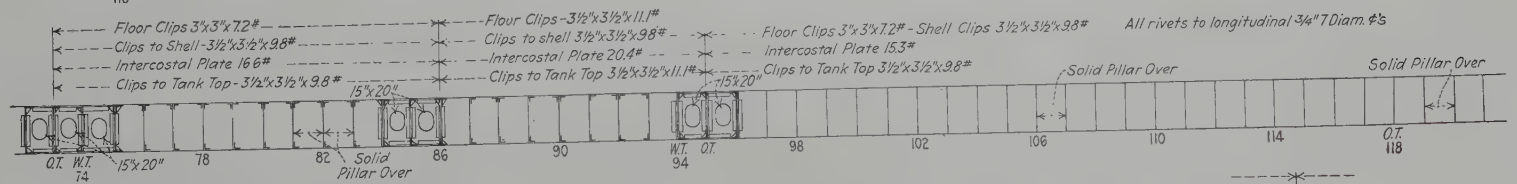


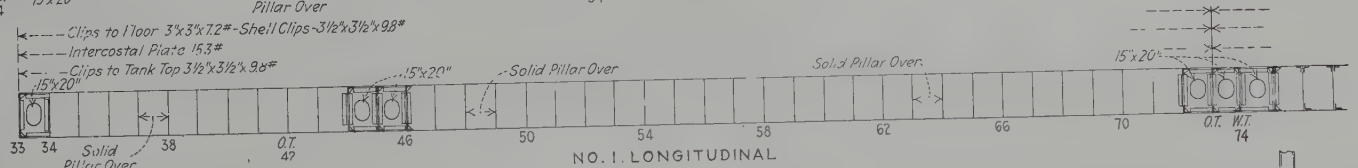
AUXILIARY FIVE MASTED SCHOONER

Designed by Cox & Stevens, New York City

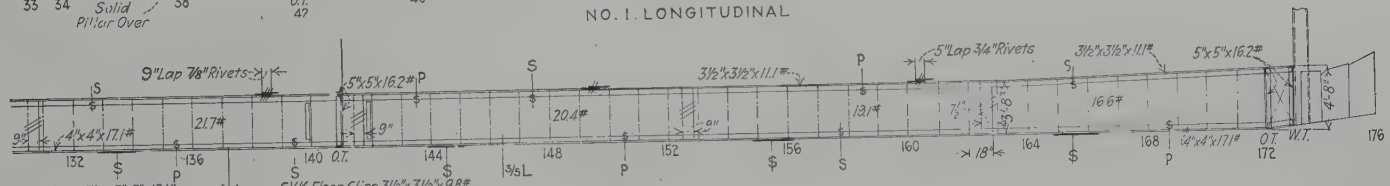
See Opposite Page

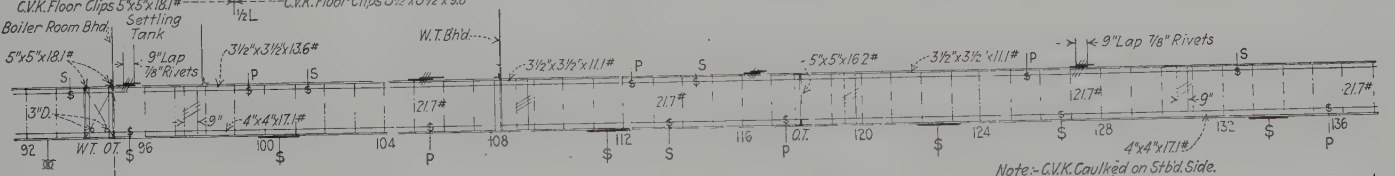


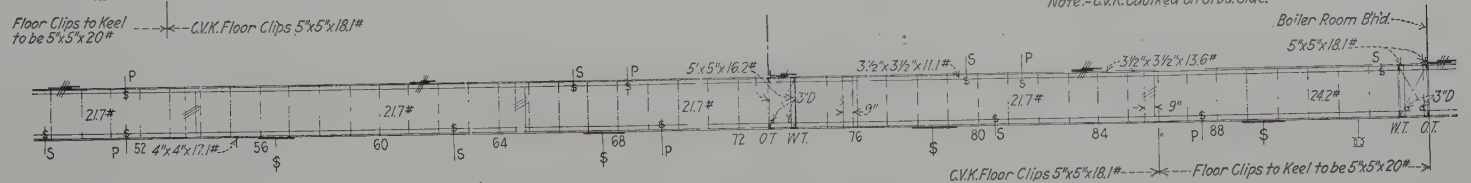


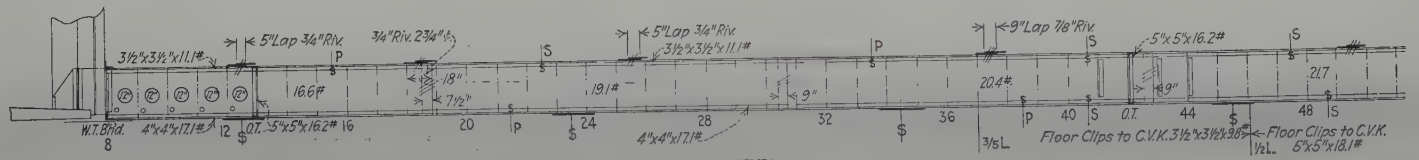


NO. 1. LONGITUDINAL

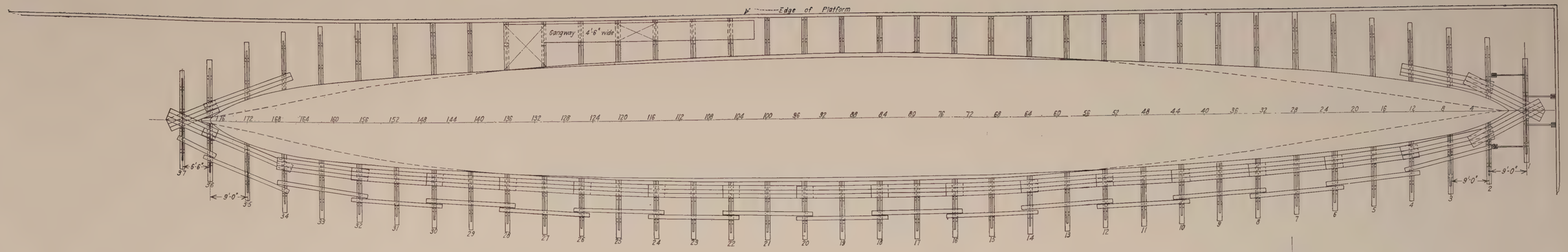


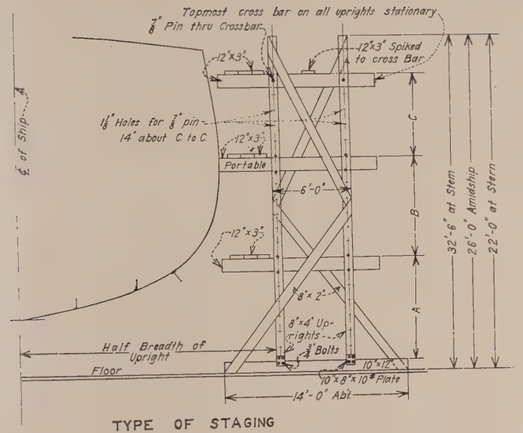




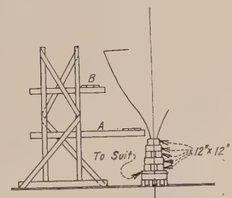


CENTER VERTICAL KEEL

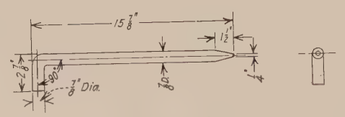




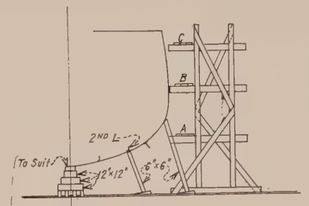
TYPE OF STAGING



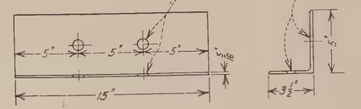
SECTION AT FR. 168



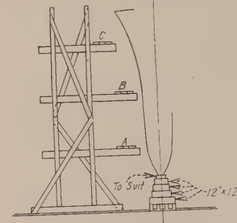
DETAIL OF PIN



SECTION AT FR. 88



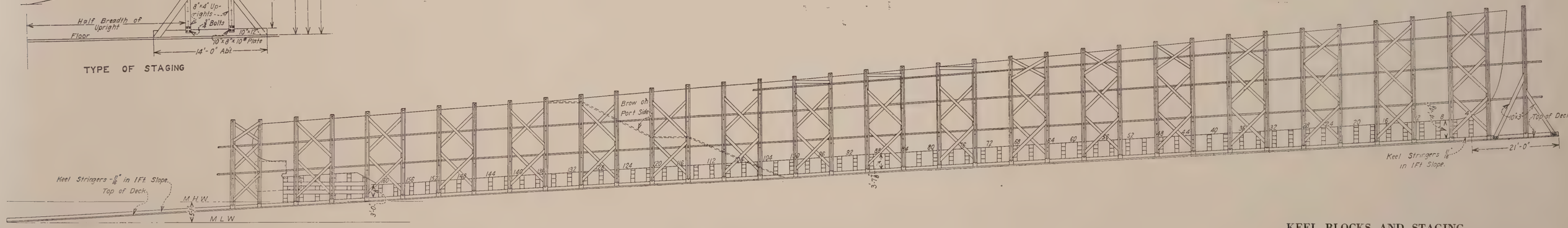
DETAIL OF CLIP



SECTION AT FR. 8

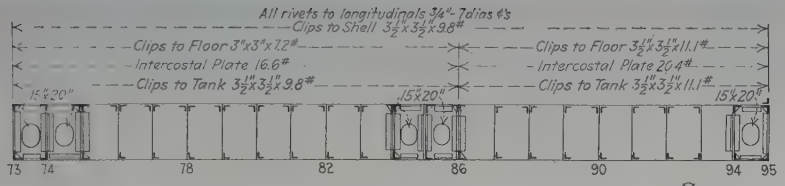
GENERAL NOTES

1 - Keel blocks spaced 4'-0" ℄ to ℄. First block, under frame N°4, 21'-0" from end of platform.
2 - Shores spaced every 3rd frame alternating 25 in each row. To be yellow pine.
3 - Uprights spaced 9'-0" except as noted.
4 - Declivity of keel blocks 3/16" per foot.
5 - Uprights, braces, and bases to be yellow pine; cross bars and planking to be spruce.
6 - Portable staging under ships bottom to be furnished as required.

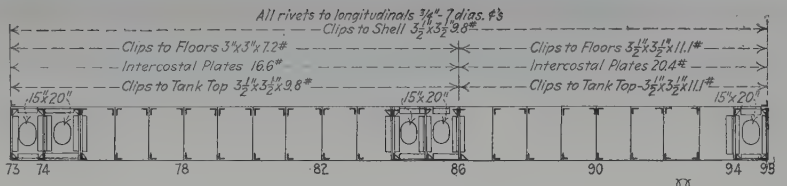


KEEL BLOCKS AND STAGING

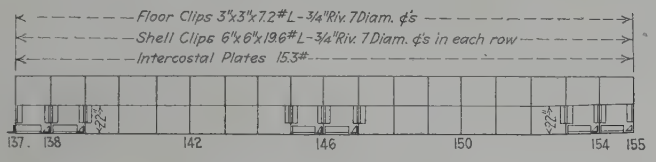
PLATE XXXII


All rivets to longitudinals 3/4"-7 dias ¢'s
Clips to Shell 3½"x3½"x9.8#
Clips to Floor 3"x3"x7.2#
Clips to Floor 3½"x3½"x11.1#
Intercostal Plate 16.6#
Intercostal Plate 20.4#
Clips to Tank 3½"x3½"x9.8#
Clips to Tank 3½"x3½"x11.1#
15¾"x20"
73 74 78 82 86 90 94 95

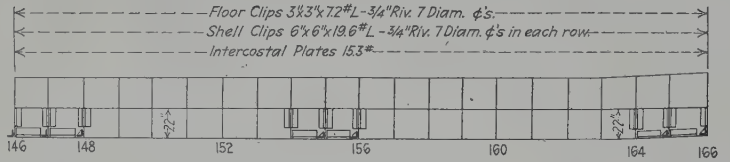
2A LONGITUDINAL
Port Side Looking Outboard


All rivets to longitudinals 3/4"-7 dias. ¢'s
Clips to Shell 3½"x3½"x9.8#
Clips to Floors 3"x3"x7.2#
Clips to Floors 3½"x3½"x11.1#
Intercostal Plates 16.6#
Intercostal Plates 20.4#
Clips to Tank Top 3½"x3½"x9.8#
Clips to Tank Top-3½"x3½"x11.1#
15¾"x20"
73 74 78 82 86 90 94 98

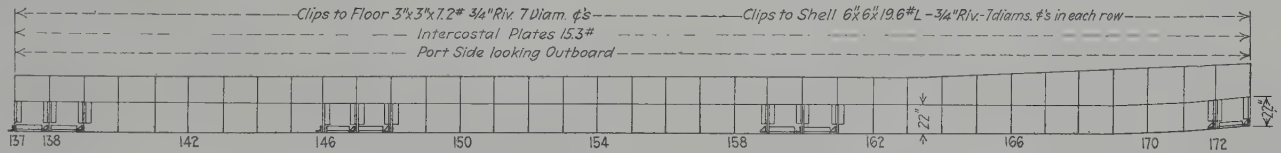
1A-LONGITUDINAL
Port Side Looking Outboard


Floor Clips 3"x3"x7.2#L-3/4"Riv. 7 Diam. ¢'s
Shell Clips 6"x6"x19.6#L-3/4"Riv. 7 Diam. ¢'s in each row
Intercostal Plates 15.3#
22"
137 138 142 146 150 154 155

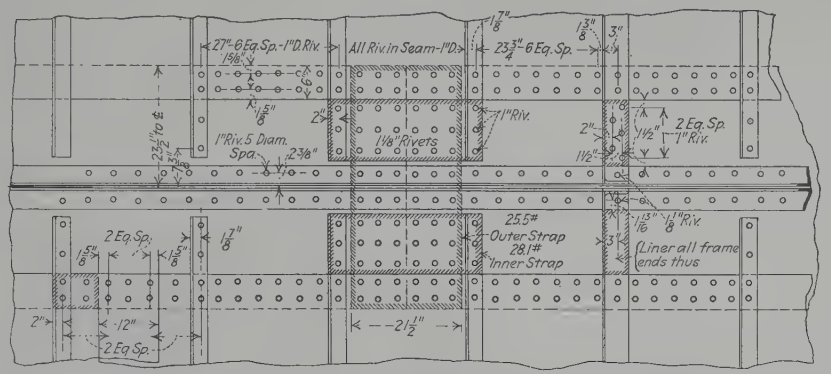
HALF DEPTH LONGITUDINAL


Floor Clips 3"x3"x7.2#L-3/4"Riv. 7 Diam. ¢'s
Shell Clips 6"x6"x19.6#L-3/4"Riv. 7 Diam. ¢'s in each row
Intercostal Plates 15.3#
22"
146 148 152 156 160 164 166

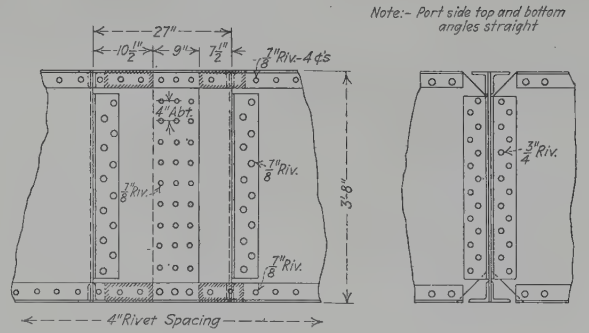
HALF DEPTH LONGITUDINAL


Clips to Floor 3"x3"x7.2# 3/4"Riv. 7 Diam. ¢'s
Clips to Shell 6"x6"x19.6#L-3/4"Riv.-7 diams. ¢'s in each row
Intercostal Plates 15.3#
Port Side looking Outboard
22"
137 138 142 146 150 154 158 162 166 170 172

HALF DEPTH LONGITUDINAL FORWARD



DETAIL OF KEEL RIVETING



DETAIL OF V.K. BUTTS

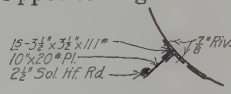
8,800-TON D. W. FREIGHTER

See Opposite Page

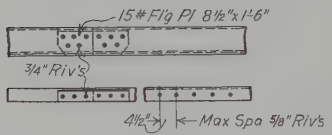
6,422-TON D. W. COLLIER

For Expansion Plan

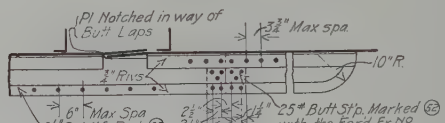
See Plate XXXIII—Opposite Page 478



SECTION THRU BILGE KEEL

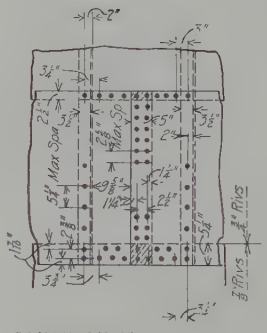


DETAIL OF SPLICE IN BULWARK

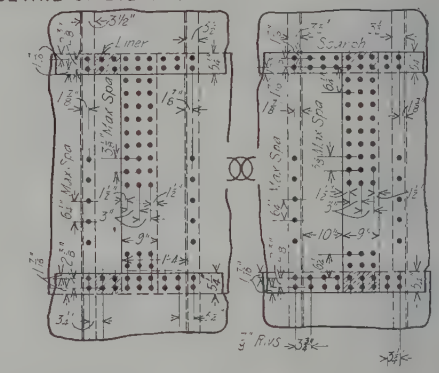


DETAIL OF BILGE KEEL

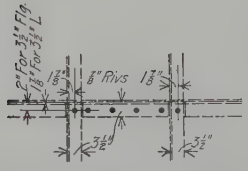
RIVETING IN WAY OF INNER BOTTOM, W.T. FLOOR, B'H'DS., & WEB FRS.



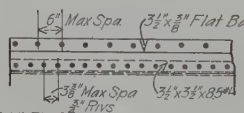
DETAIL OF 5" BUTT LAPS



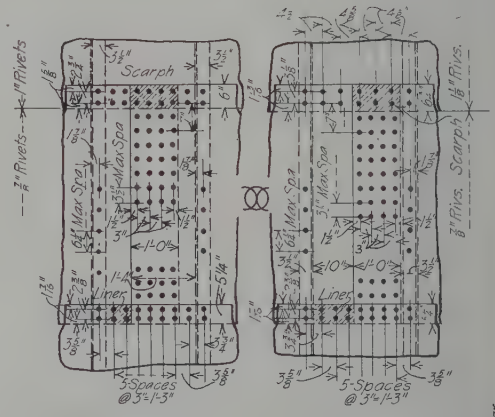
DETAIL OF TREBLE RIVETED BUTT LAPS



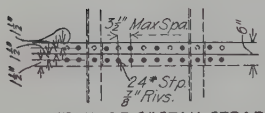
RIVETING IN WAY OF STRINGERS & LONGITUDINALS



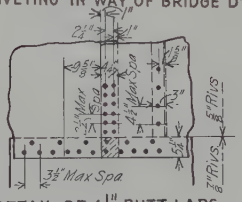
RIVETING IN WAY OF BRIDGE D'K



DETAIL OF QUADRUPLE RIVETED BUTT LAPS



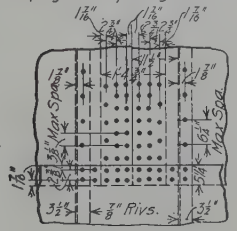
DETAIL OF 6" SEAM STRAPS



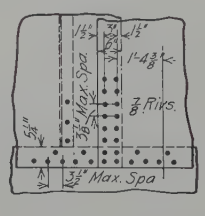
DETAIL OF 4¼" BUTT LAPS

General Notes

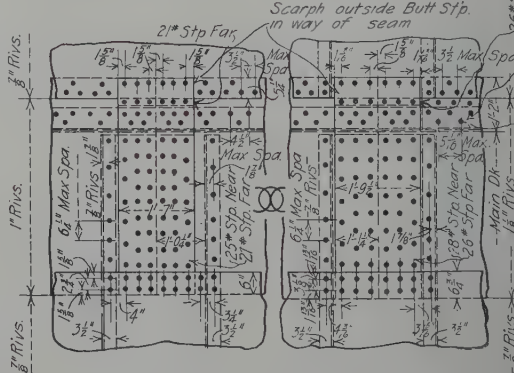
Shell Plating symmetrical abt. ℄ ship except as shown or noted
All frames are spaced 2'-2" apart unless shown or noted
Sight edges of all plates to be planed for caulking
Outside butt stp's. in sheer strake marked with the strake letter & for'd. fr. no. over "A"
Inside " " below main d'k. " " " " " " " " " " "B"
" " " above " " " " " " " " " " "C"
All rivets countersunk on outside of shell.
" " " in bilge keel.
Riveting of frs. to shell in way of deep tank to be 4 13/16" max. spa.
Tack rivs. in d'b'l pls. spaced abt. 1'0" ℄ to ℄
Riveting in shell plating to suit holes in mooring pipe castings



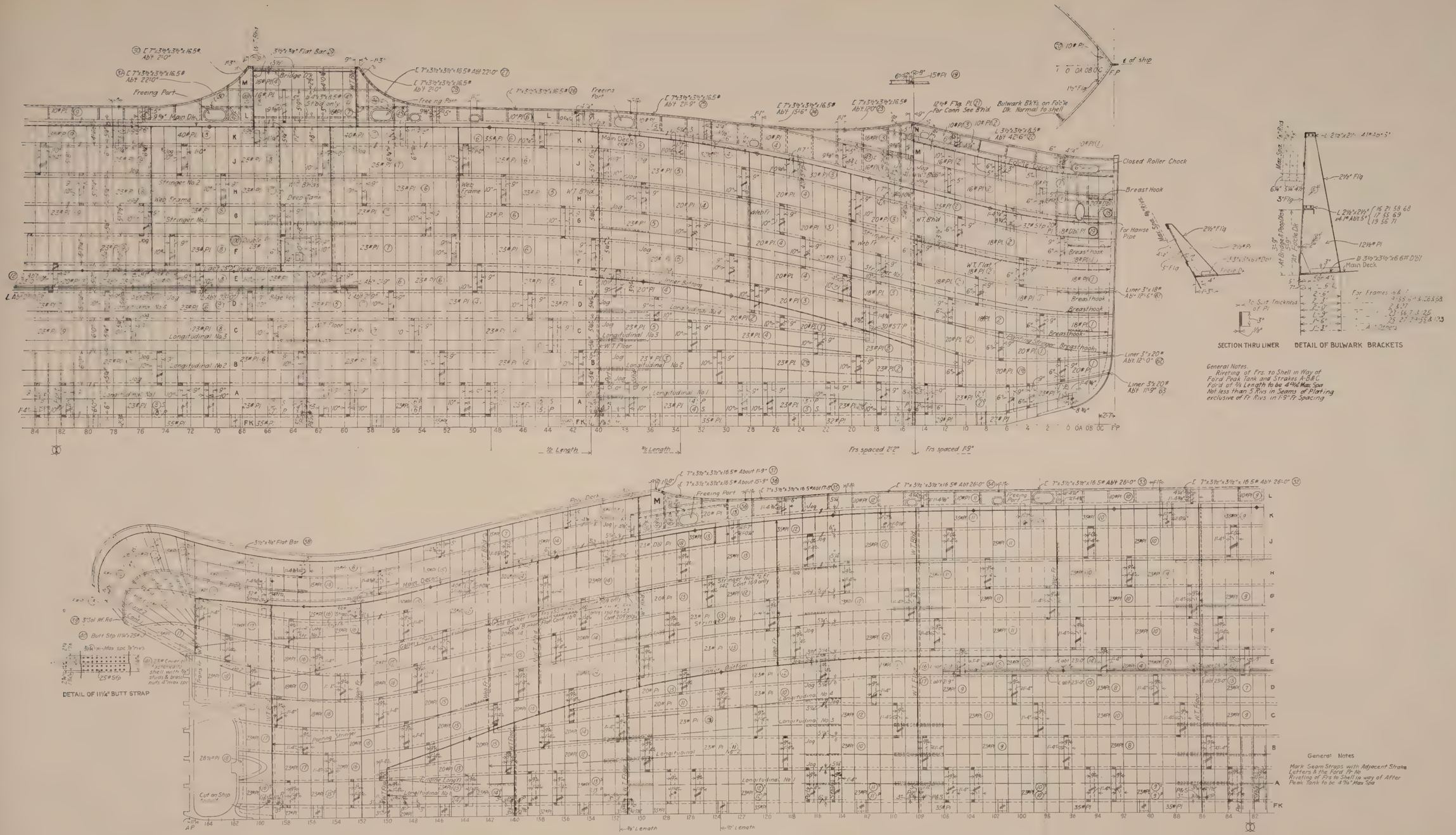
DETAIL OF 1'-4¾" BUTT STRAP

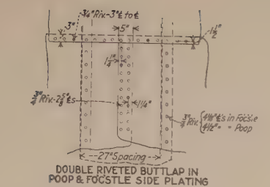


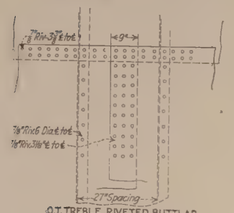
DETAIL OF 6" BUTT LAP

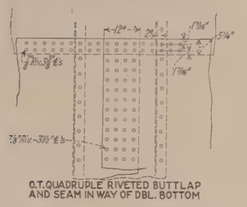


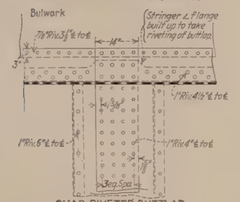
DETAIL OF RIVETING IN SHEER STRAKE

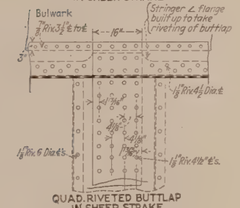

Freeing Port
Bridge Dk
Main Dk
Main Deck
Stringer No.2
Stringer No.1
Deep Tank
Longitudinal No.3
Longitudinal No.2
Longitudinal No.1
Inner Bottom
Longitudinal No.4
W.T. Floor
Bilge Vert.
Web Frame
W.T. Bhd
Jog
Frs spaced 2'-2"
Frs spaced 1'-9"
½ Length
⅞ Length
Closed Roller Chock
Breast Hook
For Hawse Pipe
Liner 3"x 18" Abt 11'-1" (61)
Liner 3"x 20" Abt 12'-0" (62)
Liner 3"x 20" Abt 11'-9" (63)
Bulwark 8"x½ on Fdc'le Dk Normal to shell
Fdc'le Dk
Main Spa 9'-9"
Bridge Dk
Fdc'le Dk
Main Deck
SECTION THRU LINER
DETAIL OF BULWARK BRACKETS
Frs 1 to 4
Frs 5 to 8
Frs 9 to 12
Frs 13 to 16
Frs 17 to 20
Frs 21 to 24
Frs 25 to 28
Frs 29 to 32
Frs 33 to 36
Frs 37 to 40
Frs

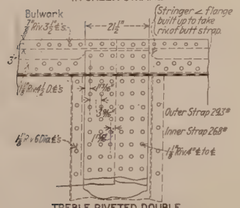


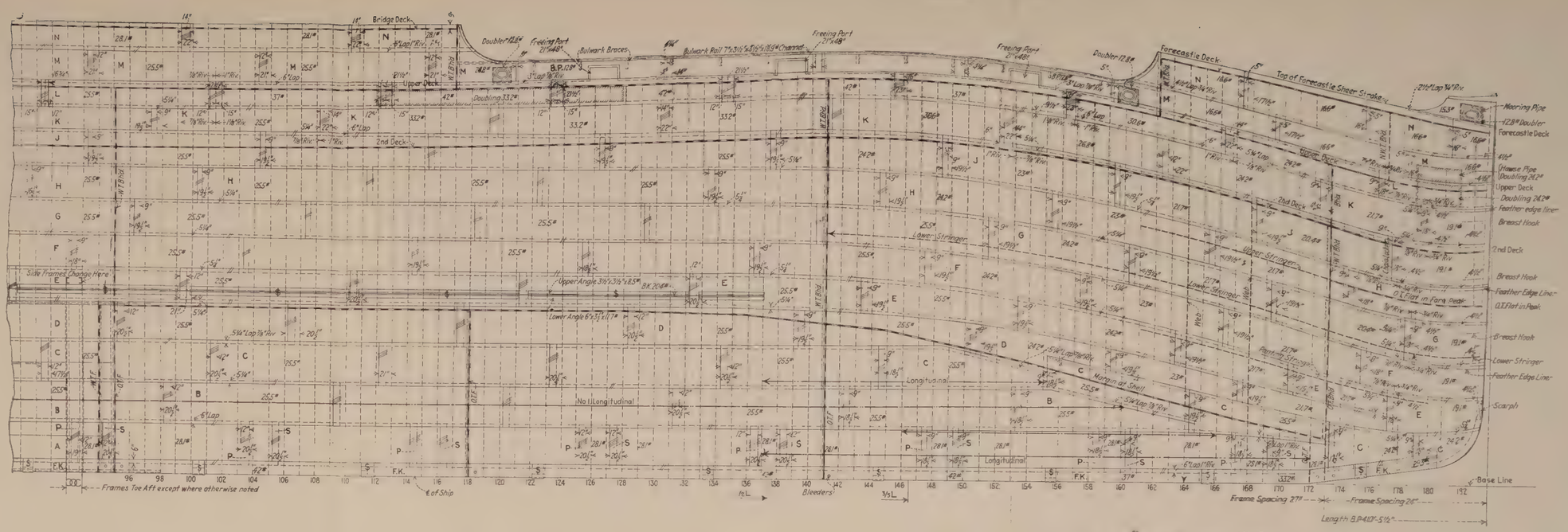


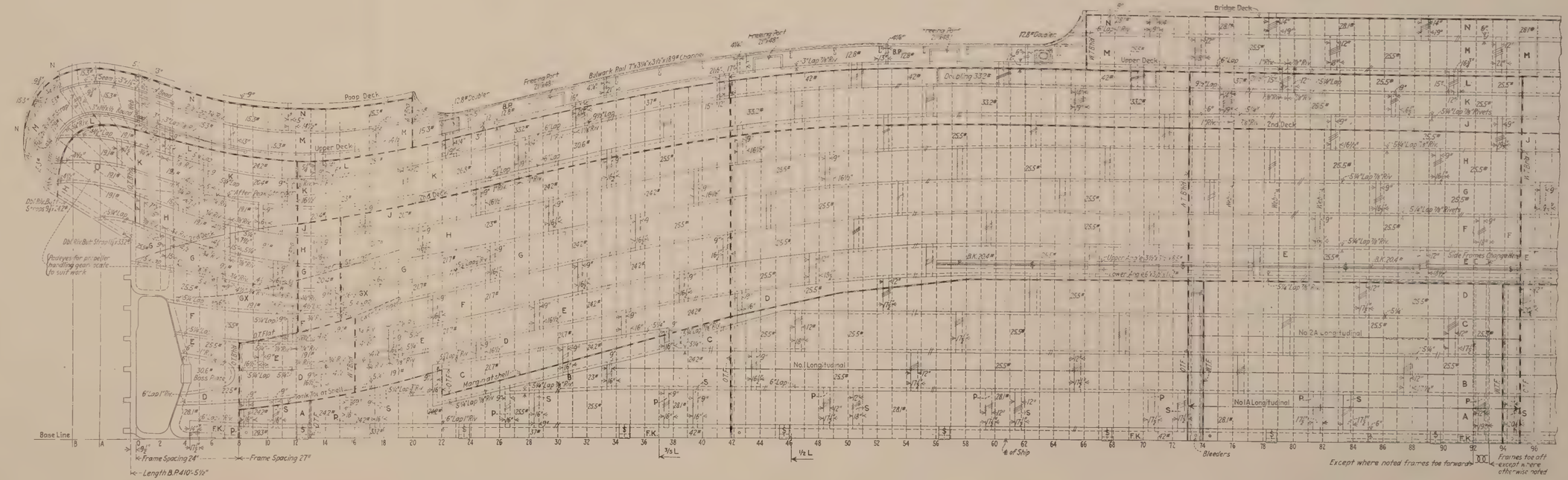












SHELL EXPANSION
8,800-TON D. W. FREIGHTER

PLATE XXXIV

8,800-TON D. W. FREIGHTER

For Expansion Plan
See Plate XXXIV—Opposite Page 478

SCHEDULE OF RIVETING

9¾″ Buttstraps	¾″ rivets	2⅝″ centers
16¾″ Buttstraps	⅞″ rivets	3⅛″ centers
21½″ Buttstraps	1⅛″ rivets	4″ centers
4¼″ Butt lap	⅝″ rivets	2½″ centers
5″ Butt lap	¾″ rivets	3″ centers
7½″ Butt lap	¾″ rivets	2⅝″ centers
9″ Butt lap	⅞″ rivets	3⅛″ centers
12″ Butt lap	⅞″ rivets	3½″ centers
14″ Butt lap	1″ rivets	4″ centers
16″ Butt lap	1⅛″ rivets	4½″ centers
2½″ Seam	¾″ rivets	3″ centers
3″ Seam	⅞″ rivets	3½″ centers
4½″ Seam	¾″ rivets	3″ centers
5¼″ Seam	⅞″ rivets	3½″ centers
6″ Seam	1″ rivets	4″ centers
9½″ Seam	1⅛″ rivets	4½″ centers

All seams double riveted except in way of wash plates, bulwark and side plating between upper and poop decks.

Doubling Plates

33.2# Doubling plates
- Edges single riveted 1⅛″ riv. 5⅝″ centers
- Quilting 1⅛″ riv. 13½″ centers

24.2# Doubling plates
- Edges single riveted ⅞″ riv. 4⅜″ centers
- Quilting ⅞″ riv. 10½″ centers

12.8# Doubling plates
- Edges single riveted ¾″ riv. 3¾″ centers
- Quilting ¾″ riv. 9″ centers

Connections of Shapes to Plates

10″ Channel frames
- In way 37# sheer strake 1⅛″ riv. 6¾″ centers
- Below upper deck (except 37# sheer strake) 1″ riv. 6″ centers from 3/5 L aft
- 1″ riv. 5½″ centers from 3/5 L forward
- Upper to bridge deck 1″ riv. 6″ centers
- Upper to forecastle deck ¾″ riv. 4⅛″ centers
- Upper to poop deck ¾″ riv. 4½″ centers

6″ x 3½″ x 13.5# intermediate frames
- Upper deck to bridge 1″ riv. 6″ centers

6″ x 3½″ x 11.7# intermediate frames
- Upper deck to for's'le ¾″ riv. 4⅛″ centers
- Upper deck to poop ¾″ riv. 4½″ centers

6″ x 3½″ x 11.7# frames in fore peak
- To plating 19.1# and under ¾″ riv. 4⅛″ centers
- To plating over 19.1# ⅞″ riv. 4¾″ centers

6″ x 3½″ x 11.7# frames in after peak
- To plating 19.1# and under ¾″ riv. 4½″ centers

To plating over 19.1# ⅞″ riv. 5¼″ centers

N. W. T. floor angles to plating 19.1# or less ¾″ riv. 4½″ centers

N. W. T. floor angles to plating over 19.1# to 26.8# ⅞″ riv. 5¼″ centers

O. T. margin angle to 19.1# plating ¾″ riv. 3⅜″ centers

O. T. margin angle to plating over 19.1# ⅞″ riv. 4″ centers

Intercostal shell clips ⅞″ riv. 5 riv. in each frame space

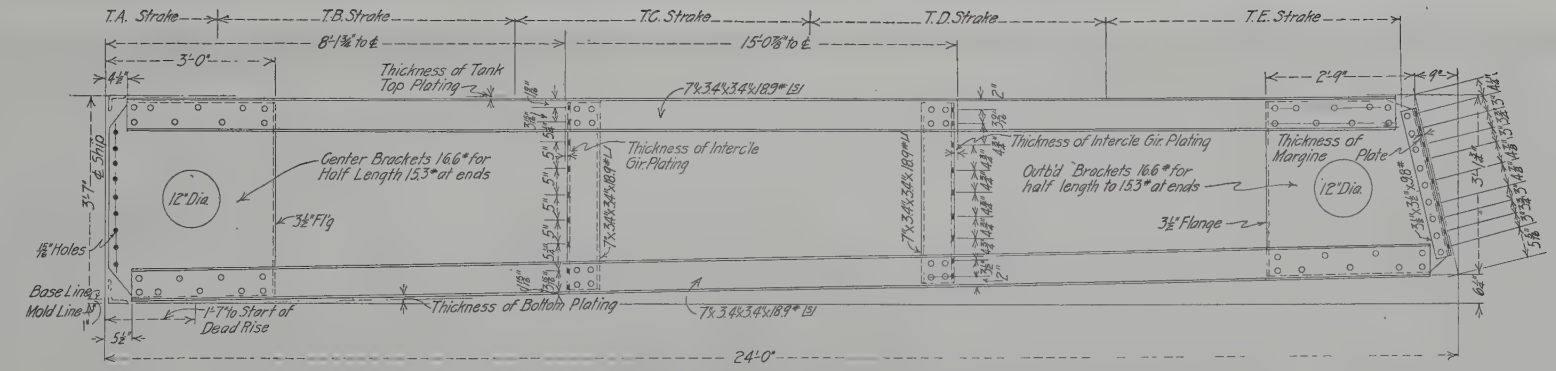
3″ half round at lower knuckle ¾″ riv. 5¼″ centers

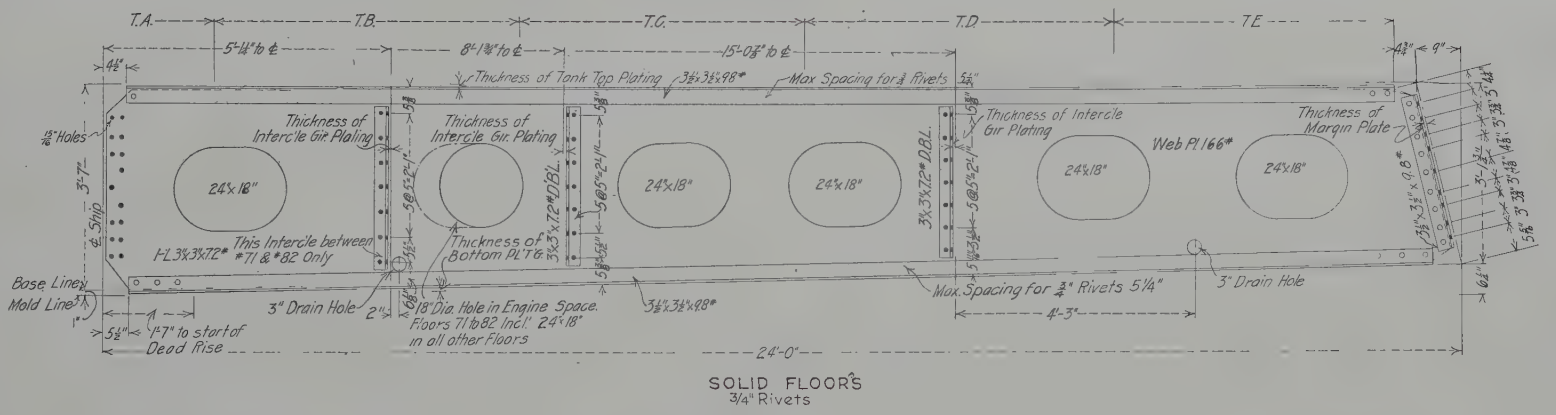
3″ half round at upper knuckle to take seam rivets

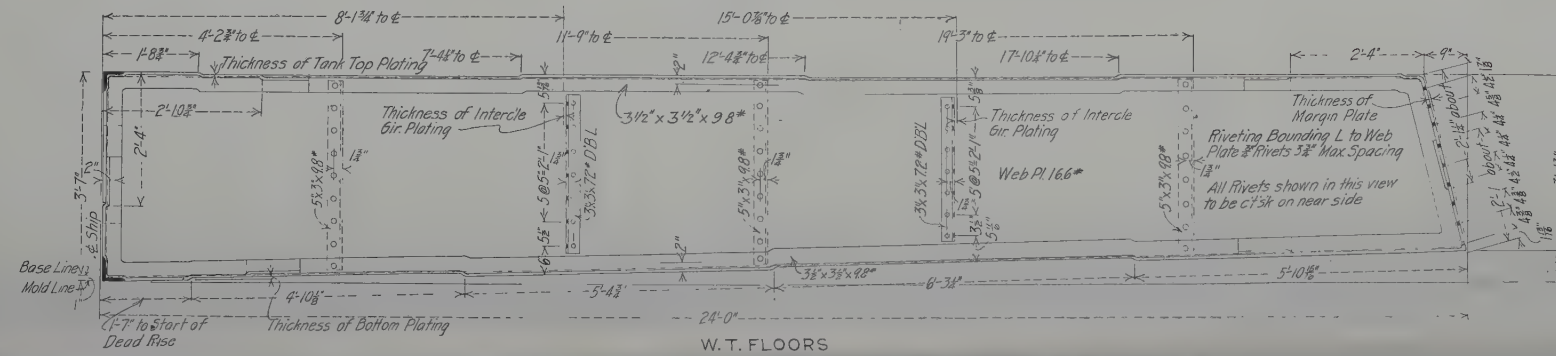
W. T. Bhd. and O. T. floor bounding angles to be as shown on bhd. and floor plans

Deck stringer angles to be as shown on deck plans

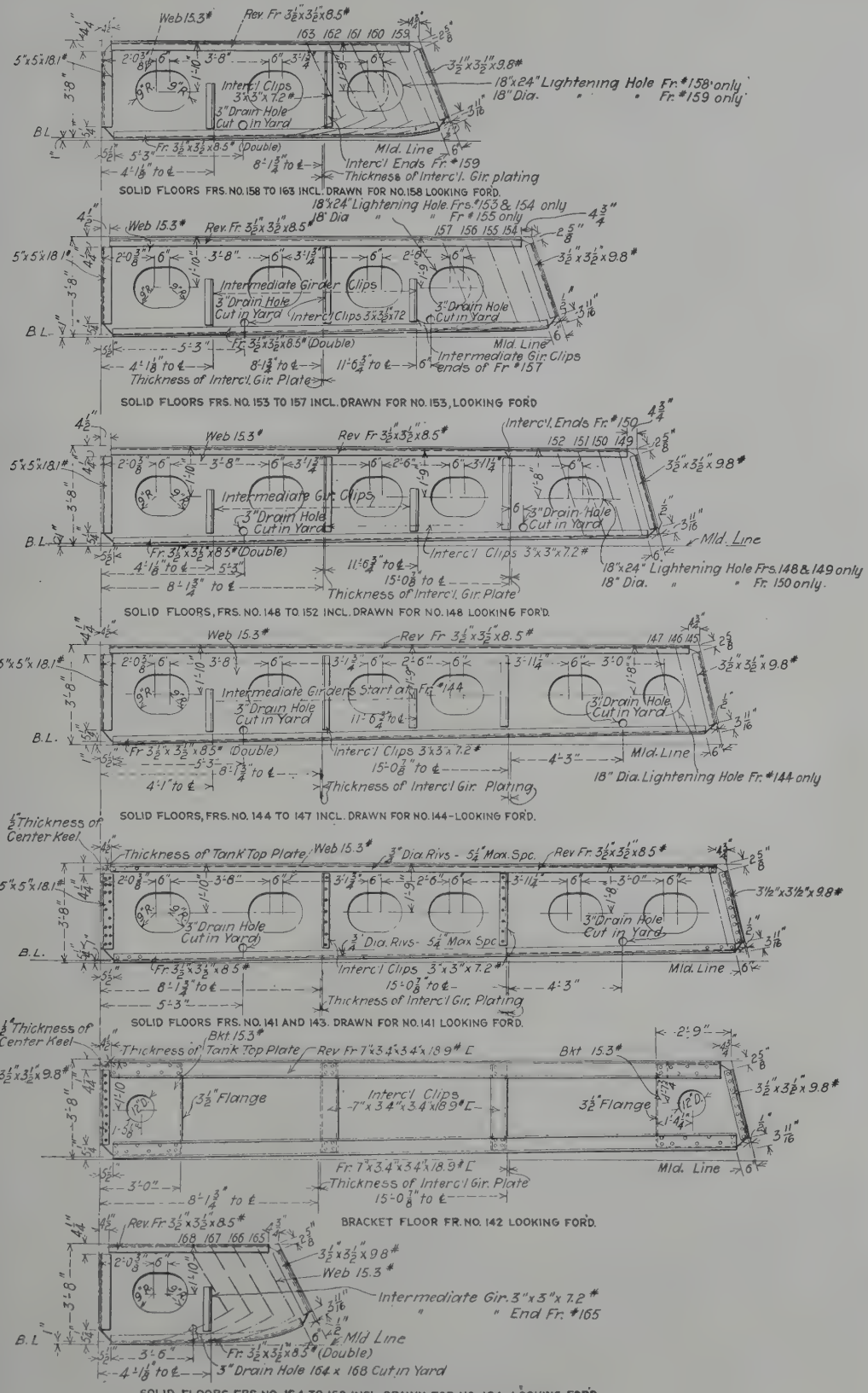
Bilge keel as per detail

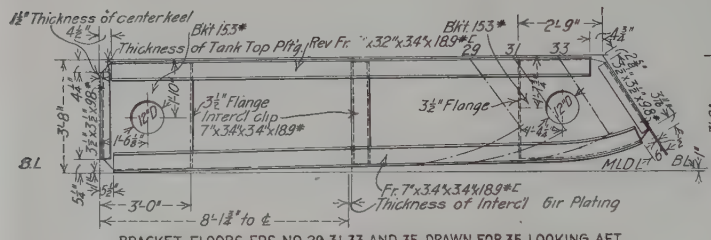




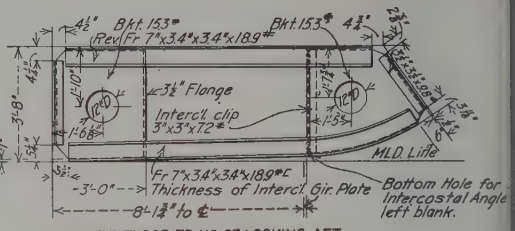


9,000 TON D. W. FREIGHTER

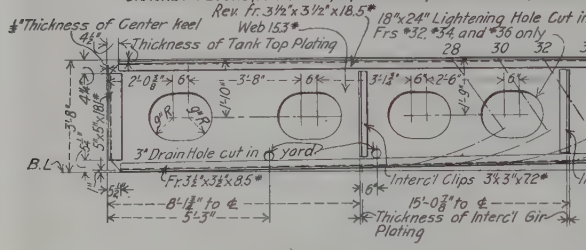

Web 15.3#
Rev Fr 3½"x3½"x8.5#
163 162 161 160 159
5"x5"x18.1#
Interc'l Clips 3"x3"x7.2#
3" Drain Hole Cut in Yard
3½"x3½"x9.8#
18"x24" Lightening Hole Fr.#158 only
18" Dia. " " Fr.#159 only
B.L.
Fr. 3½"x3½"x8.5# (Double)
Mld. Line
Interc'l Ends Fr.#159
Thickness of Interc'l. Gir. plating
SOLID FLOORS FRS. NO. 158 TO 163 INCL. DRAWN FOR NO. 158 LOOKING FORD.
18"x24" Lightening Hole. Frs.#153 & 154 only
18" Dia " " Fr.#155 only
Web 15.3#
Rev. Fr. 3½"x3½"x8.5#
157 156 155 154
Intermediate Girder Clips
3" Drain Hole Cut in Yard
Interc'l Clips 3"x3"x7.2#
Intermediate Gir. Clips ends of Fr.#157
Thickness of Interc'l. Gir. Plate
SOLID FLOORS FRS. NO. 153 TO 157 INCL. DRAWN FOR NO. 153, LOOKING FORD
Interc'l. Ends Fr.#150
152 151 150 149
Intermediate Gir. Clips
18"x24" Lightening Hole Frs. 148 & 149 only
18" Dia. " " Fr. 150 only.
Mld. Line
Thickness of Interc'l. Gir. Plate
SOLID FLOORS, FRS. NO. 148 TO 152 INCL. DRAWN FOR NO. 148 LOOKING FOR'D.
147 146 145
Intermediate Girders Start at Fr.#144
18" Dia. Lightening Hole Fr.#144 only
Thickness of Interc'l Gir. Plating
SOLID FLOORS, FRS. NO. 144 TO 147 INCL. DRAWN FOR NO. 144 - LOOKING FOR'D.
½" Thickness of Center Keel
Thickness of Tank Top Plate
3" Dia. Rivs - 5¼" Max. Spc.
3½"x3½"x9.8#
3" Drain Hole Cut in Yard
¾" Dia. Rivs - 5¼" Max Spc
Thickness of Interc'l Gir. Plating
SOLID FLOORS FRS. NO. 141 AND 143. DRAWN FOR NO. 141 LOOKING FORD.
Bkt 15.3#
Rev Fr 7"x3.4"x3.4"x18.9# L
3½" Flange
Interc'l Clips -7"x3.4"x3.4"x18.9# L-
Fr. 7"x3.4"x3.4"x18.9# L
Thickness of Interc'l Gir. Plate
BRACKET FLOOR FR. NO. 142 LOOKING FORD.
168 167 166 165
Intermediate Gir. 3"x3"x7.2#
End Fr. #165
Mld Line
Fr. 3½"x3½"x8.5# (Double)
3" Drain Hole 164 x 168 Cut in Yard
SOLID FLOORS FRS NO. 164 TO 168 INCL. DRAWN FOR NO. 164 - LOOKING FORD.



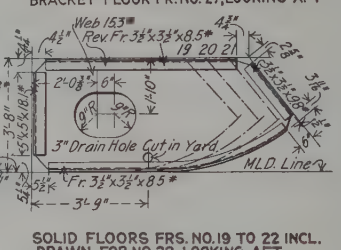
BRACKET FLOORS, FRS. NO. 29, 31, 33 AND 35, DRAWN FOR 35, LOOKING AFT.



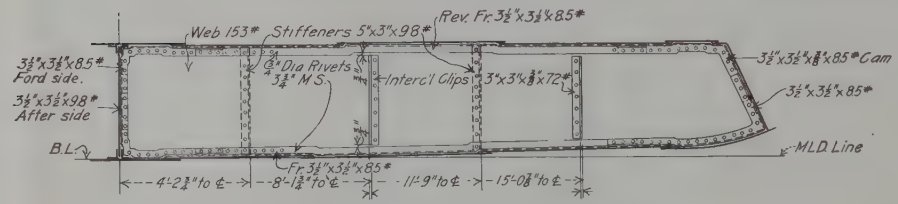
BRACKET FLOOR FR. NO. 27, LOOKING AFT



SOLID FLOORS FRS. NO. 28, 30, 32, 34 AND 36 DRAWN FOR NO. 36, LOOKING AFT.

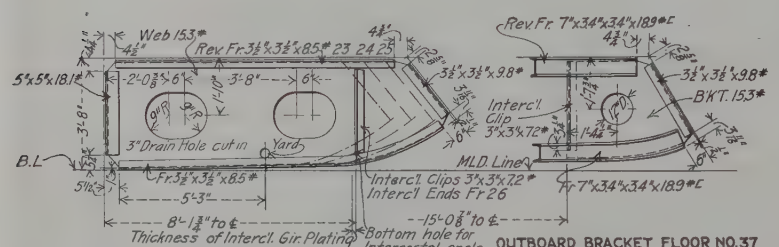


SOLID FLOORS FRS. NO. 19 TO 22 INCL. DRAWN FOR NO. 22, LOOKING AFT



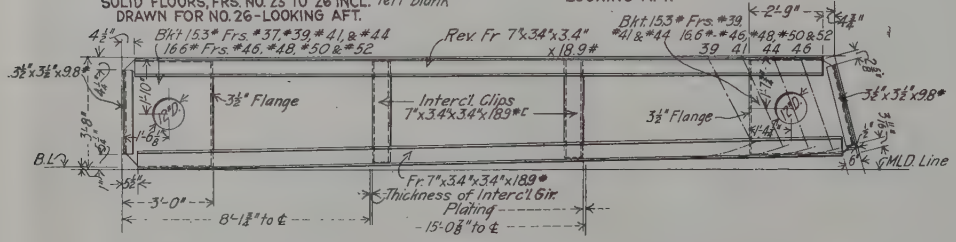
W.T. FLOOR FR. NO. 42 AND 43, LOOKING AFT

Note:- Lightening Holes to be not less than 9" from edge of Plates

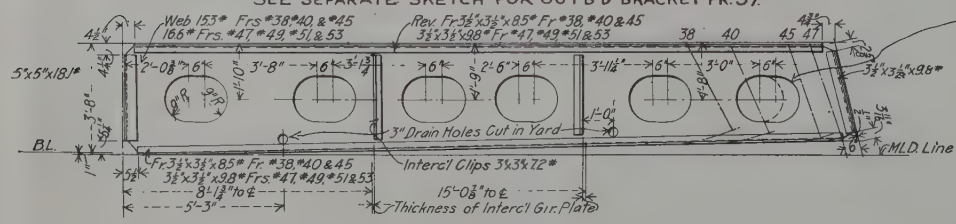


SOLID FLOORS, FRS. NO. 23 TO 26 INCL. DRAWN FOR NO. 26 - LOOKING AFT.

OUTBOARD BRACKET FLOOR NO. 37 LOOKING AFT.

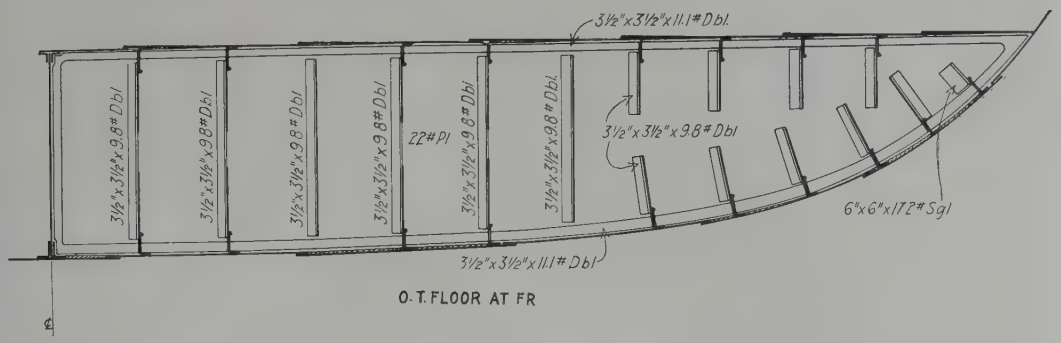


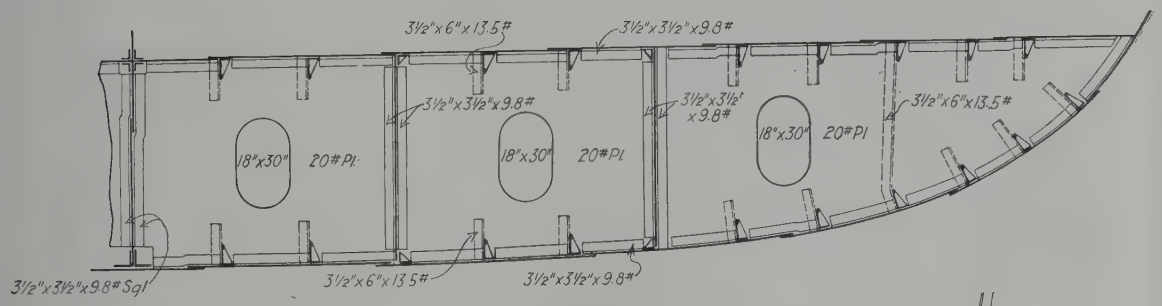
BRACKET FLOORS, FRS. NO. 37, 39, 41, 44, 46, 48, 50 AND 52. DRAWN FOR *50 LOOKING AFT.
SEE SEPARATE SKETCH FOR OUTB'D BRACKET FR. 37.

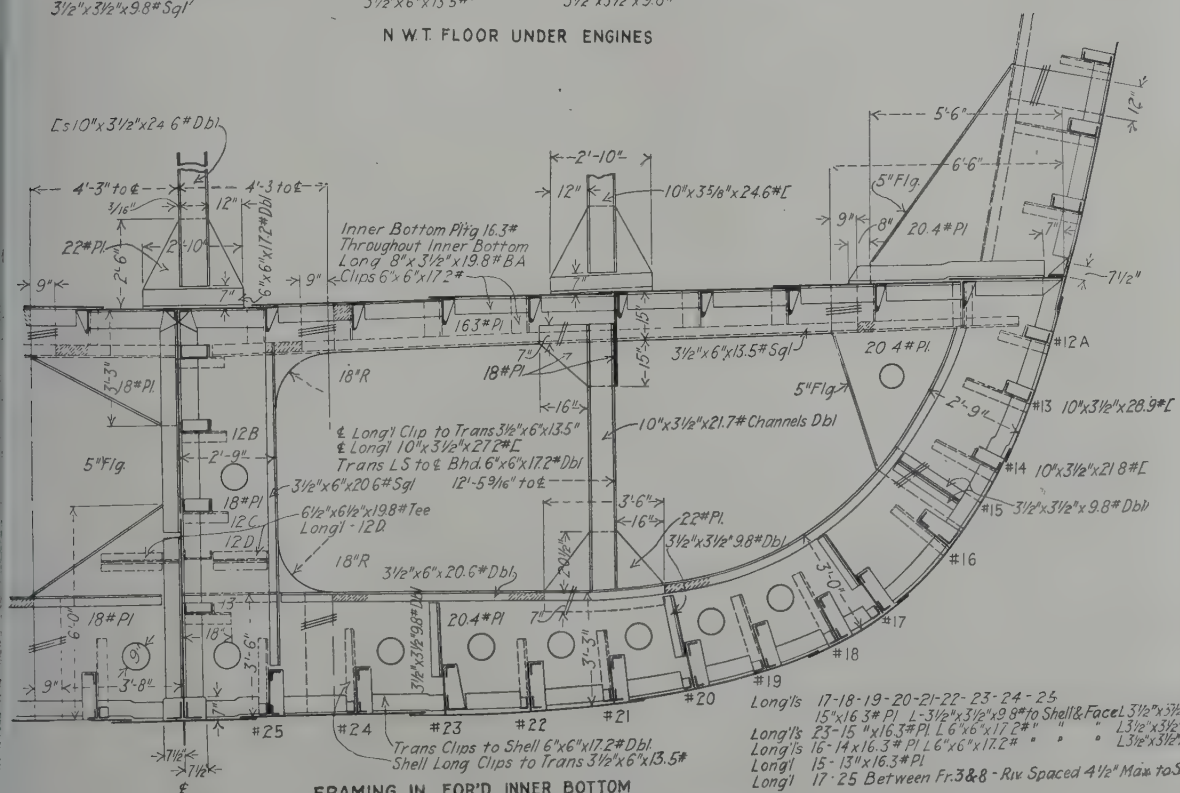


SOLID FLOORS, FR'S., NO. 38, 40, 45, 47, 49, 51 AND 53. DRAWN FOR NO. 53, LOOKING AFT.

9,000-TON D. W. FREIGHTER



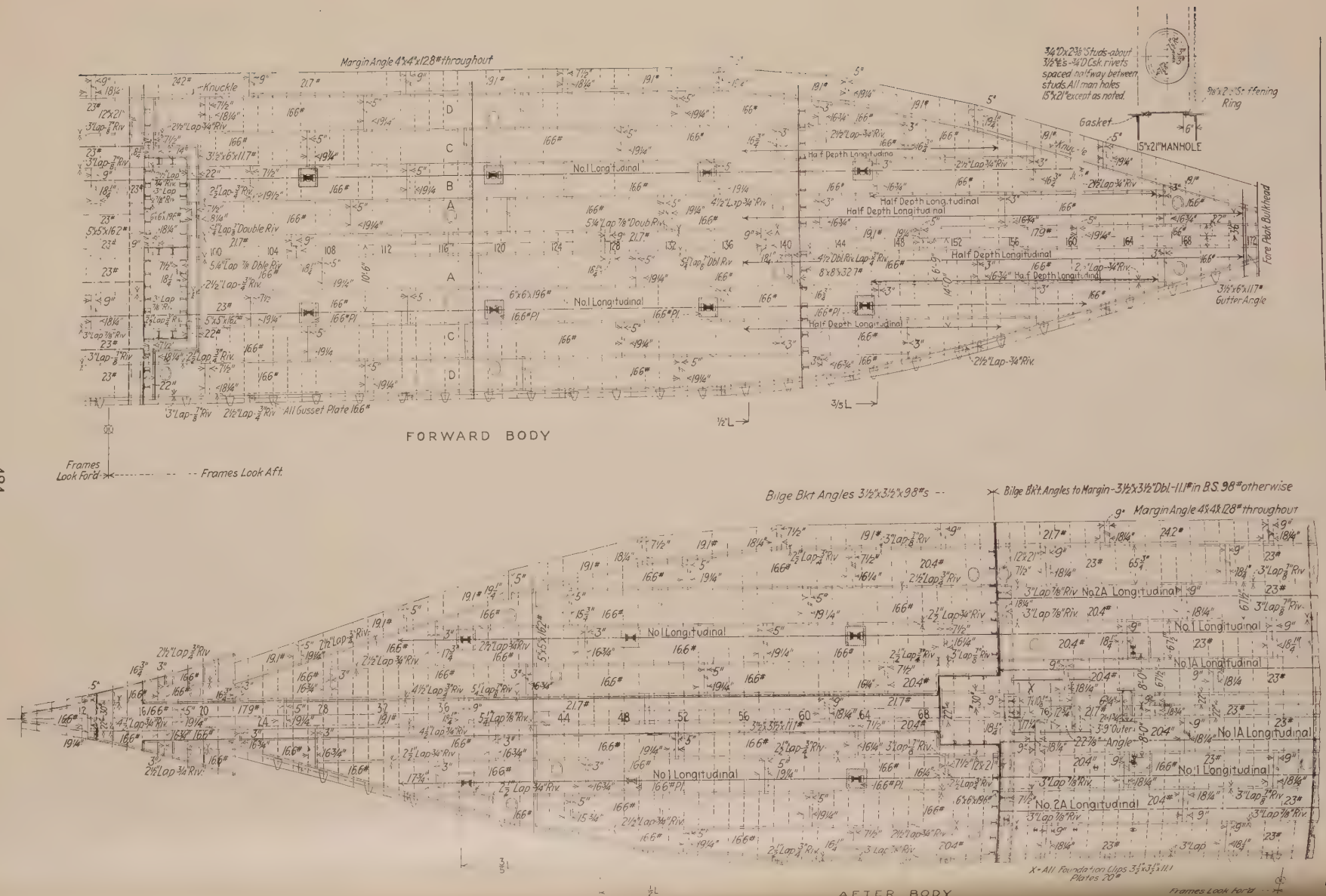




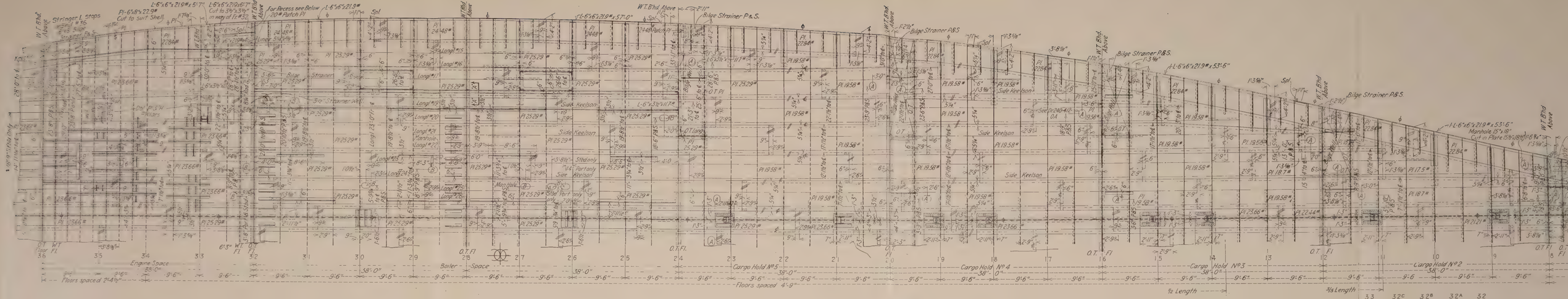
Long'ls 17-18-19-20-21-22-23-24-25
15"x16.3# Pl L-3½"x3½"x9.8# to Shell & Face L 3½"x3½"x9.8#
Long'ls 23-15"x16.3# Pl. L 6"x6"x17.2# " " " L 3½"x3½"x9.8#
Long'ls 16-14x16.3# Pl L 6"x6"x17.2# " " " L 3½"x3½"x9.8#
Long'l 15-13"x16.3# Pl
Long'l 17-25 Between Fr. 3 & 8 - Riv. Spaced 4½" Max. to Shell

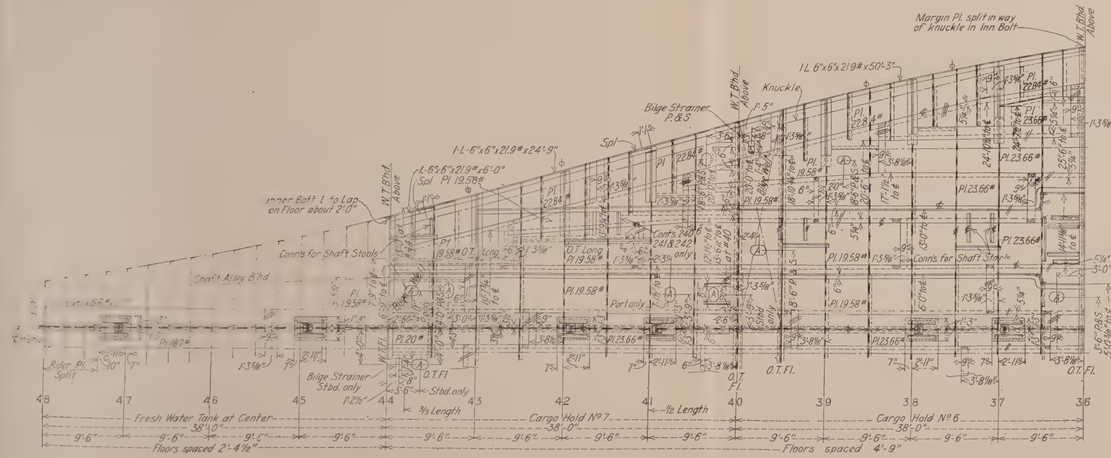
12,000-TON D. W. TANKER

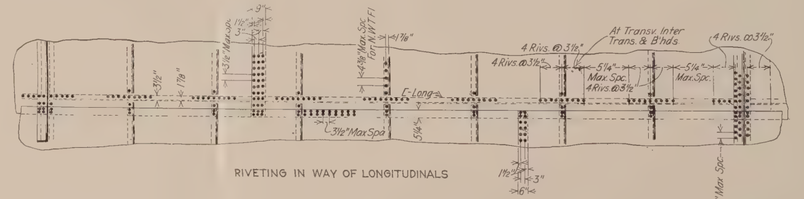
Builders, Bethlehem Shipbuilding Corp.

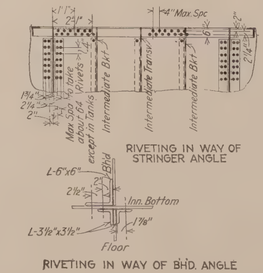


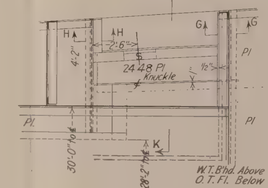
8,800-TON D. W. FREIGHTER

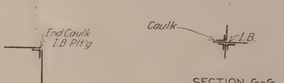


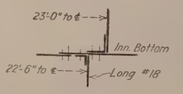










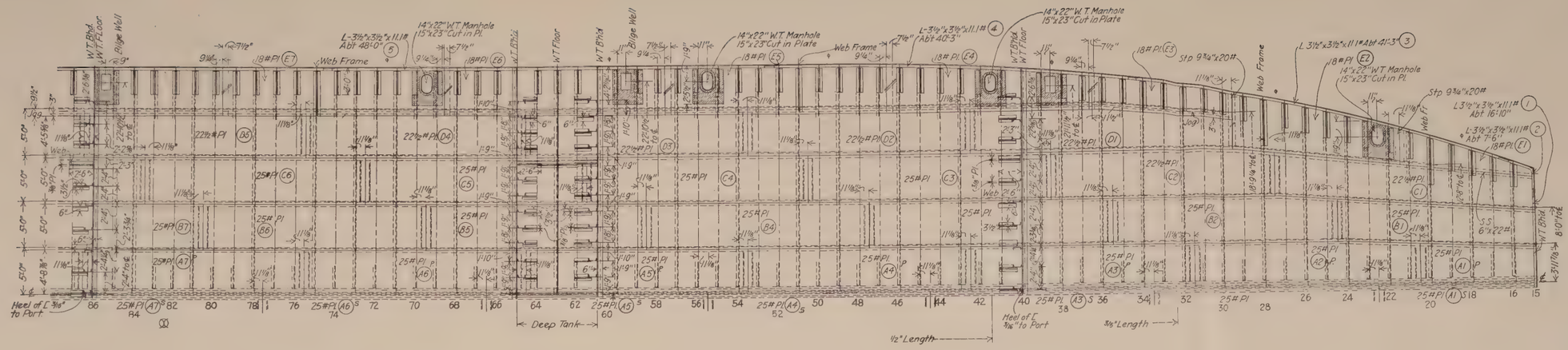


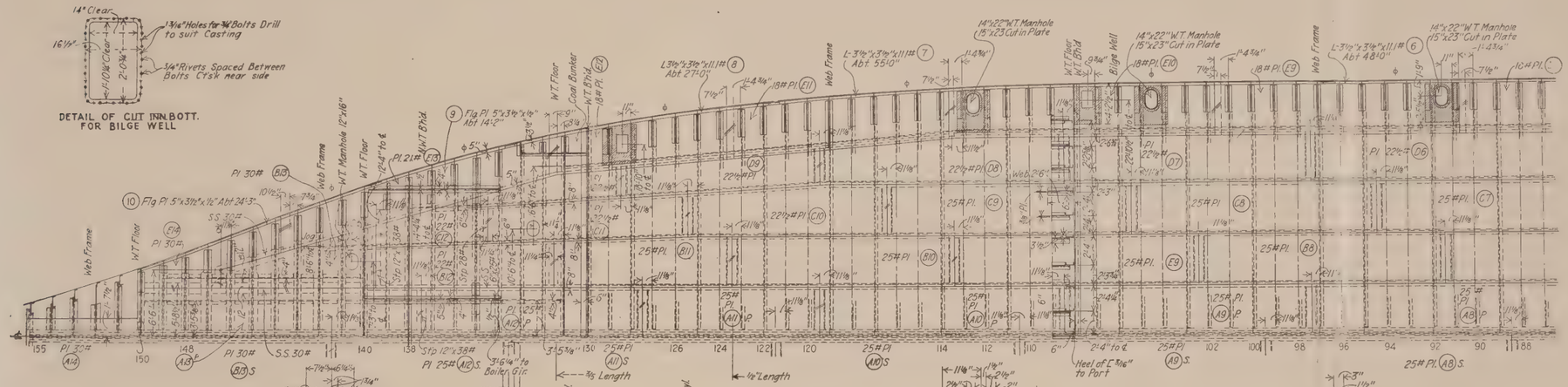
INNER BOTTOM PLATING

13,000-TON D. W. COMBINED PASSENGER AND FREIGHTER

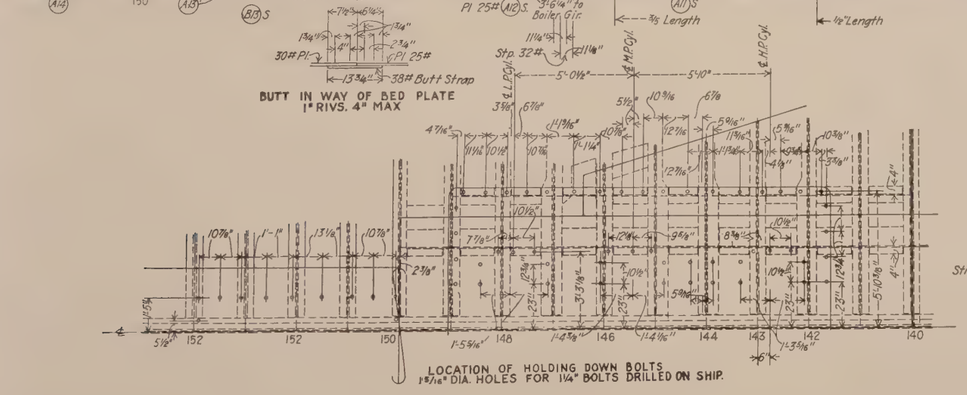
Builders, Bethlehem Shipbuilding Corp.

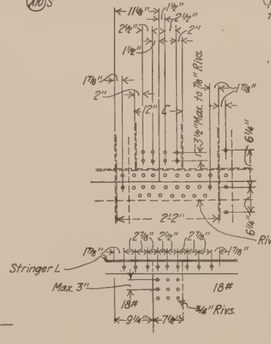
New York Shipbuilding Corp.

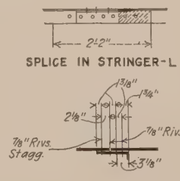


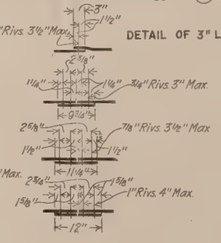


DETAIL OF CUT IN N. BOTT. FOR BILGE WELL









DETAILS OF BUTTSTRAPS

RIVETING SCHEDULE

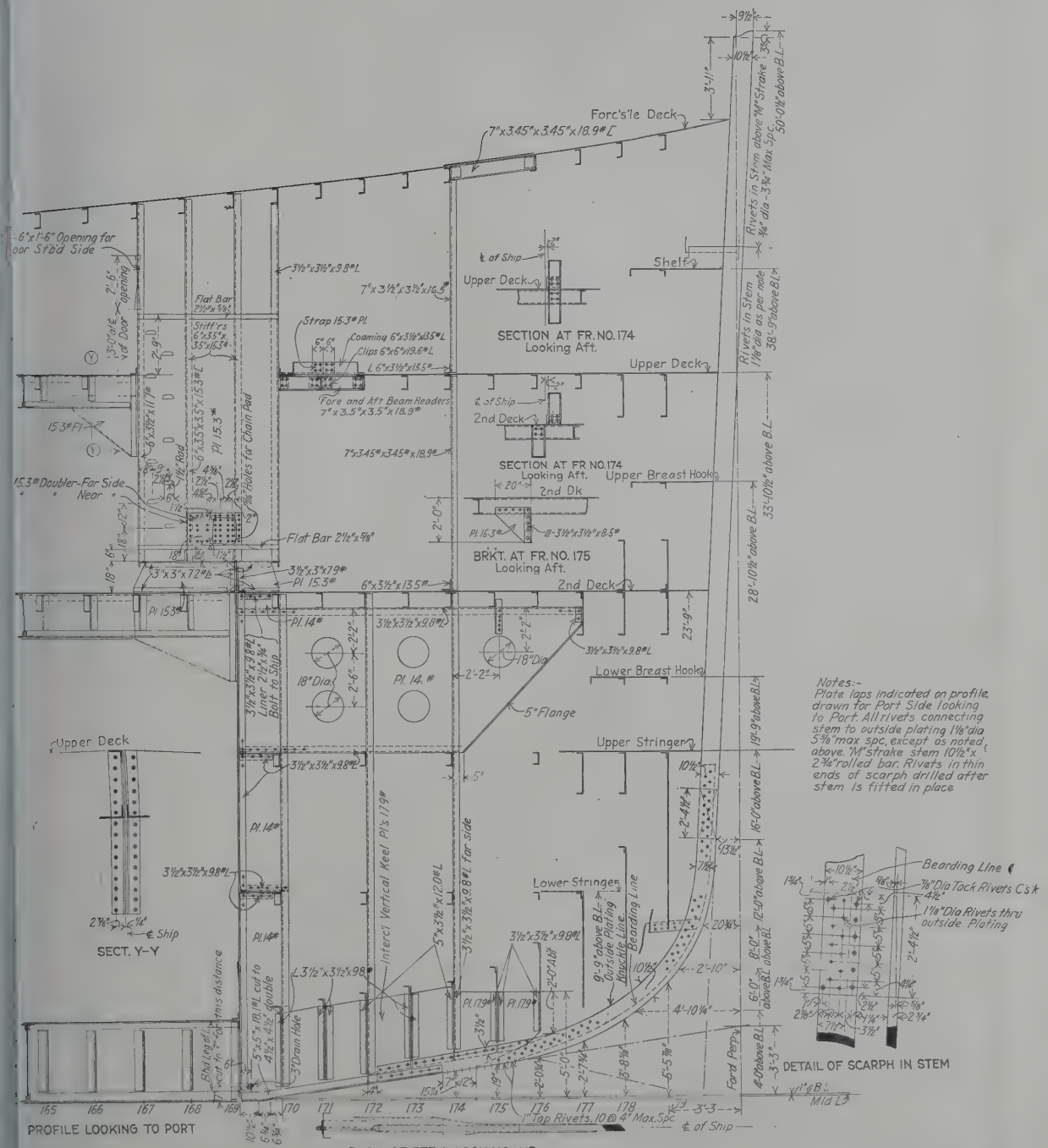
Connection	Diam. in Riv. diam's	Max. Space in inches	Max. Space in inches
Seams. In 18# to 25# Pl't'g....	7/8"	4	3 1/2
Seam Straps. 30# to 30# Pl't'g.	1"	4	4
Seam Straps. 30# to 20# Pl't'g.	7/8"	4	3 1/2
Seam Straps. 20# to 25# Pl't'g.	7/8"	4	3 1/2
W. T. B'h'd bounding angles, 20#, 22 1/2#, 25#.....	7/8"	5	4 3/8
W. T. B'h'd bounding angles, 18#	3/4"	5	3 3/4
Stringer angle to 18# Pl't'g...	3/4"	4 1/2	3 3/8
N. W. T. Floors 30# Pl't'g....	1"	7	7
W. T. Floors 30# Pl't'g.....	1"	5	5
N. W. T. Floors 20#, 22 1/2#, 25#	7/8"	7	6 1/8
W. T. Floors 18#.....	3/4"	5	3 3/4
N. W. T. Floors 18#.....	3/4"	7	5 1/4
W. T. Floors 20#, 22 1/2#, 25#..	7/8"	5	4 3/8
Doublers to Inner Bottom.....	3/4"	4	3
Stringer angle to 21# Pl't'g....	7/8"	4 1/2	315/16
Stringer angle to 30# Pl't'g....	1"	4 1/2	4 1/2

General Notes

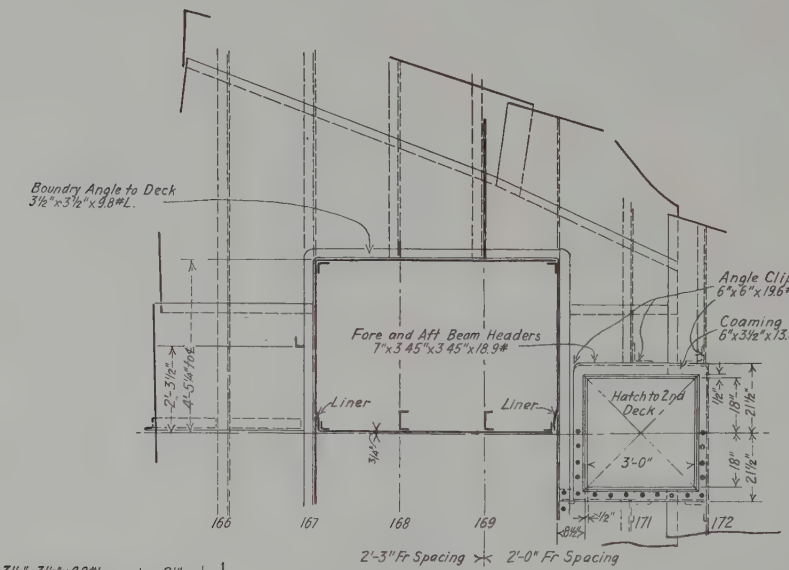
1. Inner bottom to be watertight throughout; all butts and seams to be planed and caulked. All rivets countersunk on top side of plating, except in way of angles on top of inner bottom.
2. Both flanges of all angles at top of inner bottom to be countersunk and caulked.
3. All doublers in way of manholes and bilge wells to be 18# plates.
4. Buttstraps to be marked with strake letter and ford frame No. All channel buttstraps are 12"x3 1/2"x3 1/2"x35# channels in holds.
5. Where plates of different weight butt use rivets for heavier plating.
6. W. T. and N. W. T. floors to have 3 1/2" fl'g'd conn. to Inner Bottom unless noted.
7. All angle connections on top of Inner Bottom to have 3 1/2" fl'g'd connection to Inner Bottom unless noted.
8. Seam strap to be marked with strake letters and ford fr. No. thus A-B 142.
9. Fr. Spacing 2'—2".

INNER BOTTOM PLATING
6,422-TON D. W. COLLIER
New York Shipbuilding Corp., Camden, N. J.

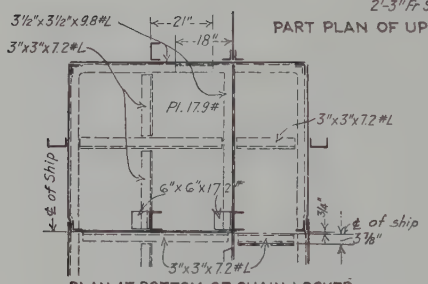
PLATE XXXVI


Forc'sle Deck
7"x3.45"x3.45"x18.9# L
Shelf
Upper Deck
2nd Deck
Upper Breast Hook
2nd Dk
Lower Breast Hook
Upper Stringer
Lower Stringer
SECTION AT FR. NO. 174
Looking Aft.
SECTION AT FR NO. 174
Looking Aft.
BRKT. AT FR. NO. 175
Looking Aft.
Flat Bar 2½"x⅝"
Strap 15.3# Pl.
Coaming 6"x3½"x13.5# L
Clips 6"x6"x13.6# L
L 6"x3½"x13.5#
Fore and Aft Beam Headers
7"x3.5"x3.5"x18.9#
Pl 15.3#
15.3# Doubler-For Side Near
Flat Bar 2½"x⅝"
3½"x3"x7.9#
3"x3"x7.2# lb
Pl 15.3#
6"x3½"x13.5#
Pl. 14#
18" Dia.
Pl. 14. #
5" Flange
Intercl Vertical Keel Pl's 17.9#
5"x3½"x12.0# L
3½"x3½"x9.8# L for side
3½"x3½"x9.8# L
Liner 2½"x¾"
Bolt to Ship
Pl. 17.9#
3" Drain Hole
Bhd Lgt cut to 2"-0" this distance
5"x3½"x18.1# L cut to 4½"x4½" double
Ford Perp
Rivets in Stem 1⅛" dia as per note
Rivets in Stm above "M" Strake ¾" dia - 3¾" Max Spc
Notes:-
Plate laps indicated on profile, drawn for Port Side looking to Port. All rivets connecting stem to outside plating 1⅛" dia 5⅝" max spc, except as noted above. "M" strake stem 10½"x 2¾" rolled bar. Rivets in thin ends of scarph drilled after stem is fitted in place
Bearding Line
⅞" Dia Tack Rivets C's k
1⅛" Dia Rivets thru outside Plating
DETAIL OF SCARPH IN STEM
SECT. Y-Y
PROFILE LOOKING TO PORT
PLAN OF STEM-LOOKING UP
1" Tap Rivets 10 @ 4" Max. Spc
165 166 167 168 169 170 171 172 173 174 175 176 177 178 179
℄ of Ship

9,000-TON D. W. FREIGHTER



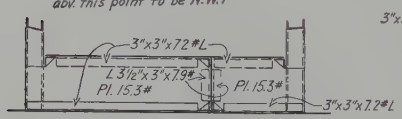
PART PLAN OF UPPER DECK IN WAY OF CHAIN LOCKER



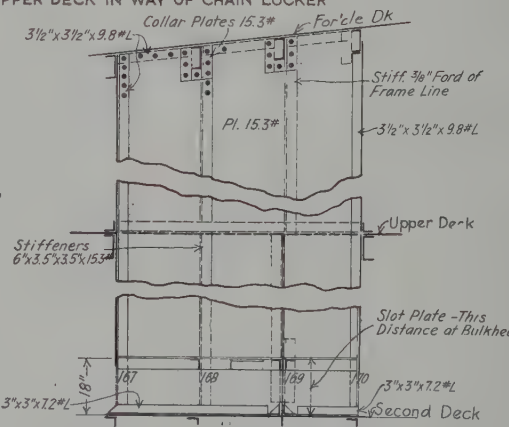
PLAN AT BOTTOM OF CHAIN LOCKER

Riveting Notes

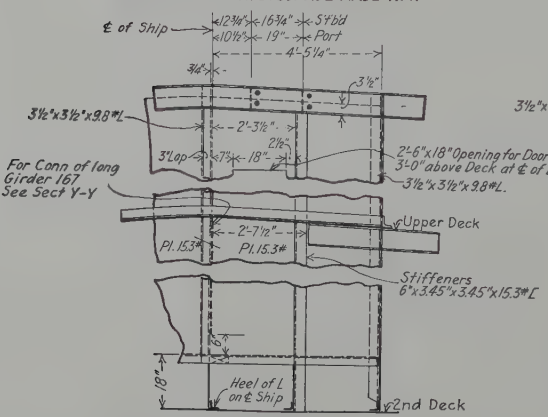
Riveting in chain locker ¾" dia. Riv's 3⅜" max. spc. in seams and bounding bars, and ¾" dia. riv's, 5¼" max. spc. in stiffeners, unless otherwise indicated. All other riveting to be ¾" dia. rivets, 5¼" max. spc. unless otherwise noted.
All chain locker bhds to be made W.T. to a height of 1'-6" abv Upper Deck from the bottom. Bhds abv. this point to be N.W.T



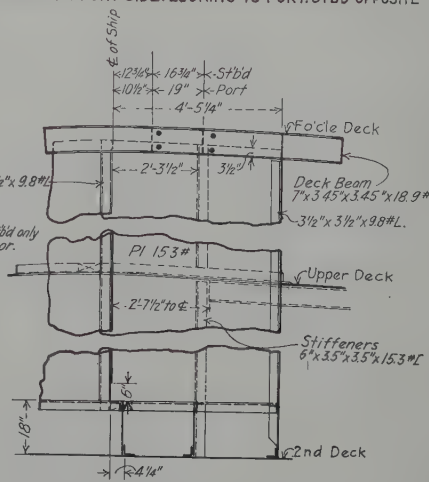
GIRDER UNDER CHAIN LOCKER. 2'-3½" FROM ℄ PORT SIDE SHOWN. STBD. SIDE MADE W.T.



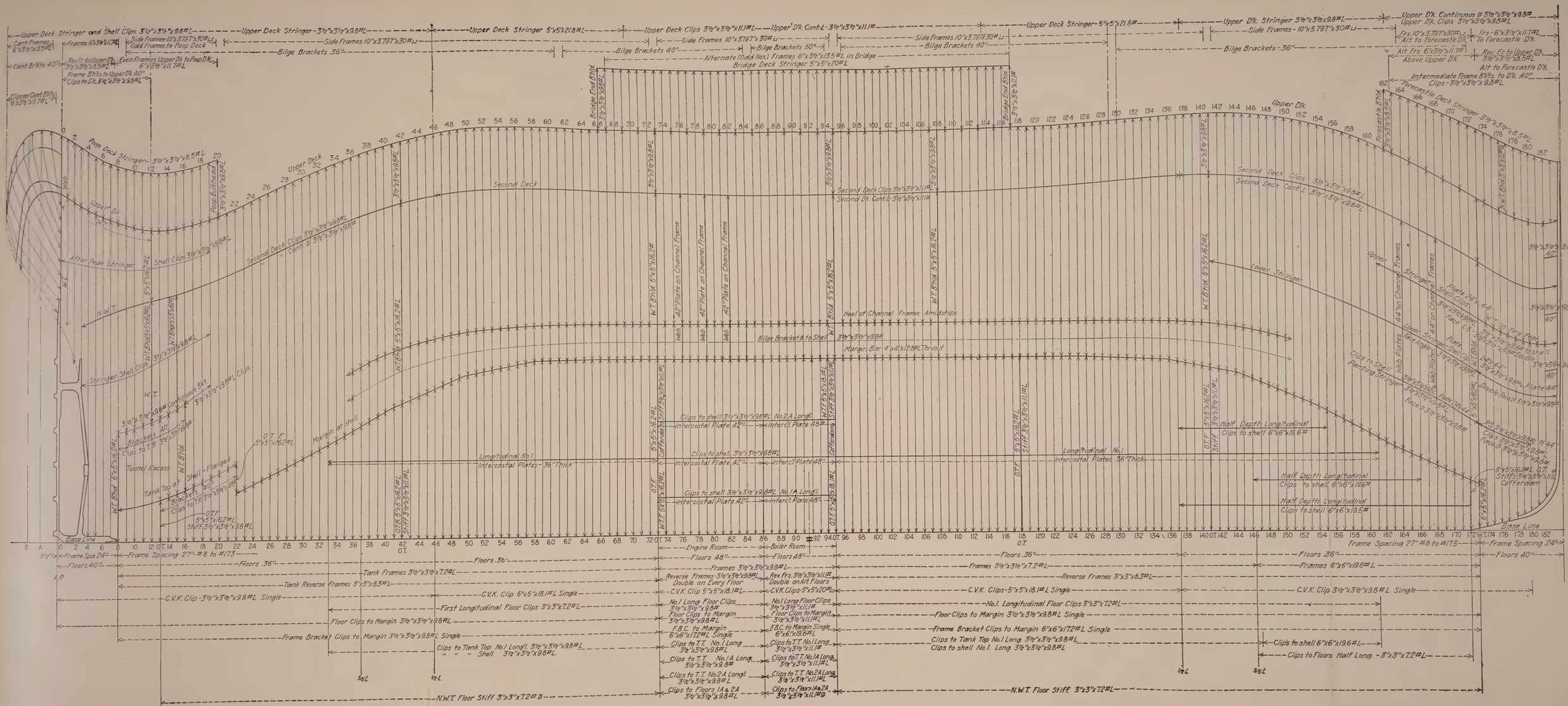
ELEVATION OF OUTBOARD SIDE OF CHAIN LOCKER DRAWN FOR PORT SIDE. LOOKING TO PORT. STBD OPPOSITE



ELEVATION OF AFTER END OF CHAIN LOCKER DRAWN FOR STBD. SIDE LOOKING FORD. PORT OPPOSITE

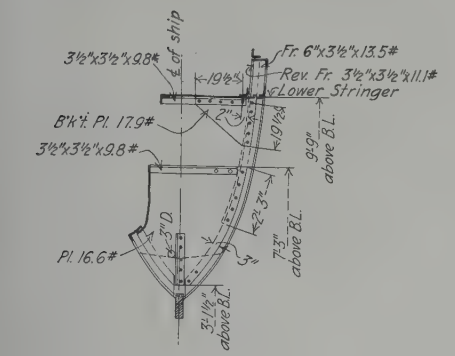


ELEVATION OF FORD END OF CHAIN LOCKER DRAWN FOR STBD. SIDE, LOOKING FORD, PORT OPPOSITE

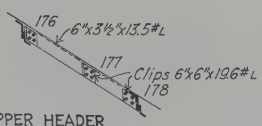


FRAMING PLAN

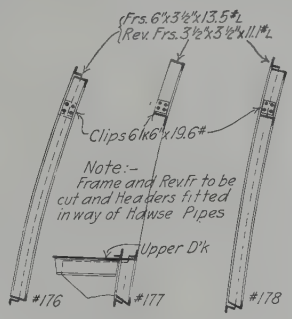
8,300-TON D. W. FREIGHTER



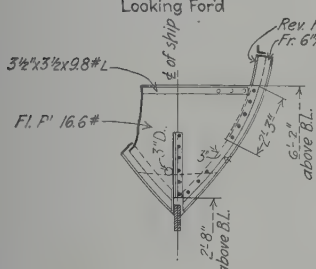
FR. NO. 176
Looking Ford



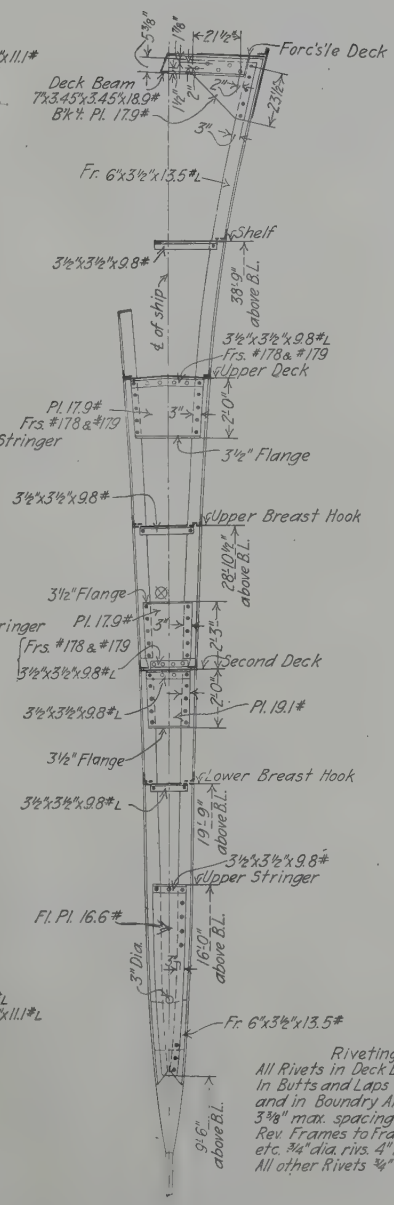
UPPER HEADER



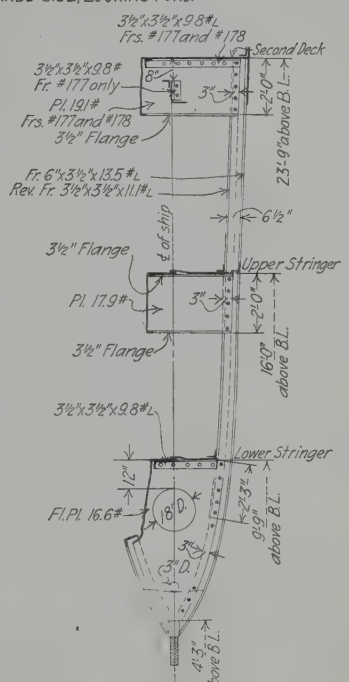
DETAIL OF FRAMING IN WAY OF HAWSE PIPE
STARBD SIDE, LOOKING FORD.



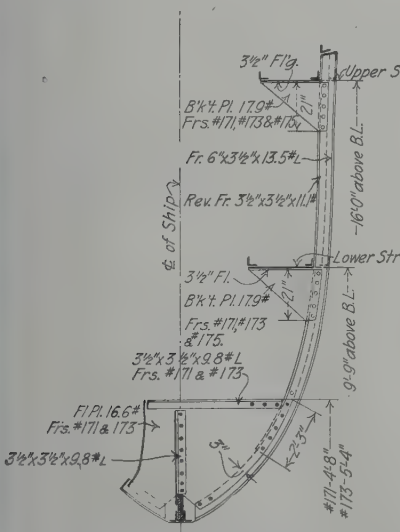
FR. NO. 175
Looking Ford



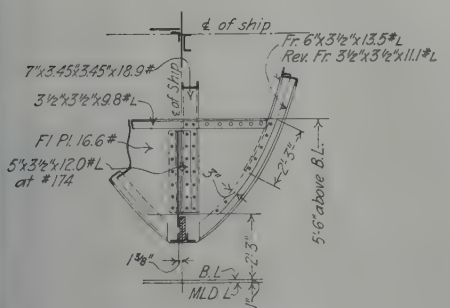
FR. NO. 179, LOOKING FORD.
ALSO PART FR. NO. 178



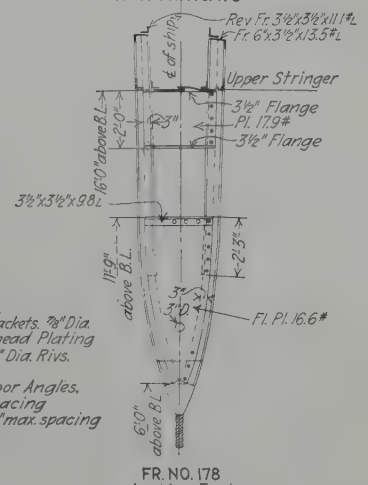
FR. NO. 177 STARBD SIDE
LOOKING FORD ALSO
PART FR. NO. 178



FR. NO. 173, LOOKING FORD
ALSO PART FRAMES NO.
171 AND 175

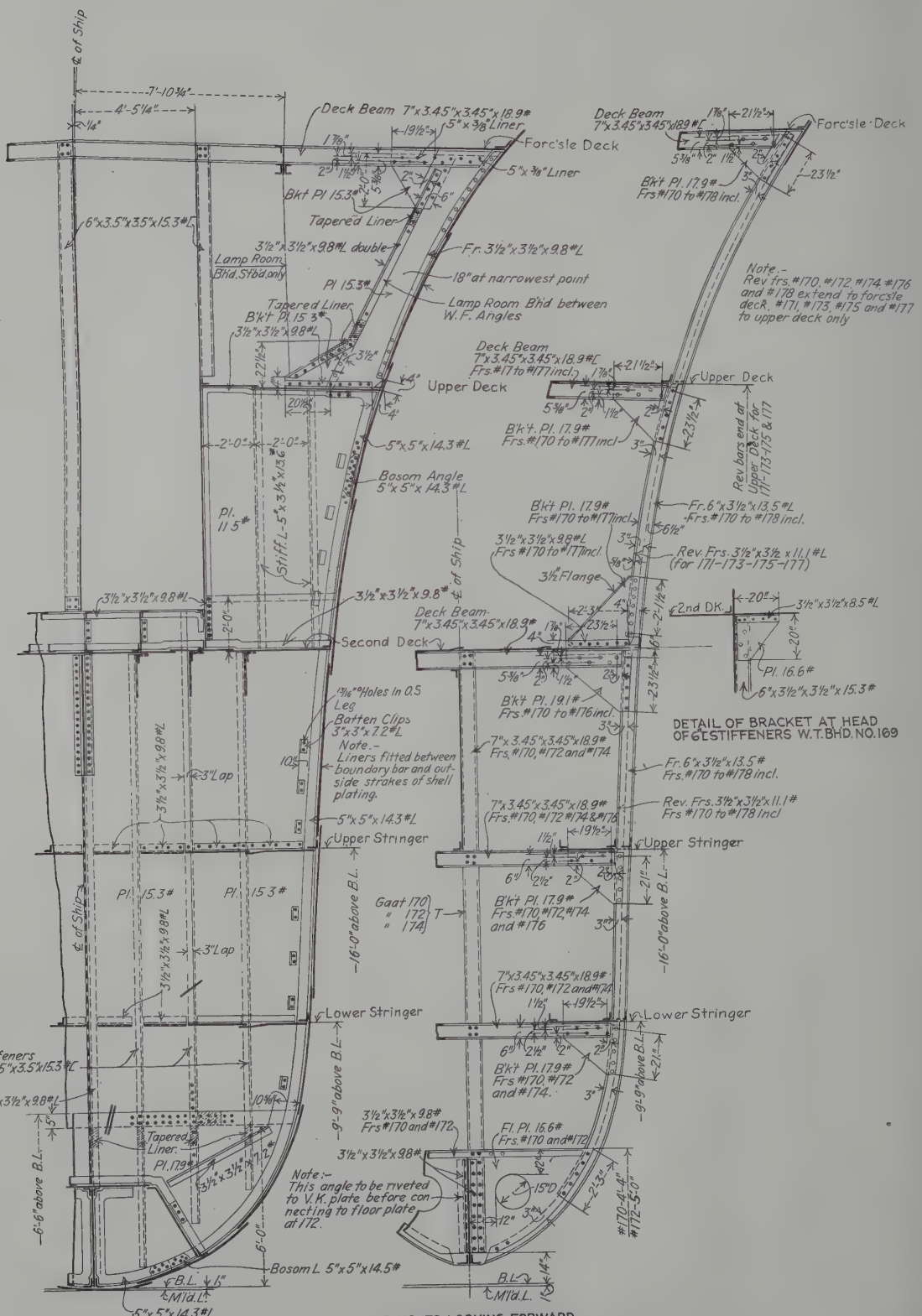


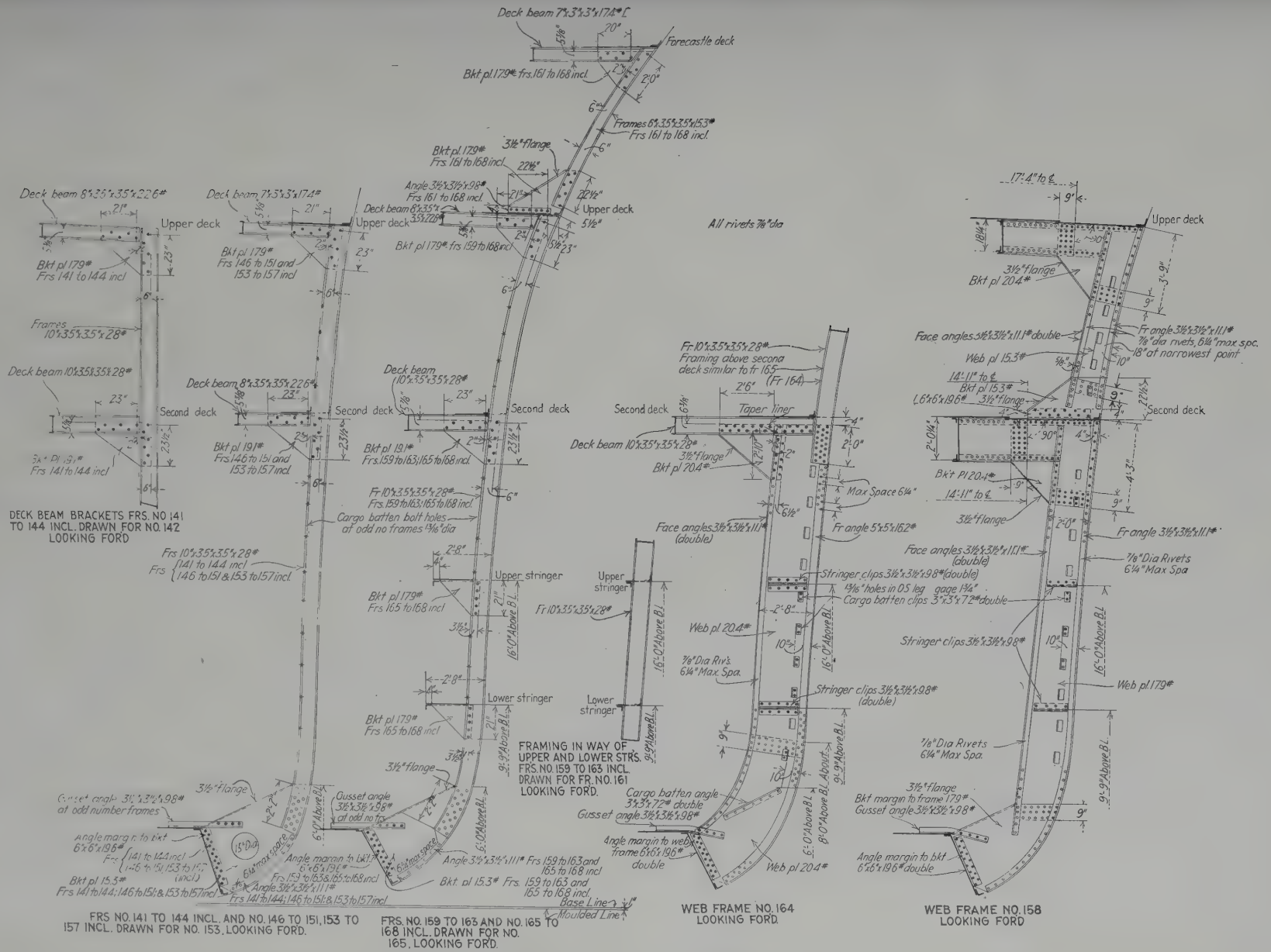
FR. NO. 174 LOOKING FORD.



FR. NO. 178
Looking Ford.

Riveting Notes.
All Rivets in Deck Beam Brackets ⅞" Dia.
In Butts and Laps of Bulkhead Plating and in Boundry Angles ¾" Dia. Rivs.
3⅜" max. spacing
Rev. Frames to Frames, Floor Angles, etc. ¾" dia. rivs. 4" max. spacing
All other Rivets ¾" dia. 5¼" max. spacing

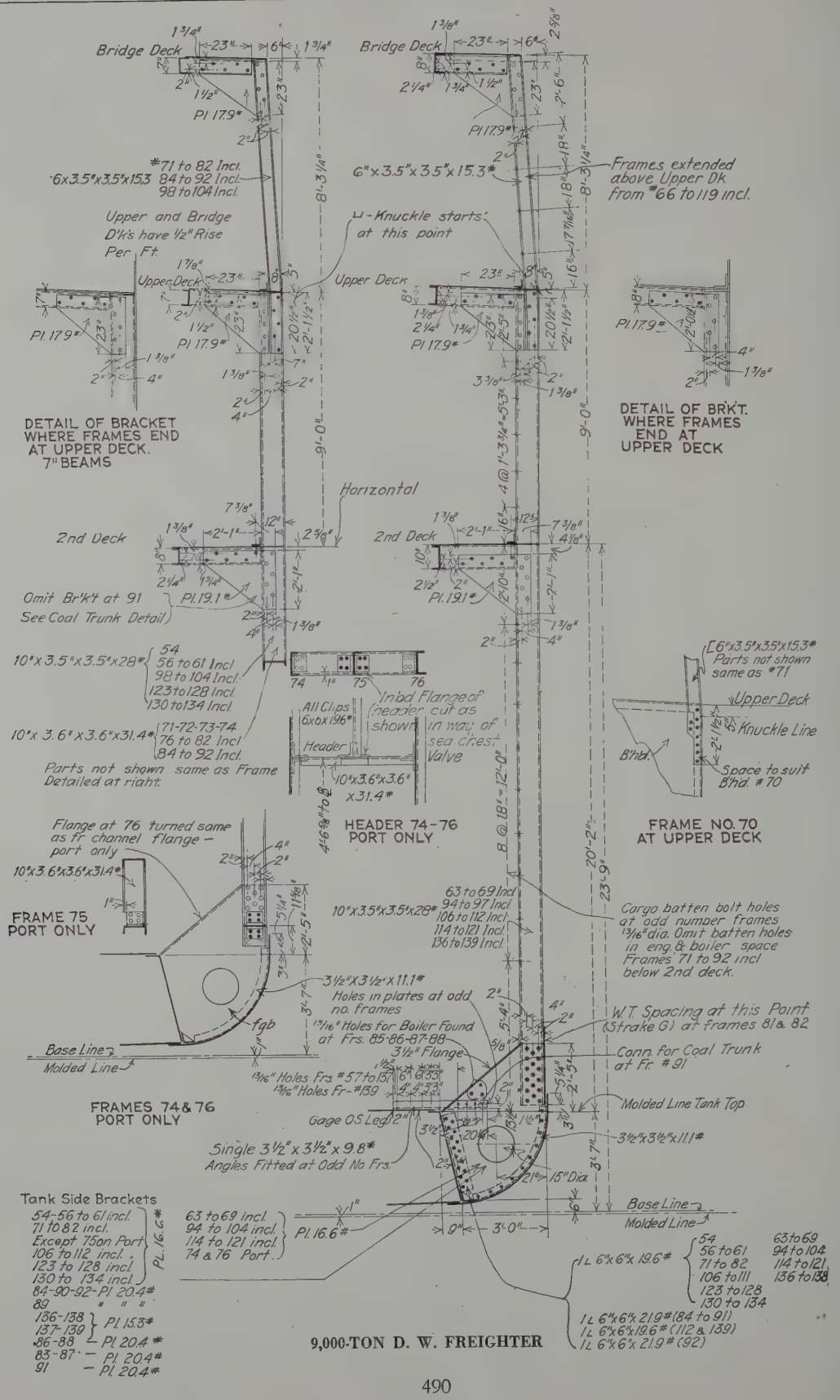

℄ of Ship
7'-10¾"
4'-5¼"
Deck Beam 7"x3.45"x3.45"x18.9#
5"x⅜" Liner
Forc'sle Deck
Bkt Pl 15.3#
Tapered Liner
6"x3.5"x3.5"x15.3#L
3½"x3½"x9.8#L double
Lamp Room B'hd. Stbd only
Pl 15.3#
Fr. 3½"x3½"x9.8#L
18" at narrowest point
Lamp Room B'hd between W.F. Angles
Tapered Liner
B'kt Pl. 15.3#
3½"x3½"x9.8#L
Upper Deck
5"x5"x14.3#L
Bosom Angle 5"x5"x14.3#L
Pl. 11.5#
Stiff. L-5"x3½"x13.6
3½"x3½"x9.8#L
Second Deck
1⅛" ϕ Holes in 0.5 Leg Batten Clips 3"x3"x12#L
Note:- Liners fitted between boundary bar and outside strakes of shell plating.
3"Lap
5"x5"x14.3#L
Upper Stringer
Pl. 15.3#
Lower Stringer
Stiffeners 6"x3.5"x3.5"x15.3#L
Tapered Liner
Pl. 17.9#
Bosom L 5"x5"x14.5#
B.L.
M'ld.L.
W.T. BHD FR. NO. 169 Looking Ford
Deck Beam 7"x3.45"x3.45"x18.9#
Frs.#171 to #177 incl.
B'kt Pl. 17.9# Frs.#170 to #177 incl
Fr. 6"x3½"x13.5#L Frs.#170 to #178 incl.
3½"x3½"x9.8#L Frs #170 to #177 incl.
Rev. Frs. 3½"x3½"x11.1#L (for 171-173-175-177)
3½" Flange
Deck Beam 7"x3.45"x3.45"x18.9#
B'kt Pl. 19.1# Frs.#170 to #176 incl.
7"x3.45"x3.45"x18.9# Frs.#170, #172 and #174
7"x3.45"x3.45"x18.9# (Frs.#170, #172 #174 & #176
B'kt Pl. 17.9# Frs.#170, #172, #174 and #176
7"x3.45"x3.45"x18.9# (Frs.#170, #172 and #174
B'kt Pl. 17.9# Frs.#170, #172 and #174.
3½"x3½"x9.8# Frs #170 and #172.
Fl. Pl. 16.6# Frs.#170 and #172
Note:- This angle to be riveted to V.K. plate before connecting to floor plate at 172.
Gaat 170 " 172 " 174
16'-0" above B.L.
9'-9" above B.L.
6'-6" above B.L.
6'-0"
Deck Beam 7"x3.45"x3.45"x189#
Forc'sle Deck
B'kt Pl. 17.9# Frs.#170 to #178 incl.
Note:- Rev frs. #170, #172, #174, #176 and #178 extend to forc'sle deck, #171, #173, #175 and #177 to upper deck only
Upper Deck
B'kt Pl. 17.9# Frs.#170 to #177 incl
Rev bars end at Upper Deck for 171-173-175 & 177
2nd DK.
3½"x3½"x8.5#L
Pl. 16.6#
6"x3½"x3½"x15.3#
DETAIL OF BRACKET AT HEAD OF GL STIFFENERS W.T. BHD. NO. 169
Fr. 6"x3½"x13.5# Frs.#170 to #178 incl.
Rev. Frs. 3½"x3½"x11.1# Frs #170 to #178 incl
Upper Stringer
Lower Stringer
#170-4'-4" #172-5'-0"
FR. NO. 172 LOOKING FORWARD
FR. NO. 170 (LOOKING FORD) AS NOTED
ALSO PART FRS. NO. 171 AND 173 TO 176 INCL.


Deck beam 7"x3"x3"x17#
Forecastle deck
Bkt pl.179# Frs.161 to 168 incl.
Frames 6"x3.5"x3.5"x15.3#
Frs 161 to 168 incl.
3½" flange
Bkt pl.179#
Frs. 161 to 168 incl.
Angle 3½"x3½"x.98#
Frs 161 to 168 incl.
Upper deck
Bkt pl 179# Frs 159 to 168 incl
Deck beam 8"x3.5"x22.6#
Deck beam 7"x3"x3"x17#
Bkt pl 179# Frs 146 to 151 and 153 to 157 incl
Deck beam 8"x3.5"x3.5"x22.6#
Bkt pl 179# Frs 141 to 144 incl
Frames 10"x3.5"x3.5"x28#
Deck beam 10"x3.5"x3.5"x28#
Second deck
Bkt pl 191# Frs 146 to 151 and 153 to 157 incl
Bkt pl 191# Frs 141 to 144 incl
Deck beam 10"x3.5"x3.5"x28#
Bkt pl 191# Frs.159 to 163; 165 to 168 incl.
Fr 10"x3.5"x3.5"x28#
Frs. 159 to 163; 165 to 168 incl.
Cargo batten bolt holes at odd no frames 13/16" dia
Frs 10"x3.5"x3.5"x28#
Frs (141 to 144 incl
146 to 151 & 153 to 157 incl.
Upper stringer
Bkt pl 179# Frs 165 to 168 incl
16'-0" Above B.L.
Lower stringer
Bkt pl 179# Frs 165 to 168 incl
9'-9" Above B.L.
3½" flange
Gusset angle 3½"x3½"x.98# at odd number frames
Gusset angle 3½"x3½"x.98# at odd no frs
Angle margin to bkt 6"x6"x.196#
Frs (141 to 144 incl
146 to 151, 153 to 157 incl)
15" Dia.
6" max spacing
Angle margin to bkt 6"x6"x.196#
Frs 153 to 163 & 165 to 168 incl
Angle 3½"x3½"x.111#
Bkt pl 15.3# Frs 141 to 144; 146 to 151; & 153 to 157 incl
Angle 3½"x3½"x.111# Frs 159 to 163 and 165 to 168 incl
Bkt. pl 15.3# Frs. 159 to 163 and 165 to 168 incl.
Base Line
Moulded Line
FRAMING IN WAY OF UPPER AND LOWER STRS. FRS. NO. 159 TO 163 INCL. DRAWN FOR FR. NO. 161 LOOKING FORD.
All rivets 7/8" dia
Fr 10"x3.5"x3.5"x28#
Framing above second deck similar to fr 165 (Fr 164)
Taper liner
Face angles 3½"x3½"x.111# (double)
Stringer clips 3½"x3½"x.98# (double)
1 13/16" holes in OS leg gage 1¾"
Cargo batten clips 3"x3"x.72# double
Web pl 20.4#
3/8" Dia Rivs. 6¼" Max. Spa.
Stringer clips 3½"x3½"x.98# (double)
Cargo batten angle 3"x3"x.72# double
Gusset angle 3½"x3½"x.98#
Angle margin to web frame 6"x6"x.196# double
Web pl 20.4#
WEB FRAME NO. 164 LOOKING FORD.
17'-4" to ℄
Upper deck
3½" flange
Bkt pl 20.4#
Face angles 5½"x3½"x.111# double
Fr angle 3½"x3½"x.111#
⅞" dia rivets, 6½" max. spc.
18" at narrowest point
Web pl 15.3#
14'-11" to ℄
Bkt pl 15.3#
L 6"x6"x.196#
Second deck
Bkt Pl 20.4#
Fr angle 5"x5"x.162#
Fr angle 3½"x3½"x.111#
Face angles 3½"x3½"x.111# (double)
⅞" Dia Rivets 6¼" Max Spa
Stringer clips 3½"x3½"x.98#
Web pl 179#
⅞" Dia Rivets 6¼" Max Spa.
Bkt margin to frame 179#
Gusset angle 3½"x3½"x.98#
Angle margin to bkt 6"x6"x.196# double
WEB FRAME NO. 158 LOOKING FORD

DECK BEAM BRACKETS FRS. NO 141 TO 144 INCL. DRAWN FOR NO. 142 LOOKING FORD

FRS NO. 141 TO 144 INCL. AND NO. 146 TO 151, 153 TO 157 INCL. DRAWN FOR NO. 153, LOOKING FORD.

FRS. NO. 159 TO 163 AND NO. 165 TO 168 INCL. DRAWN FOR NO. 165, LOOKING FORD.


Bridge Deck
Upper and Bridge D'k's have ½" Rise Per Ft.
#71 to 82 Incl. 84 to 92 Incl. 98 to 104 Incl.
6"x3.5"x3.5"x15.3
Pl 17.9#
Upper Deck
Knuckle starts at this point
6"x3.5"x3.5"x15.3#
Frames extended above Upper Dk from #66 to 119 incl.
DETAIL OF BRACKET WHERE FRAMES END AT UPPER DECK. 7" BEAMS
DETAIL OF BRK'T. WHERE FRAMES END AT UPPER DECK
Horizontal
2nd Deck
Omit Br'k't at 91 See Coal Trunk Detail
Pl. 19.1#
10"x3.5"x3.5"x28# 54 56 to 61 Incl 98 to 104 Incl. 123 to 128 Incl. 130 to 134 Incl.
10"x 3.6"x3.6"x31.4# 71-72-73-74 76 to 82 Incl. 84 to 92 Incl.
Parts not shown same as Frame Detailed at right.
All Clips 6"x6"x196"
Header
10"x3.6"x3.6" x31.4#
In'bd Flange of (header cut as shown in way of sea chest Valve
HEADER 74-76 PORT ONLY
L 6"x3.5"x3.5"x15.3# Parts not shown same as #71
Upper Deck
Knuckle Line
B'hd.
Space to suit B'hd. #70
FRAME NO. 70 AT UPPER DECK
Flange at 76 turned same as fr channel flange — port only
FRAME 75 PORT ONLY
63 to 69 Incl 94 to 97 Incl 106 to 112 Incl 114 to 121 Incl 136 to 139 Incl
10"x3.5"x3.5"x28#
Cargo batten bolt holes at odd number frames 13/16" dia. Omit batten holes in eng. & boiler space Frames 71 to 92 incl below 2nd deck.
3½"x3½"x11.1#
Holes in plates at odd no. frames
13/16" Holes for Boiler Found at Frs. 85-86-87-88
3½" Flange
W.T. Spacing at this Point (Strake G) at frames 81 & 82
Conn. for Coal Trunk at Fr. #91
Base Line
Molded Line
FRAMES 74 & 76 PORT ONLY
Gage OS Leg
Molded Line Tank Top
Single 3½"x3½"x9.8# Angles Fitted at Odd No Frs.
3½"x3½"x11.1#
Tank Side Brackets
54-56 to 61 incl. 71 to 82 incl. Except 75on Port 106 to 112 incl. 123 to 128 incl. 130 to 134 incl. } Pl. 16.6#
84-90-92-Pl 20.4#
89 " " "
136-138 } Pl. 15.3#
137-139 }
86-88 — Pl. 20.4#
83-87 — Pl. 20.4#
91 — Pl. 20.4#
63 to 69 incl. 94 to 104 incl. 114 to 121 incl. 74 & 76 Port. } Pl. 16.6#
L 6"x6"x 19.6#
54 56 to 61 71 to 82 106 to 111 123 to 128 130 to 134
63 to 69 94 to 104 114 to 121 136 to 138
L 6"x6"x 21.9# (84 to 91)
L 6"x6"x 19.6# (112 & 139)
L 6"x6"x 21.9# (92)
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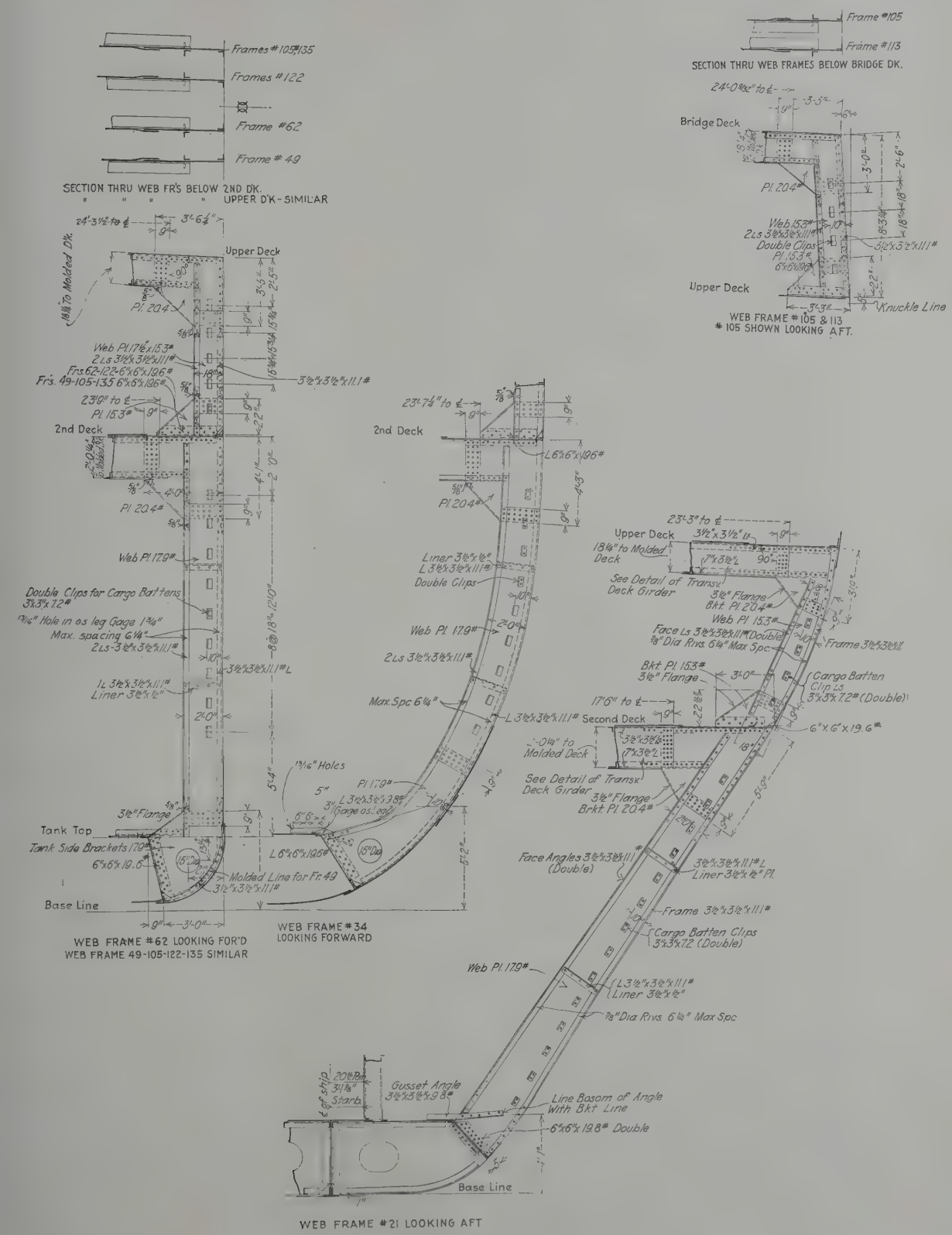

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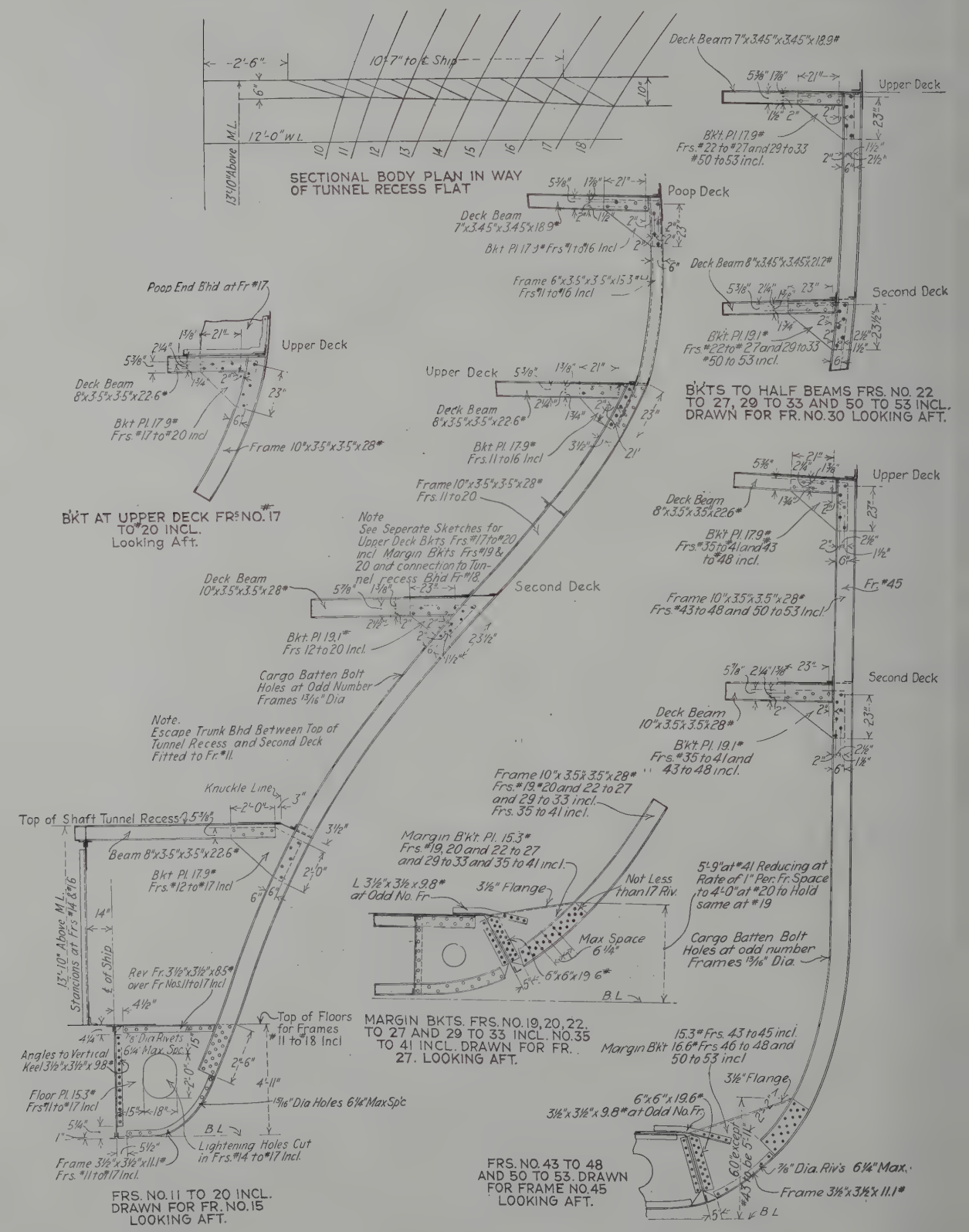
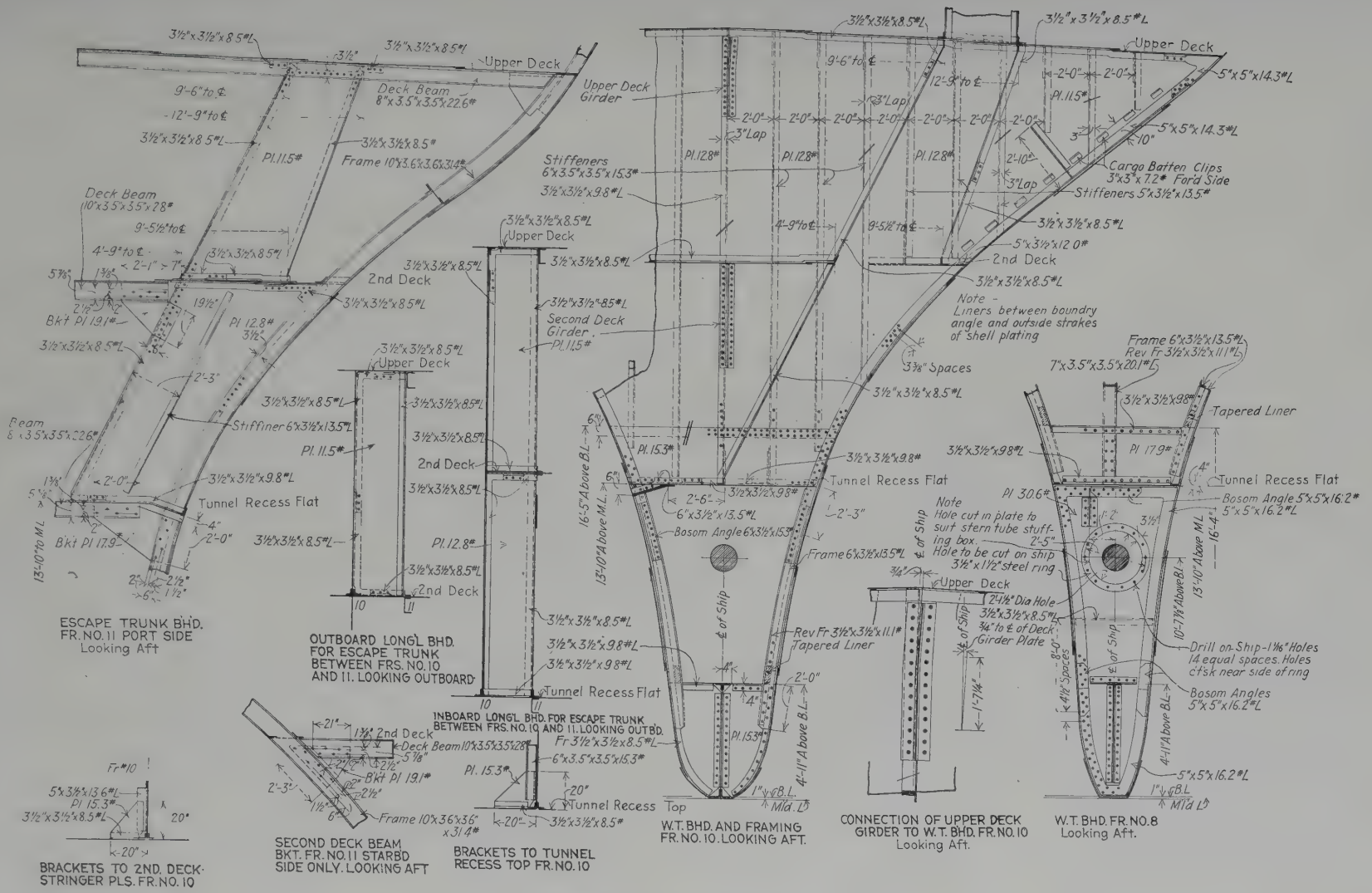

SECTIONAL BODY PLAN IN WAY OF TUNNEL RECESS FLAT
-2'-6"
10'-7" to ℄ Ship
6"
10"
12'-0" W.L.
13'-10" Above M.L.
10
11
12
13
14
15
16
17
18
Deck Beam 7"x3.45"x3.45"x18.9#
Upper Deck
Bkt. Pl. 17.9#
Frs. #22 to #27 and 29 to 33
#50 to 53 incl.
Poop Deck
Deck Beam 7"x3.45"x3.45"x18.9#
Bkt Pl 17.9# Frs #1 to #16 Incl
Frame 6"x3.5"x3.5"x15.3#
Frs #1 to #16 Incl
Deck Beam 8"x3.45"x3.45"x21.2#
Second Deck
Bkt. Pl. 19.1#
Frs. #22 to #27 and 29 to 33
#50 to 53 incl.
BKTS TO HALF BEAMS FRS. NO. 22 TO 27, 29 TO 33 AND 50 TO 53 INCL. DRAWN FOR FR. NO. 30 LOOKING AFT.
Poop End Bhd at Fr #17
Upper Deck
Deck Beam 8"x3.5"x3.5"x22.6#
Bkt Pl. 17.9#
Frs. #17 to #20 incl
Frame 10"x3.5"x3.5"x28#
BKT AT UPPER DECK FRS NO. 17 TO 20 INCL.
Looking Aft.
Upper Deck
Deck Beam 8"x3.5"x3.5"x22.6#
Bkt Pl. 17.9#
Frs. #11 to 16 Incl
Frame 10"x3.5"x3.5"x28#
Frs. 11 to 20
Note
See Seperate Sketches for Upper Deck Bkts Frs #17 to #20 incl Margin Bkts Frs #19 & 20 and connection to Tunnel recess Bhd Fr #18.
Deck Beam 10"x3.5"x3.5"x28#
Second Deck
Bkt. Pl. 19.1#
Frs 12 to 20 Incl.
Cargo Batten Bolt Holes at Odd Number Frames 13/16" Dia
Note.
Escape Trunk Bhd Between Top of Tunnel Recess and Second Deck Fitted to Fr #11.
Upper Deck
Deck Beam 8"x3.5"x3.5"x22.6#
Bkt. Pl. 17.9#
Frs. #35 to 41 and 43 to 48 incl.
Fr. #45
Frame 10"x3.5"x3.5"x28#
Frs #43 to 48 and 50 to 53 Incl
Second Deck
Deck Beam 10"x3.5"x3.5"x28#
Bkt. Pl. 19.1#
Frs. #35 to 41 and 43 to 48 incl.
Frame 10"x3.5"x3.5"x28#
Frs. #19, #20 and 22 to 27 and 29 to 33 incl.
Frs. 35 to 41 incl.
Knuckle Line
Top of Shaft Tunnel Recess
Beam 8"x3.5"x3.5"x22.6#
Bkt. Pl. 17.9#
Frs. #12 to #17 Incl
13'-10" Above M.L.
Stanchions at Frs #14 & #16
℄ of Ship
Rev Fr 3½"x3½"x.85# over Fr Nos. 11 to 17 Incl
Top of Floors for Frames 11 to 18 Incl
Angles to Vertical Keel 3½"x3½"x.98#
7/8" Dia Rivets 6¼ Max Spc
Floor Pl. 15.3# Frs #11 to #17 Incl
19/16" Dia Holes 6¼" Max Sp'c
Lightening Holes Cut in Frs. #14 to #17 Incl.
Frame 3½"x3½"x11.1#
Frs. #11 to #17 Incl.
FRS. NO. 11 TO 20 INCL. DRAWN FOR FR. NO. 15 LOOKING AFT.
Margin B'k't. Pl. 15.3#
Frs. #19, 20 and 22 to 27 and 29 to 33 and 35 to 41 incl.
L 3½"x3½"x.98# at Odd No. Fr
3½" Flange
Not Less than 17 Riv.
Max Space 6¼"
6"x6"x19.6#
B.L.
MARGIN BKTS. FRS. NO. 19, 20, 22 TO 27 AND 29 TO 33 INCL. NO. 35 TO 41 INCL. DRAWN FOR FR. 27. LOOKING AFT.
5'-9" at #41 Reducing at Rate of 1" Per. Fr. Space to 4'-0" at #20 to Hold same at #19
Cargo Batten Bolt Holes at odd number Frames 13/16" Dia.
15.3# Frs. 43 to 45 incl.
Margin B'k't 16.6# Frs 46 to 48 and 50 to 53 incl
3½" Flange
6"x6"x19.6#
3½"x3½"x9.8# at Odd No. Fr.
7/8" Dia. Riv's 6¼" Max.
Frame 3½"x3½"x11.1#
FRS. NO. 43 TO 48 AND 50 TO 53. DRAWN FOR FRAME NO. 45 LOOKING AFT.


ESCAPE TRUNK BHD. FR. NO. 11 PORT SIDE Looking Aft
OUTBOARD LONG'L BHD. FOR ESCAPE TRUNK BETWEEN FRS. NO. 10 AND 11. LOOKING OUTBOARD
INBOARD LONG'L BHD. FOR ESCAPE TRUNK BETWEEN FRS. NO. 10 AND 11. LOOKING OUTBD.
W.T. BHD. AND FRAMING FR. NO. 10. LOOKING AFT.
CONNECTION OF UPPER DECK GIRDER TO W.T. BHD. FR. NO. 10 Looking Aft.
W.T. BHD. FR. NO. 8 Looking Aft.
SECOND DECK BEAM BKT. FR. NO. 11 STARBD SIDE ONLY. LOOKING AFT
BRACKETS TO TUNNEL RECESS TOP FR. NO. 10
BRACKETS TO 2ND. DECK STRINGER PLS. FR. NO. 10
Upper Deck
2nd Deck
Tunnel Recess Flat
Tapered Liner
Cargo Batten Clips 3"x3"x7.2# Ford Side
Stiffeners 5"x3½"x13.5#
Note - Liners between boundry angle and outside strakes of shell plating
Note Hole cut in plate to suit stern tube stuffing box. Hole to be cut on ship 3½" x 1½" steel ring
Drill on Ship-1 1/16" Holes 14 equal spaces. Holes c'tsk near side of ring
Bosom Angles 5"x5"x16.2"#
Bosom Angle 5"x5"x16.2"#
Bosom Angle 6"x3½"x15.3"#
Rev Fr 3½"x3½"x11.1"# Tapered Liner
Frame 6"x3½"x13.5"#
Frame 10"x36"x36" x31.4#
Deck Beam 8"x3.5"x3.5"x22.6#
Deck Beam 10"x3.5"x3.5"x28#
Second Deck Girder Pl. 11.5#
Upper Deck Girder
Stiffeners 6"x3.5"x3.5"x15.3#
Bkt Pl 19.1#
Bkt Pl 17.9#
Pl 12.8#
Pl 15.3#
Pl 17.9#
Pl 30.6#
Pl. 11.5#
Pl. 12.8#
Pl. 15.3#
Pl. 11.5#
3" Lap
3⅛" Spaces
℄ of Ship
Mld. ℄
B.L.
Fr #10
20"
21"
10"
8-0" Spaces
4½" Spaces
2'-4½" Dia Hole
¾" to ℄ of Deck Girder Plate
1'-7¼"
10'-7⅛" Above B.L.
13'-10" Above M.L.
16'-5" Above M.L.
4'-11" Above B.L.
16'-4"

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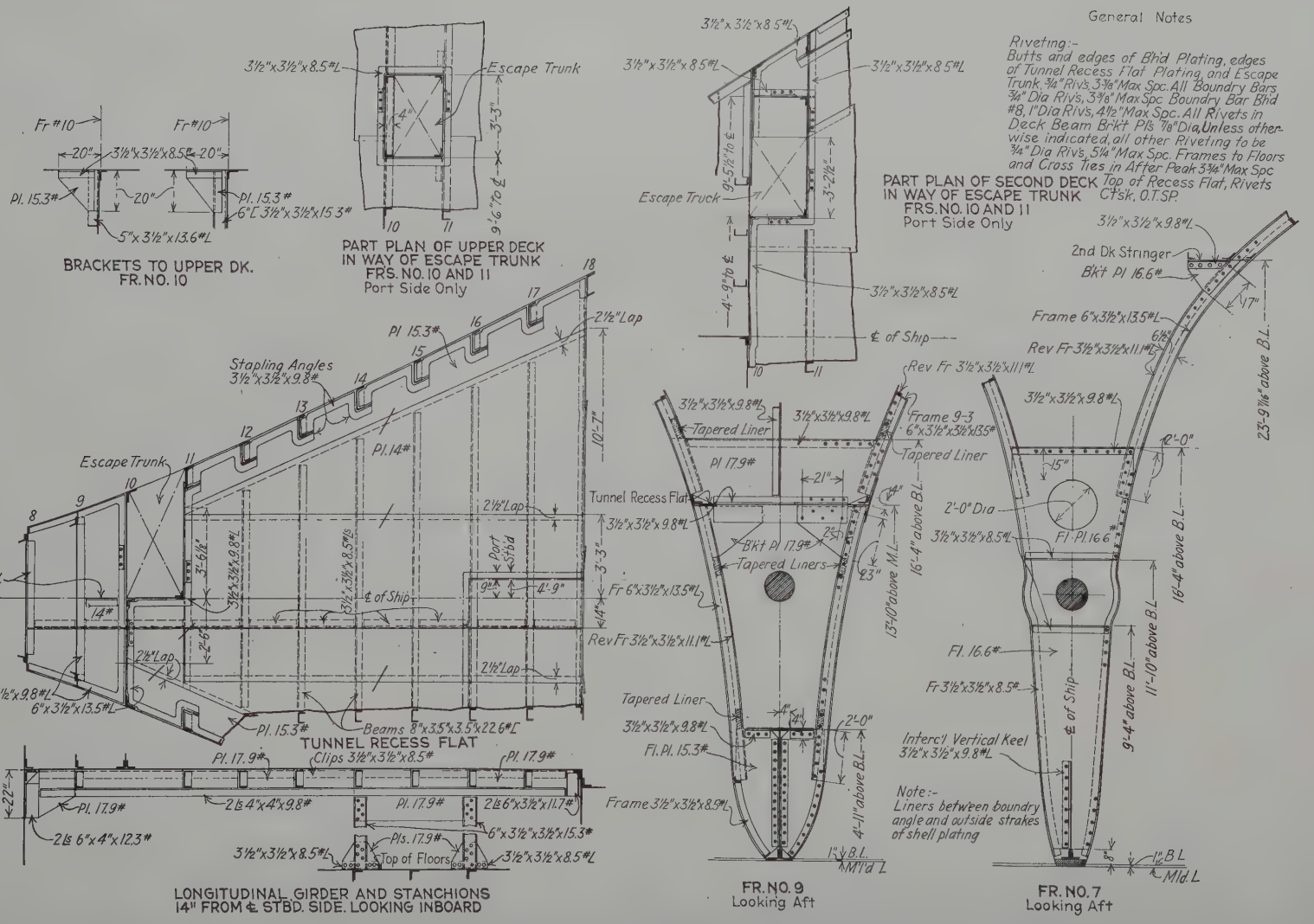

General Notes

Riveting:-
Butts and edges of Bh'd Plating, edges of Tunnel Recess Flat Plating, and Escape Trunk, ¾" Riv's, 3⅜" Max Spc. All Boundry Bars ¾" Dia Riv's, 3⅜" Max Spc Boundry Bar Bh'd #8, 1" Dia Riv's, 4½" Max Spc. All Rivets in Deck Beam Brkt Pl's ⅞" Dia, Unless otherwise indicated, all other Riveting to be ¾" Dia Riv's, 5¼" Max Spc. Frames to Floors and Cross Ties in After Peak 3¾" Max Spc

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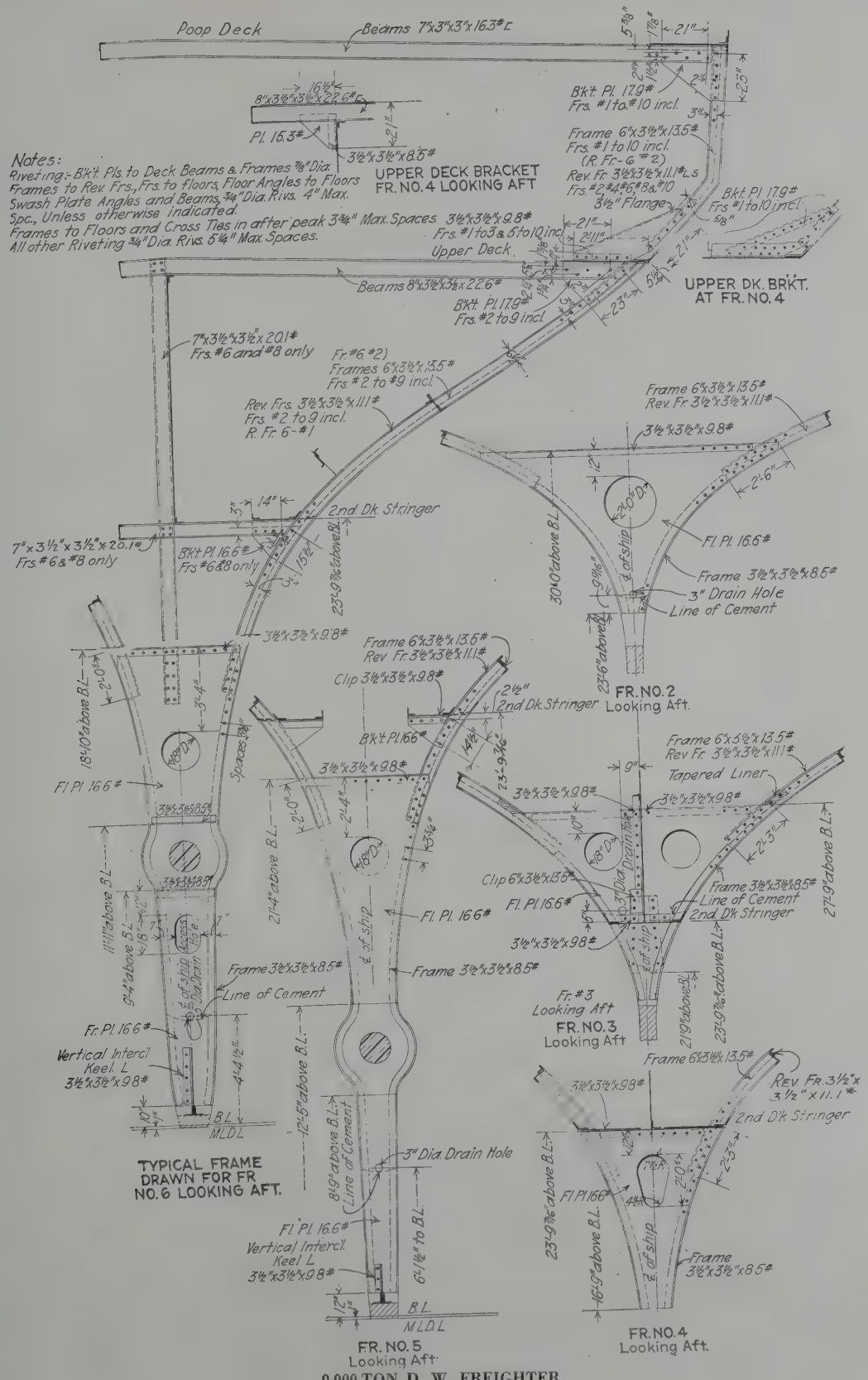
Poop Deck
Beams 7"x3"x3"x16.3#
Notes:
Riveting:-B'k't. Pls. to Deck Beams & Frames 7/8" Dia.
Frames to Rev Frs., Frs. to floors, Floor Angles to Floors
Swash Plate Angles and Beams, 3/4" Dia. Rivs. 4" Max.
Spc., Unless otherwise indicated.
Frames to Floors and Cross Ties in after peak 3 3/4" Max. Spaces
All other Riveting 3/4" Dia. Rivs. 5 1/4" Max. Spaces.
UPPER DECK BRACKET
FR. NO. 4 LOOKING AFT
Upper Deck.
Beams 8"x3 1/2"x3 1/2"x22.6#
UPPER DK. BR'KT.
AT FR. NO. 4
FR. NO. 2
Looking Aft.
FR. NO. 3
Looking Aft
Fr. #3
Looking Aft
FR. NO. 4
Looking Aft.
FR. NO. 5
Looking Aft
TYPICAL FRAME
DRAWN FOR FR
NO. 6 LOOKING AFT.
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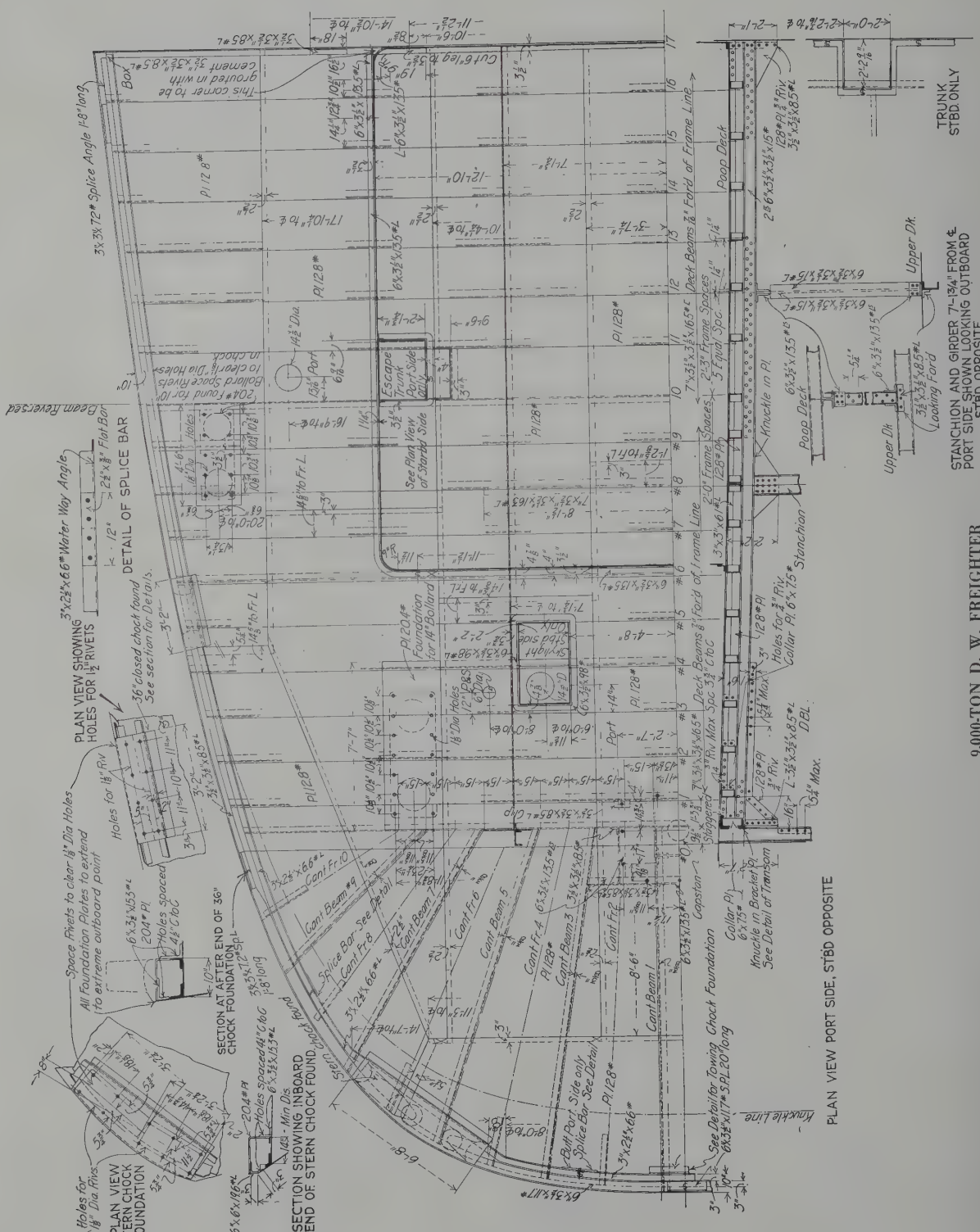
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PLAN VIEW PORT SIDE, STBD OPPOSITE
PLAN VIEW STERN CHOCK FOUNDATION
SECTION SHOWING INBOARD END OF STERN CHOCK FOUND.
SECTION AT AFTER END OF 36" CHOCK FOUNDATION
DETAIL OF SPLICE BAR
PLAN VIEW SHOWING HOLES FOR 1½" RIVETS
STANCHION AND GIRDER 7'-13¾" FROM & PORT SIDE SHOWN LOOKING OUTBOARD STBD. OPPOSITE
TRUNK STBD. ONLY
Poop Deck
Upper Dk.
Stanchion
Capstan
Knuckle Line
Escape Trunk Port Side only
See Plan View of Starbd Side
Cant Beam 1
Cant Beam 2
Cant Beam 3
Cant Beam 4
Cant Beam 5
Cant Fr 4
Cant Fr 6
Cant Fr 8
Cant Fr 10
Splice Bar See Detail
Butt Port Side only Splice Bar See Detail
See Detail for Towing Chock Foundation
Deck Beams 8" Fordof Frame Line
2-0 Frame Spaces
5 Equal Spc
Knuckle in Pl.
Collar Pl. 6"x 7½" Stanchion
Holes for 1" Riv
Holes for 1⅛" Riv
Holes for 1⅛" Dia Holes
Holes spaced 4½" C to C
Space Rivets to clear 1⅛" Dia Holes All Foundation Plates to extend to extreme outboard point
36" closed chock found See section for Details.
Bolted Spool Rivets in chock
204# found for 10" Dia Holes
Beam Reversed
3"x2½"x66# Water Way Angle
3"x 3"x 72# Splice Angle 1'-8" long
This corner to be grouted in with cement
Box
Cut 6" leg to 3½"
Pl 128#
Pl 204# Foundation for 14" Bollard
Pl 12 8#
Cont Beam #9
Cont Fr. 10
Cont Fr. 6
Cont Beam 5
Cont Fr. 4
Cont Beam 3
Cont Fr. 2
Cont Beam 1
Cont Fr. 8
Cont Beam #7
Cont Beam #8
Cont Beam #6
Cont Beam #4
Cont Beam #2
Cont Beam #1
Port
Stbd
Frame Line
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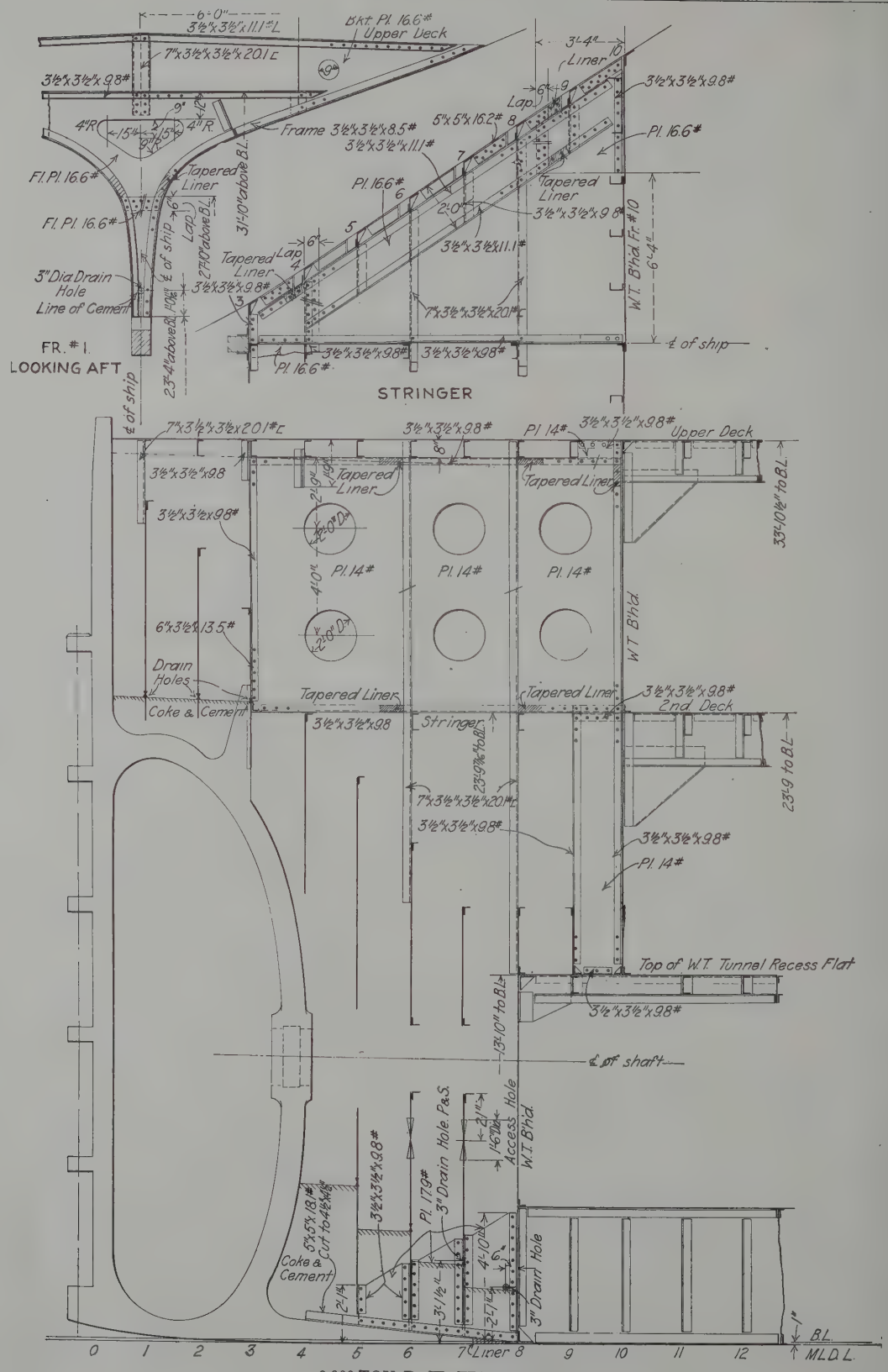
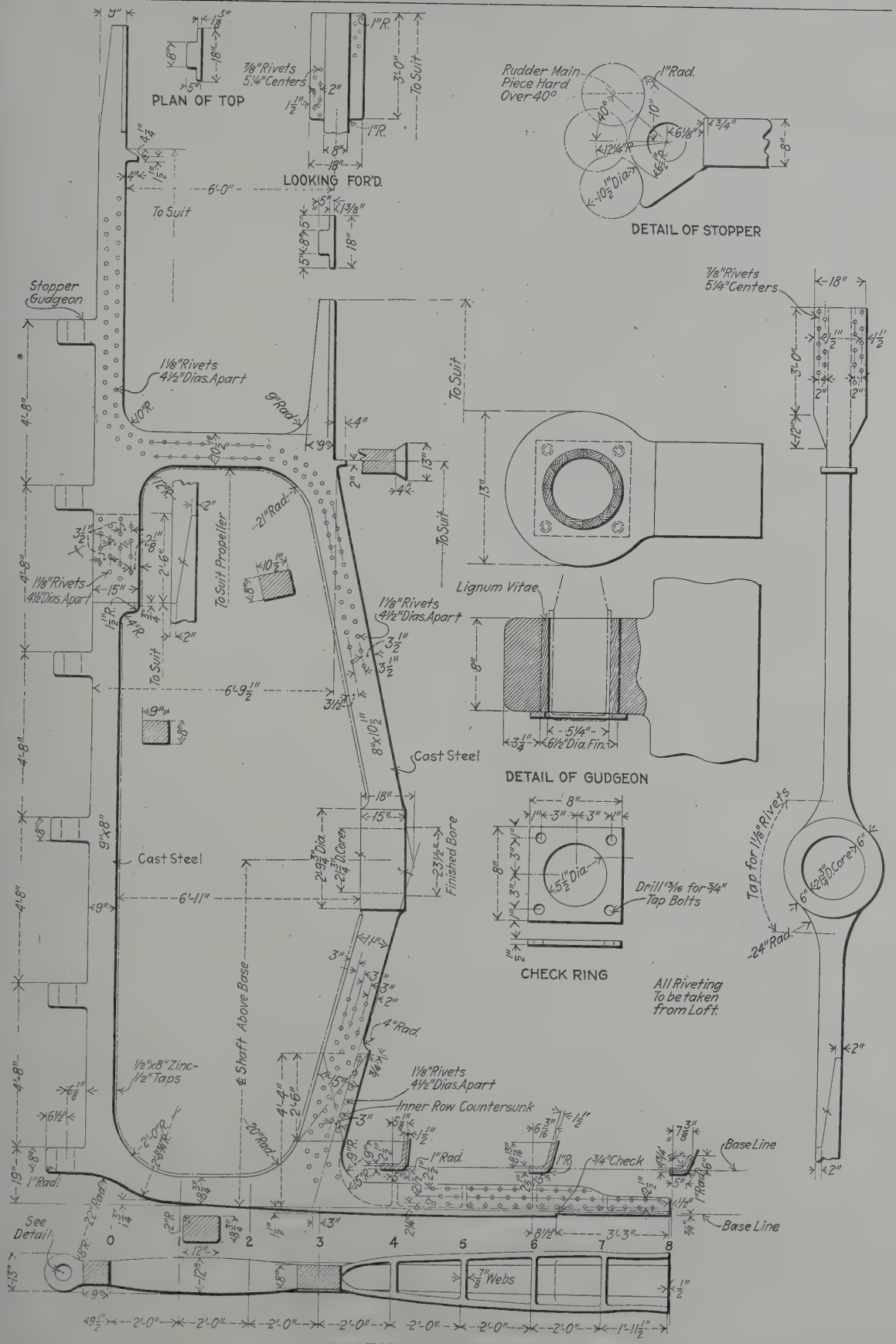
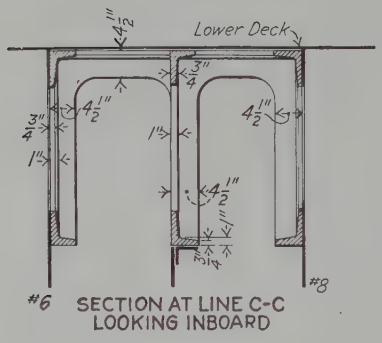
DETAIL OF BRKT. FOR LIFTING RUDDER STOCK
CANT. FRAME NO. 1
AFTER END W.T. COMPARTMENT
Looking Forward
FOUNDATION FOR TOWING CHOCK
TYPICAL FOR FR. NO. 2, 4, 6, 8 & 10. FOR PART NOT SHOWN SEE FR. NO. 3, 5, 7 AND 9
TYPICAL FOR FR. NO. 3, 5, 7 AND 9
PLAN VIEW OF STARBD SIDE SHOWING ANGLE FOR WASH ROOM BHD AND LADDER ON STARBD SIDE ONLY
These Ls reversed for 7, 8, 9, 10
SECTION "A-A"
General Notes
All holes in foundation plates, for chocks and bollards, to be templeted. Deck cts'k. except under Ls. Laps, etc. All outside of B'hd's. to be c'ts'k except under connections.
TRANSOM FRAME
Port Side, Looking Aft
DETAIL OF HORIZONTAL BRKT. 4'-0" ABOVE UPPER DECK
DETAIL OF TOP OF STIFF. 11'-11½" FROM ℄ STARBD SHOWN PORT OPPOSITE
BHD AT FRAME NO. 17

9,000-TON D. W. FREIGHTER

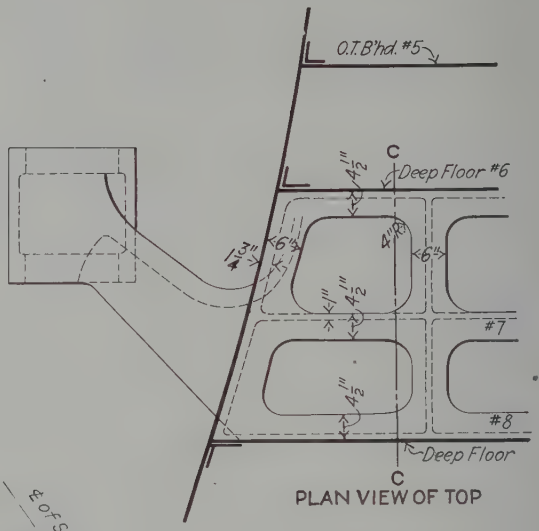


9,000-TON D. W. FREIGHTER

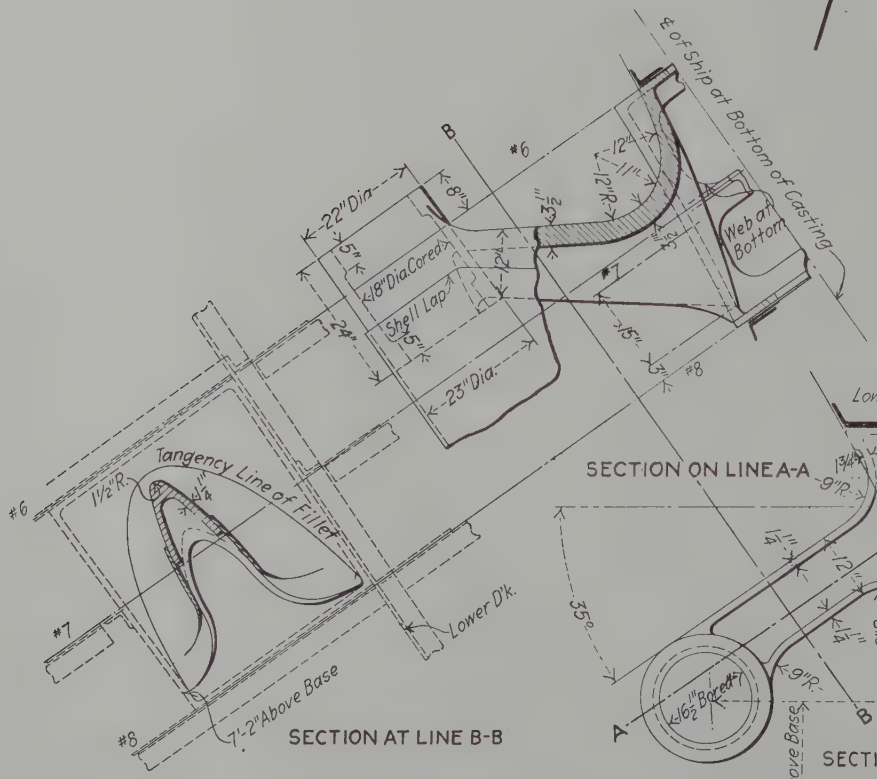

PLAN OF TOP
LOOKING FOR'D.
DETAIL OF STOPPER
DETAIL OF GUDGEON
CHECK RING
Stopper Gudgeon
7/8"Rivets 5 1/4" Centers
1 1/8"Rivets 4 1/2" Dias. Apart
To Suit Propeller
Lignum Vitae
Cast Steel
Finished Bore
Inner Row Countersunk
All Riveting To be taken from Loft.
Tap for 1 1/8" Rivets
Drill 1 3/16 for 3/4" Tap Bolts
1 1/2"x8" Zinc-1/2" Taps
Shaft Above Base
Base Line
3/4" Check
See Detail
7/8" Webs
8,800-TON D. W. FREIGHTER



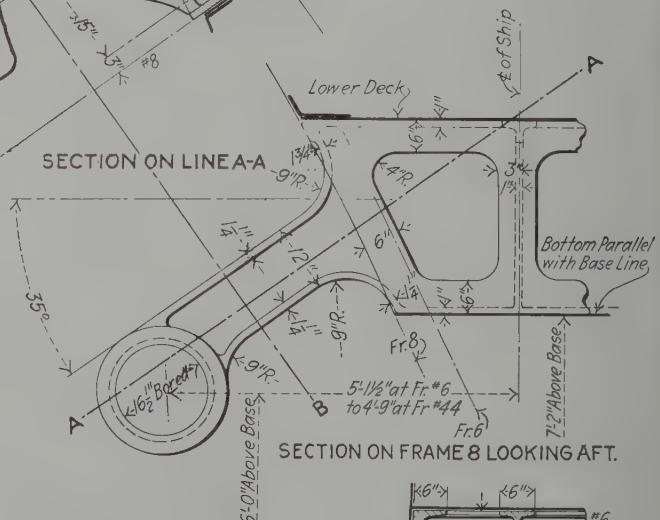
SECTION AT LINE C-C
LOOKING INBOARD



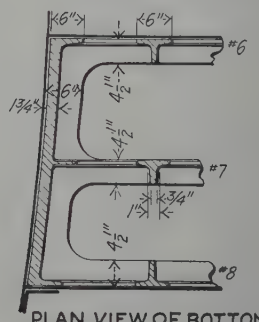
PLAN VIEW OF TOP



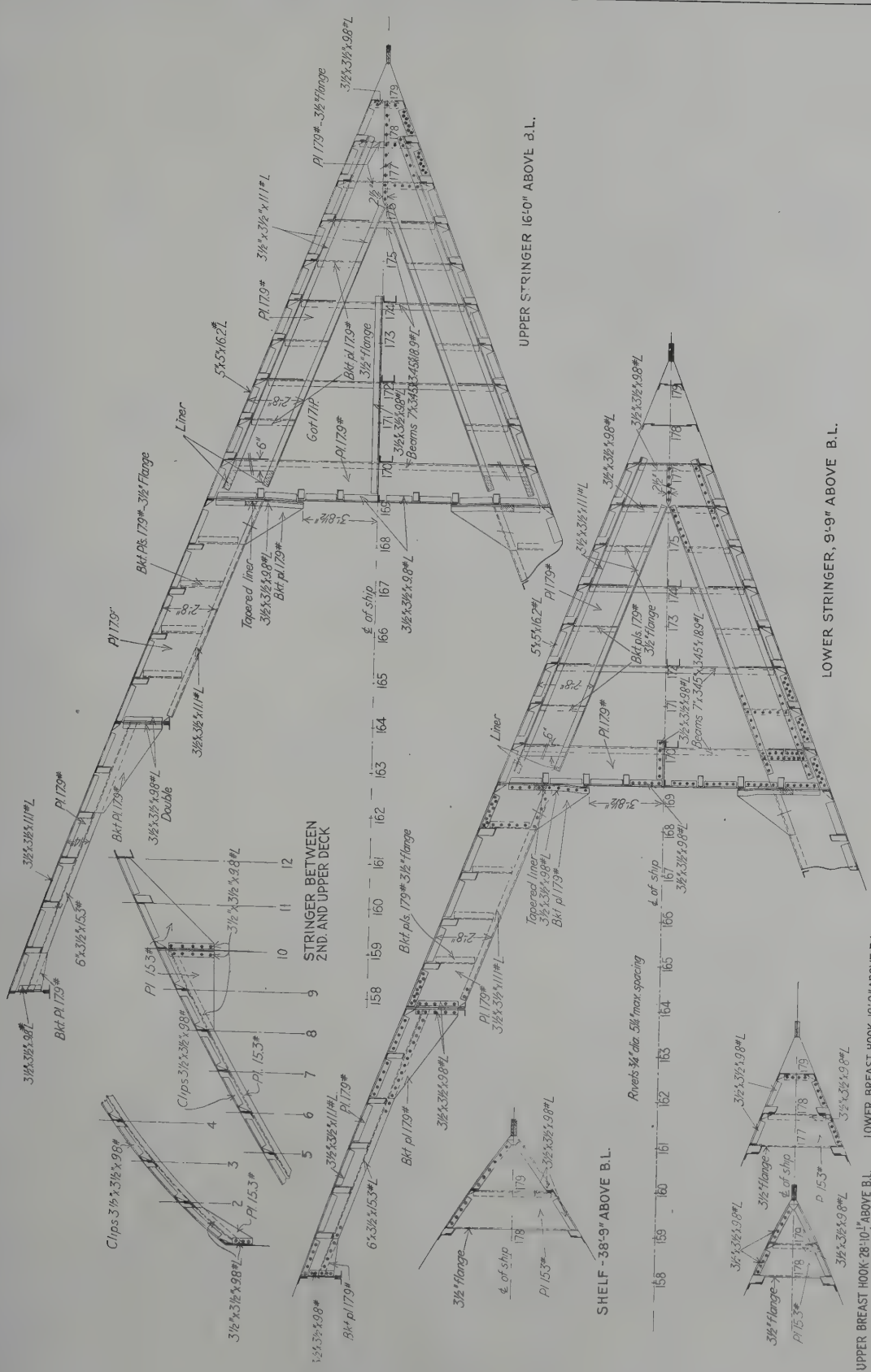
SECTION AT LINE B-B

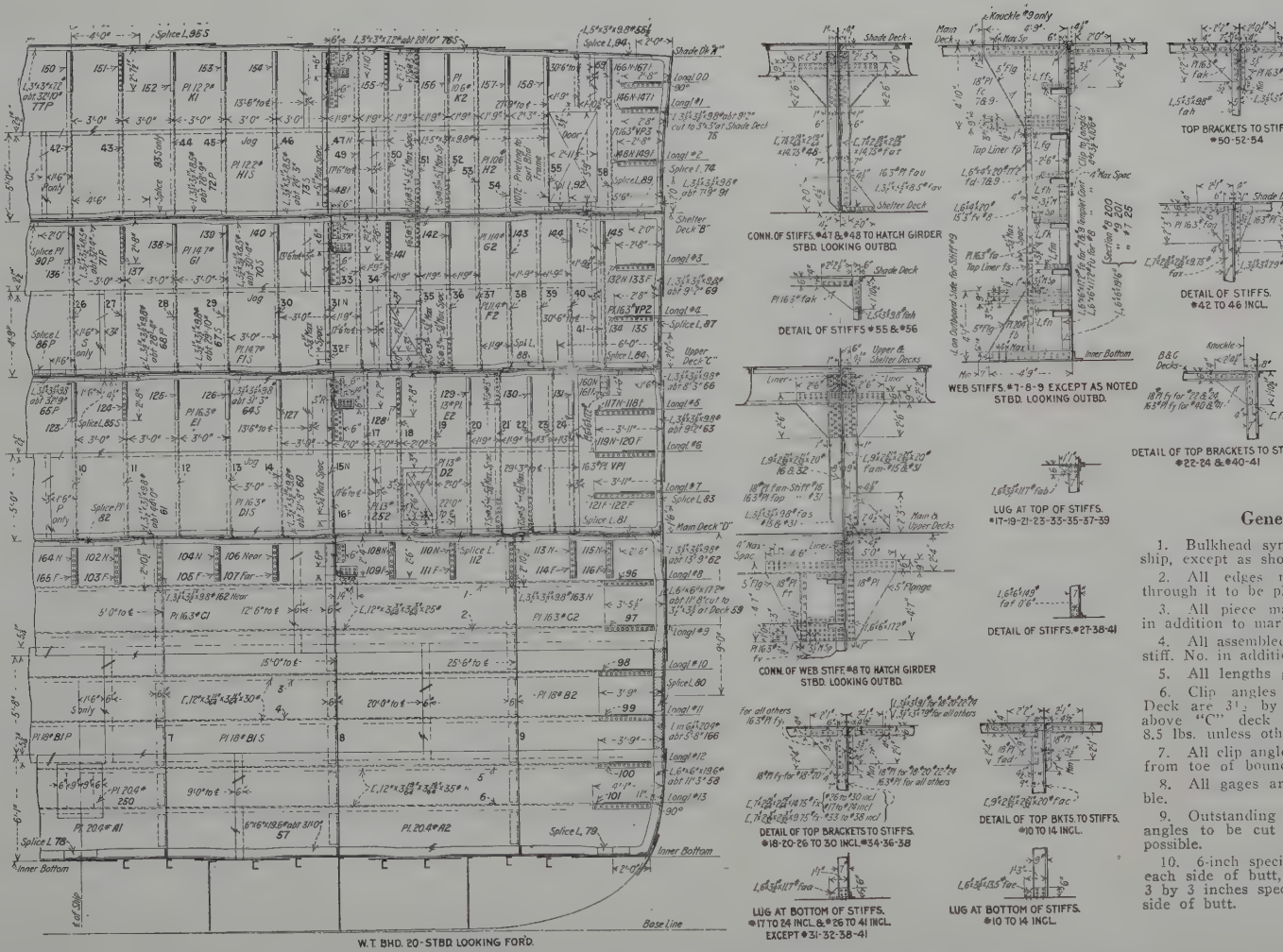


SECTION ON FRAME 8 LOOKING AFT.



PLAN VIEW OF BOTTOM


UPPER STRINGER 16'0" ABOVE B.L.
LOWER STRINGER, 9'9" ABOVE B.L.
9,000-TON D. W. FREIGHTER
STRINGER BETWEEN 2ND. AND UPPER DECK
SHELF - 38'9" ABOVE B.L.
UPPER BREAST HOOK-28'10½" ABOVE B.L.
LOWER BREAST HOOK-19'9" ABOVE B.L.
Liner
Tapered liner
Bkt pl 179#
Bkt pls. 179#-3½" Flange
Pl 179#
Pl 15.3#
Clips 3½"x3½"x.98#
3½"x3½"x.98#L
3½"x3½"x.111#L
6"x3½"x15.3#L
5"x5"x16.2#L
Beams 7"x3.45#x18.9#L
Rivets ¾" dia. 5¼" max spacing


W.T. BHD. 20-STBD. LOOKING FORD.
CONN. OF STIFFS. ⊕47 & ⊕48 TO HATCH GIRDER STBD. LOOKING OUTBD.
DETAIL OF STIFFS ⊕55 & ⊕56
CONN. OF WEB STIFF. ⊕8 TO HATCH GIRDER STBD. LOOKING OUTBD.
DETAIL OF TOP BRACKETS TO STIFFS. ⊕18-20-26 TO 30 INCL. ⊕34-36-38
LUG AT BOTTOM OF STIFFS. ⊕17 TO 24 INCL. & ⊕26 TO 41 INCL. EXCEPT ⊕31-32-38-41
WEB STIFFS. ⊕7-8-9 EXCEPT AS NOTED STBD. LOOKING OUTBD.
LUG AT TOP OF STIFFS. ⊕17-19-21-23-33-35-37-39
DETAIL OF STIFFS. ⊕27-38-41
DETAIL OF TOP BKTS. TO STIFFS. ⊕10 TO 14 INCL.
LUG AT BOTTOM OF STIFFS. ⊕10 TO 14 INCL.
TOP BRACKETS TO STIFFS ⊕50-52-54
DETAIL OF STIFFS. ⊕42 TO 46 INCL.
DETAIL OF TOP BRACKETS TO STIFFS. ⊕22-24 & ⊕40-41

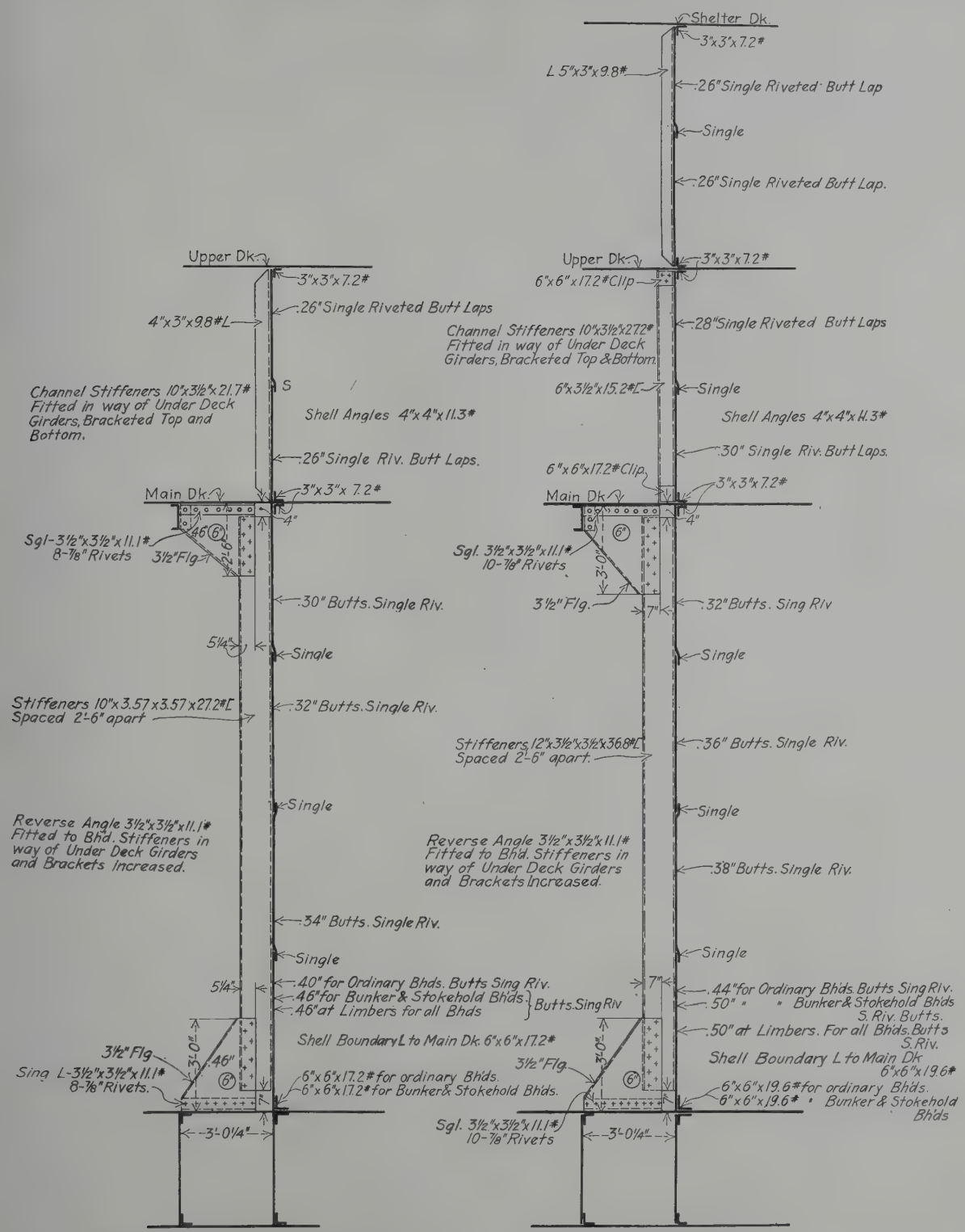
General Notes

1. Bulkhead symmetrical about C.L. of ship, except as shown or noted.
2. All edges marked "C" with line through it to be planed for caulking.
3. All piece marks to have Bhd. No. in addition to mark given.
4. All assembled pieces on stiff. to take stiff. No. in addition to marks given.
5. All lengths given are about.
6. Clip angles to longl's below "C" Deck are 3½ by 3½ inches by 9.8 lbs. above "C" deck 3½ by 3½ inches by 8.5 lbs. unless otherwise noted.
7. All clip angles to be cut back 1 inch from toe of boundary angle.
8. All gages are standard where possible.
9. Outstanding legs of all channels and angles to be cut back 45 degrees where possible.
10. 6-inch special angle to have 5 rivs. each side of butt, 3½ by 3½ inches and 3 by 3 inches special to have 3 rivs. each side of butt.

13,000-TON D. W. COMBINED PASSENGER AND FREIGHTER

Builders, Bethlehem Shipbuilding Corp.
New York Shipbuilding Corp.

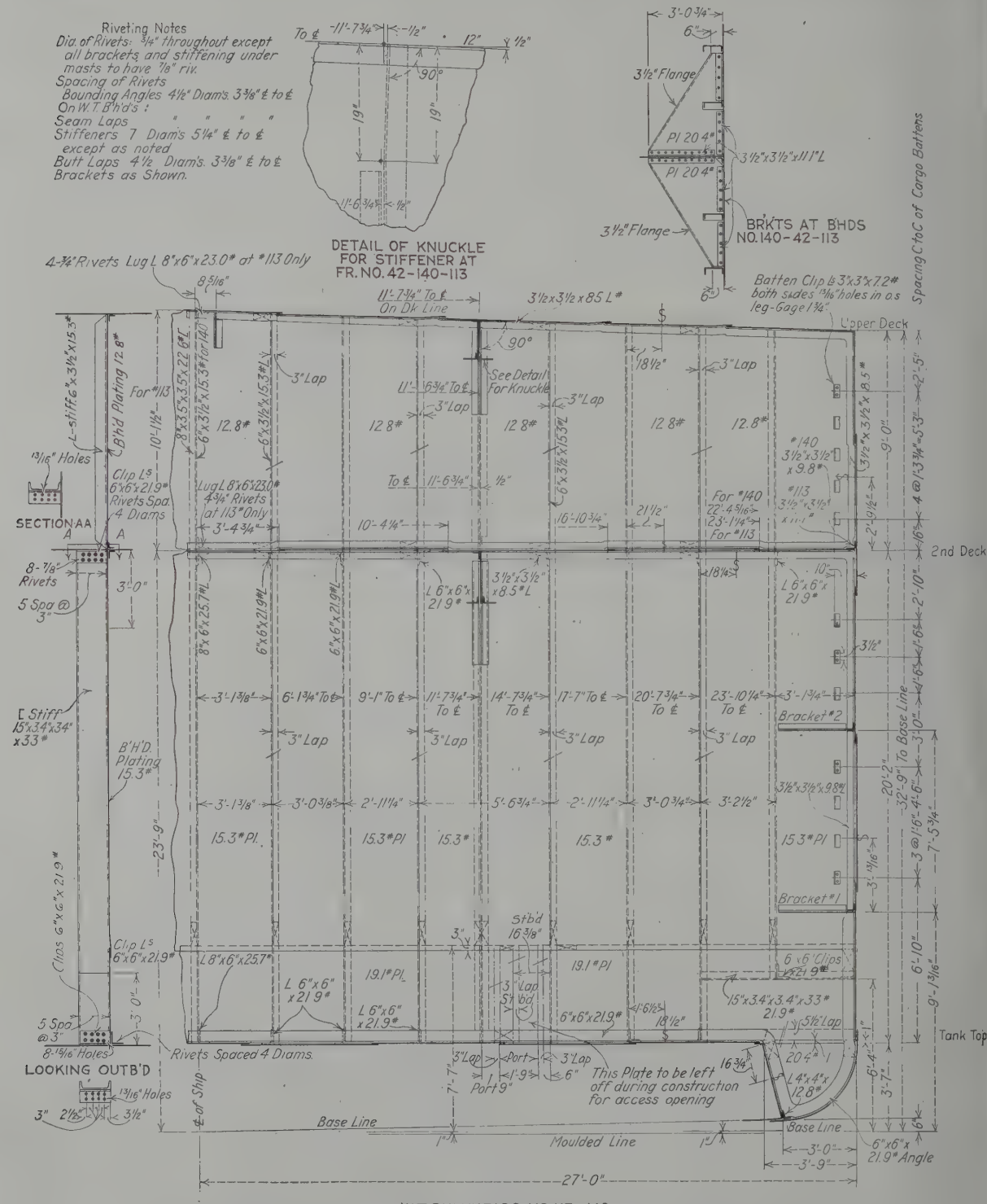
SECTION THRU MAIN W. T. BULKHEADS



W.T. BHDS. EXCEPT DEEP TANK. SCANTLINGS FOR BHDS. WITH OPEN SHELTER DECK (TONNAGE OPENING & FREEING PORT) BHDS. TO UPPER DECK ONLY.

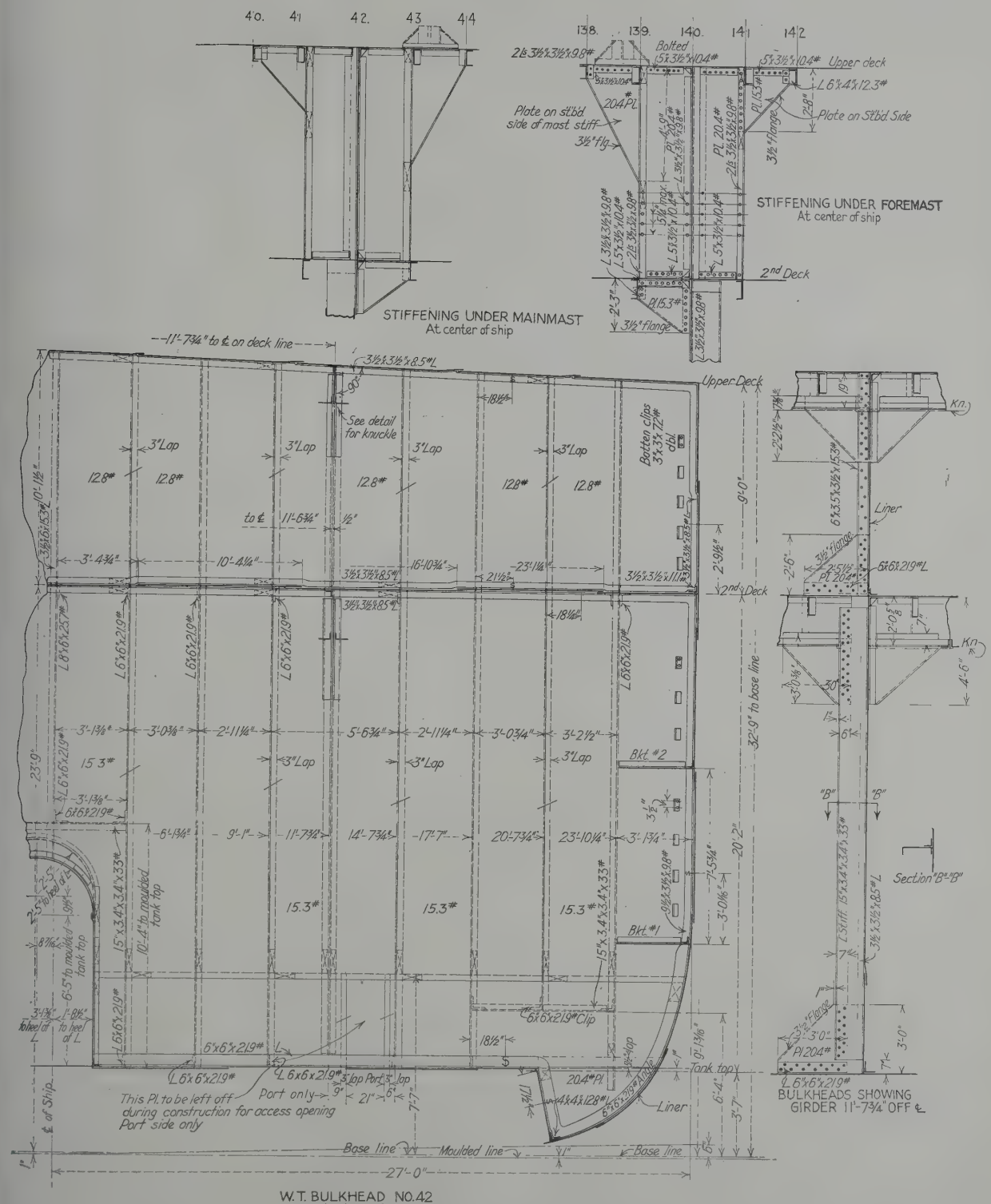
W.T. BHDS. TO SHELTER DECK. SCANTLINGS FOR BHDS. WITH CLOSED SHELTER DECK (BHDS. TO SHELTER DECK.)

12,000-TON D. W. FREIGHTER
Sun Shipbuilding Co., Chester, Pa.


Riveting Notes
Dia. of Rivets: 3/4" throughout except all brackets and stiffening under masts to have 7/8" riv.
Spacing of Rivets
Bounding Angles 4 1/2" Diam's. 3 3/8" ℄ to ℄
On W.T. B'hd's :
Seam Laps " " " "
Stiffeners 7 Diam's 5 1/4" ℄ to ℄ except as noted
Butt Laps 4 1/2 Diam's. 3 3/8" ℄ to ℄
Brackets as Shown.
DETAIL OF KNUCKLE FOR STIFFENER AT FR. NO. 42-140-113
BRKTS AT BHDS NO. 140-42-113
Batten Clip L's 3"x3"x7.2# both sides 13/16" holes in o.s leg-Gage 1 3/4"
Spacing C to C of Cargo Battens
4-3/4" Rivets Lug L 8"x6"x23.0# at #113 Only
SECTION A A
Upper Deck
2nd Deck
Tank Top
Bracket #2
Bracket #1
Rivets Spaced 4 Diams.
LOOKING OUTB'D
℄ of Ship
Base Line
Moulded Line
This Plate to be left off during construction for access opening
W.T. BULKHEADS NO. 113-140
Looking Forward

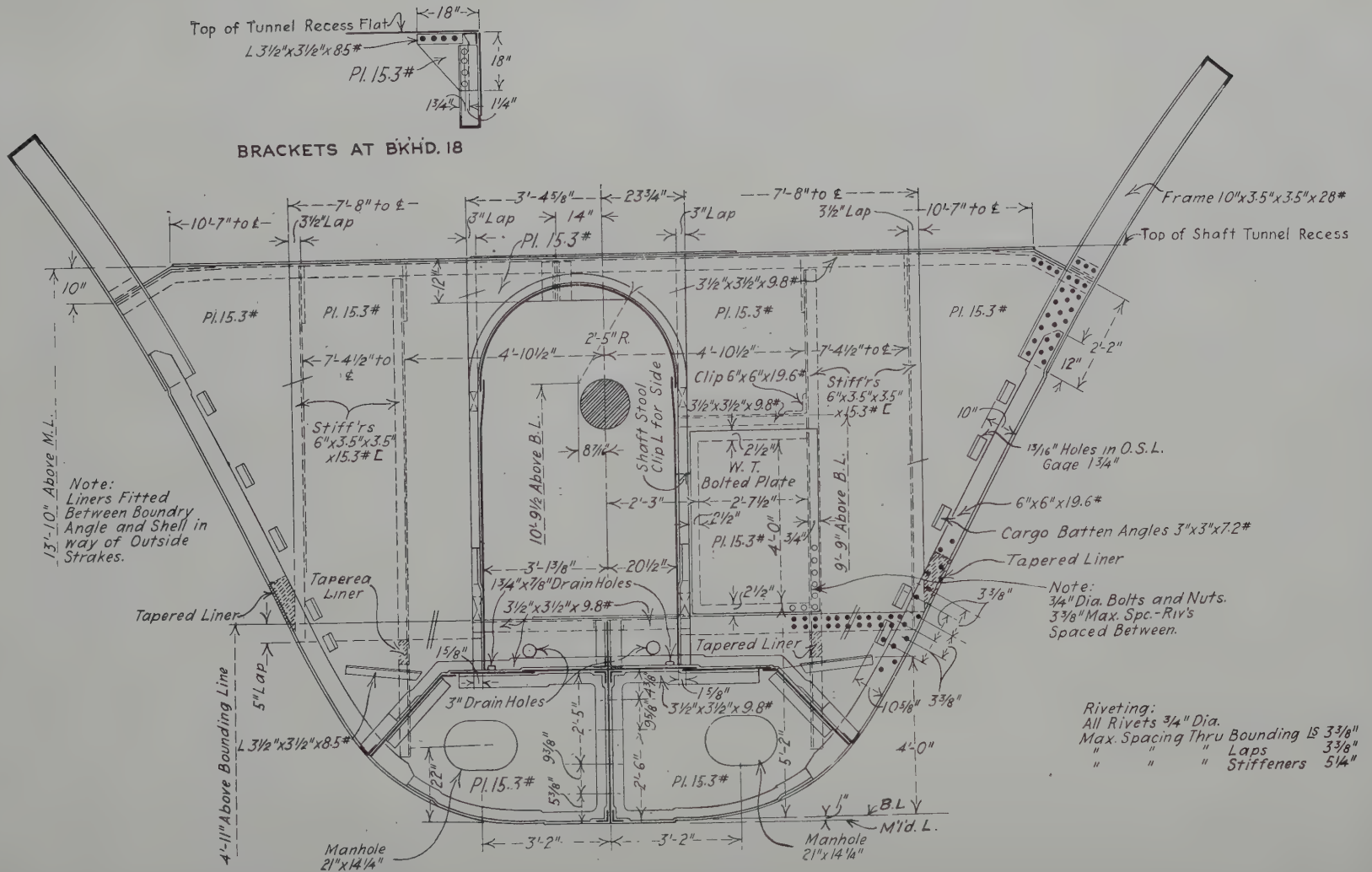
9,000-TON D. W. FREIGHTER

TRANSVERSE W. T. BULKHEAD



W. T. BULKHEAD NO. 42
Looking Aft.

9,000-TON D. W. FREIGHTER

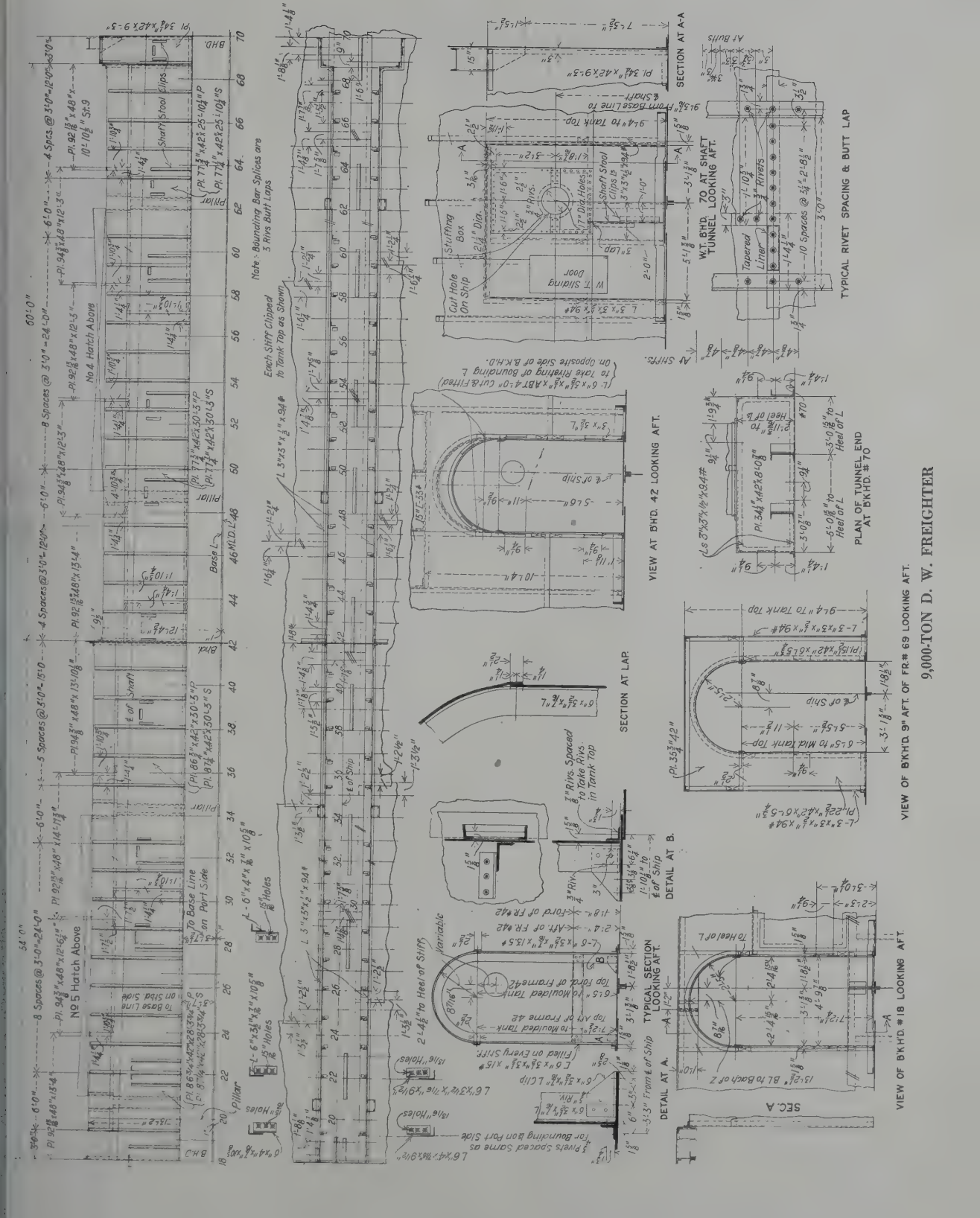


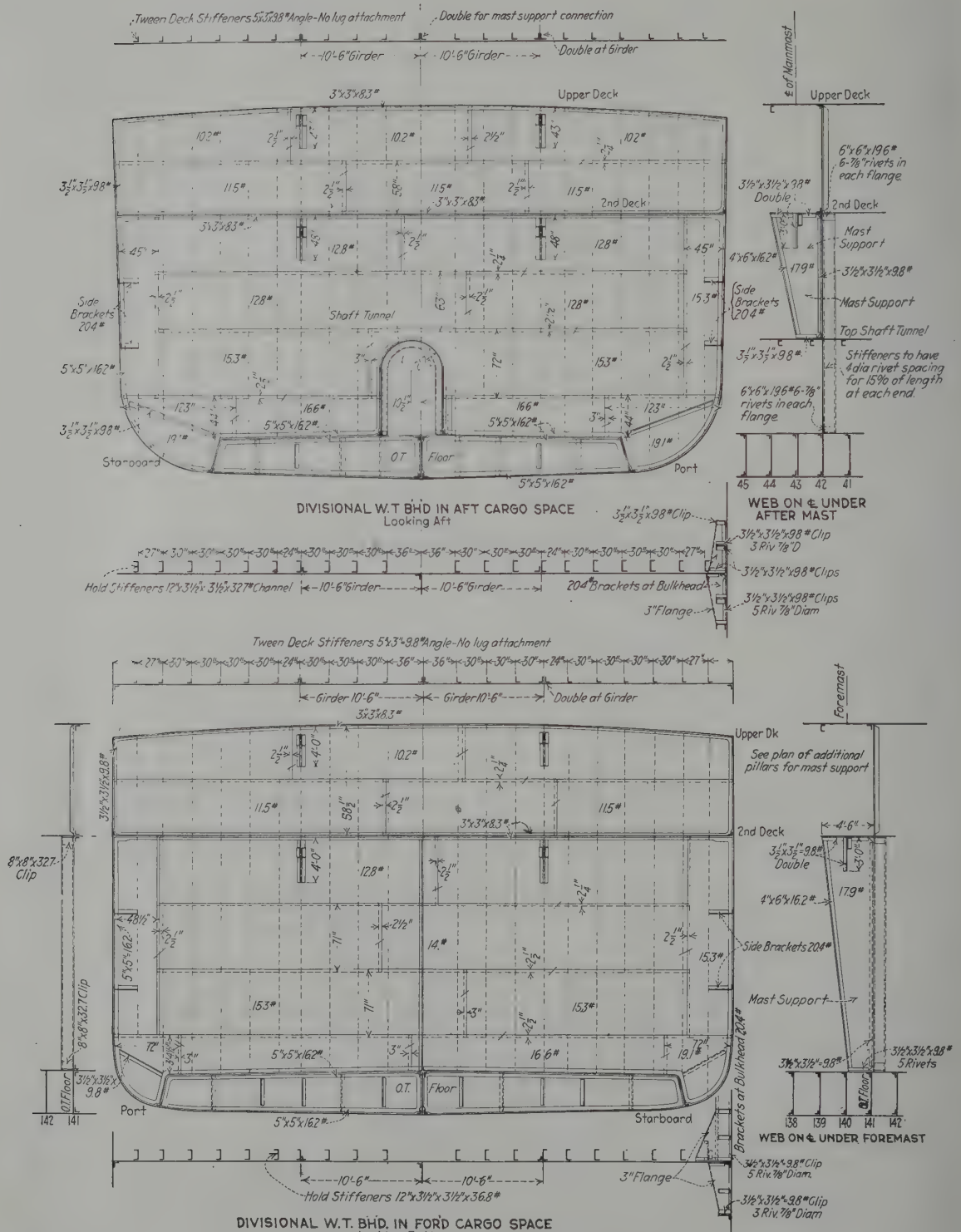
Riveting:
All Rivets ¾" Dia.
Max. Spacing Thru Bounding ℒ 3⅜"
" " " Laps 3⅜"
" " " Stiffeners 5¼"

W. T. BULKHEAD NO. 18
FORWARD END OF TUNNEL RECESS
Looking Aft

9,000-TON D. W. FREIGHTER

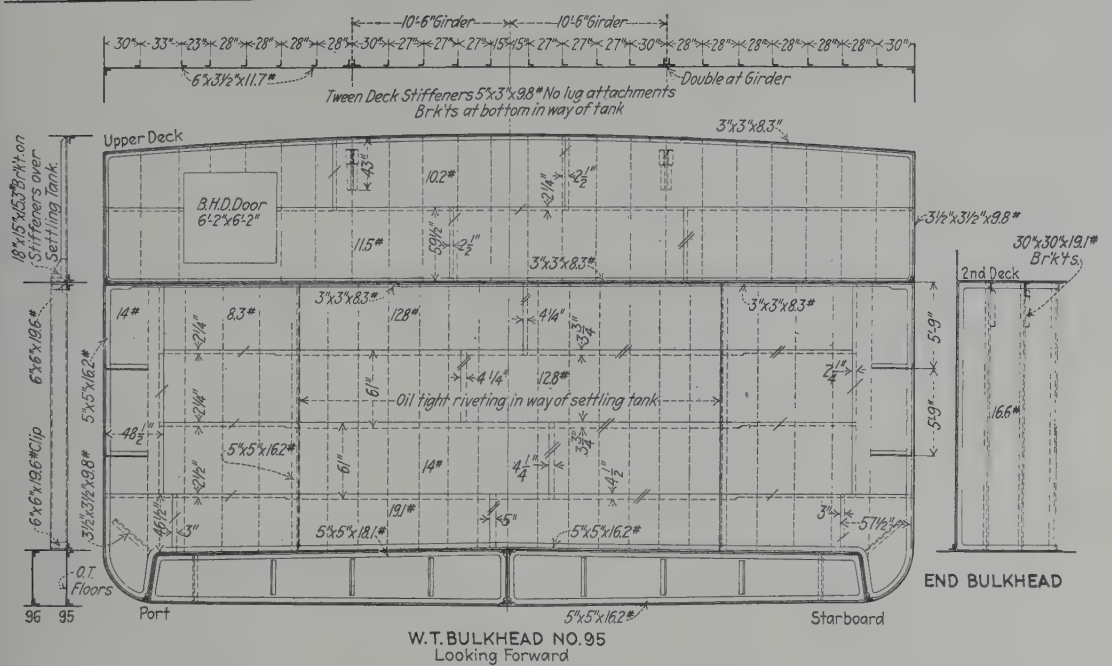
DETAILS OF SHAFT TUNNEL

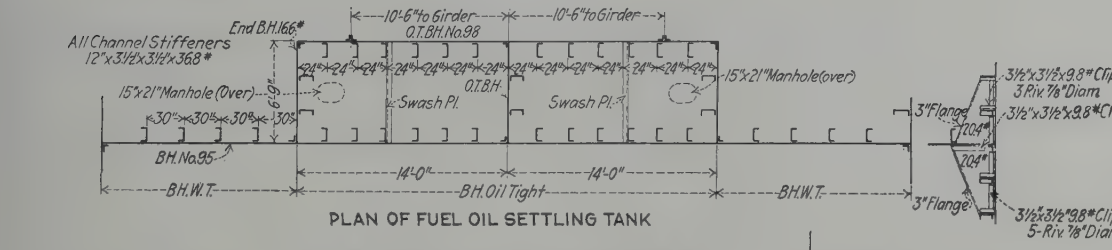

9,000-TON D. W. FREIGHTER
VIEW OF B'K'HD. 9" AFT. OF FR. # 69 LOOKING AFT.
VIEW OF B'K'HD. #18 LOOKING AFT.
VIEW AT B'HD. 42 LOOKING AFT.
PLAN OF TUNNEL END AT B'K'HD. #70
TYPICAL RIVET SPACING & BUTT LAP
SECTION AT A-A
SECTION AT LAP.
DETAIL AT B.
DETAIL AT A.
TYPICAL SECTION LOOKING AFT.
SEC. A
W.T. B'HD. 70 AT SHAFT TUNNEL LOOKING AFT.
No 5 Hatch Above
No 4 Hatch Above
Shaft Stool Clips
Strutting Box
Cut Hole On Ship
W.T. Sliding Door
Tapered Liner
Base Line
Pillar
Each Stiff. Clipped to Tank Top as Shown
Note: Bounding Bar Splices are 3 Rivs Butt Laps
To Base Line on Port Side
To Base Line on Stbd Side
To Heel of L
To Back of Z
Fillet on Every Stiff.
Top of Frame 42
Top Aft of Frame 42
Aft. of Fr. 42
Fwd of Fr. 42
Rivets Spaced as Shown for Bounding Bar on Port Side
Rivets Spaced to Take Rivs. in Tank Top
Frame & of Ship
Heel of Stiffs
Variable
Holes
Rivets

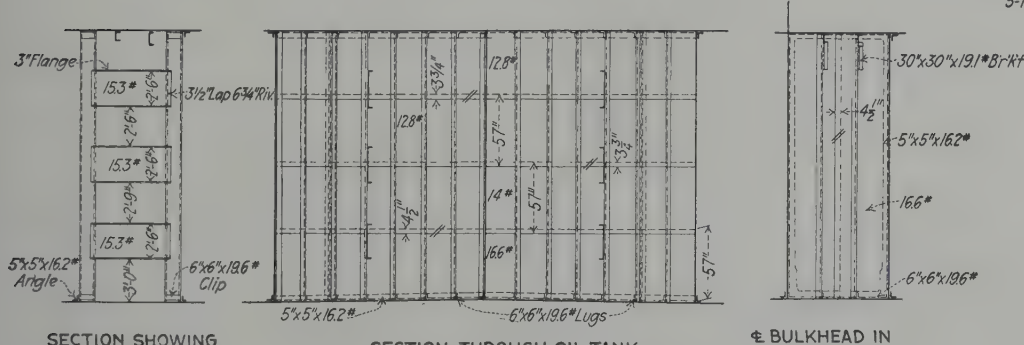


8,800-TON D. W. FREIGHTER

FORWARD BOILER ROOM BULKHEAD







8,800-TON D. W. FREIGHTER

RIVETING SCHEDULE

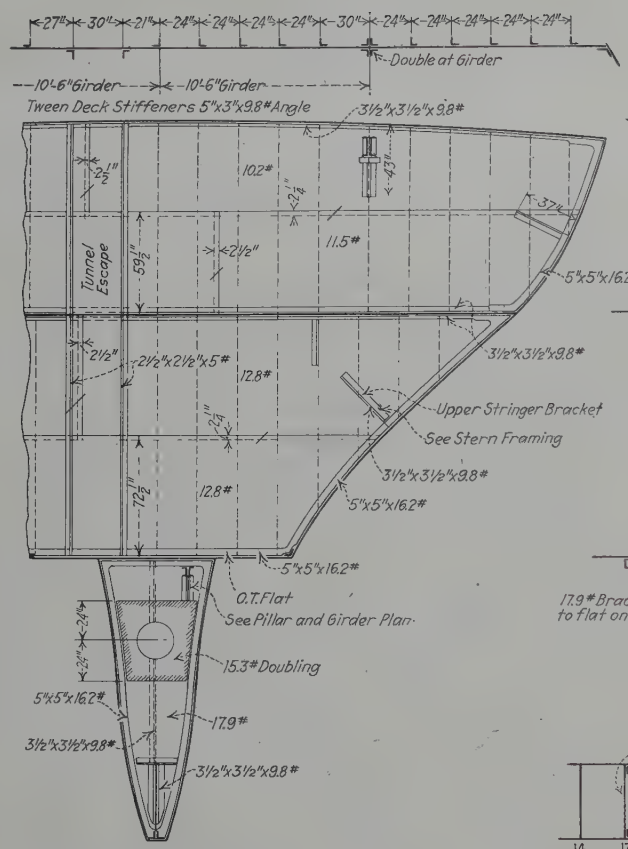
Connections	Dia. Rivet In.	Spacing Dia.	Spacing In.	Remarks
B'h'd. lap edge, 2¼"—sing. riv....	5/8	4½	2¾	
B'h'd. lap edge, 2½"—sing. riv....	¾	4½	3⅛	
B'h'd lap edge, 3¾"—dbl. riv.....	5/8	3½	2¼	O. T.
B'h'd. lap edge, 4½"—dbl. riv.....	¾	3½	2⅝	O. T.
B'h'd. lap butt, 2½"—sing. riv.....	5/8	4½	2¾	
B'h'd. lap butt, 3"—sing. riv.....	¾	4½	3⅛	
B'h'd. lap butt, 4¼"—dbl. riv.....	5/8	3½	2¼	O. T.
B'h'd. lap butt, 4½"—dbl. riv.....	¾	3½	2⅝	O. T.
B'h'd. lap butt, 5"—dbl. riv.....	¾	3½	2⅝	
B'h'd. bounding bars to b'h'd....	5/8	4½	2¾	10.2# to 14.0# pl.
B'h'd. bounding bars to b'h'd....	¾	4½	3⅛	15.3# to 19.1# pl.
B'h'd. stiffeners	5/8	7	4½	10.2# to 14.0# pl.
B'h'd. stiffeners	¾	7	5¼	15.3# to 19.1# pl.
B'h'd. stiffeners, in way of settling tanks	¾	6	4½	
B'h'd. stiffeners, in way of settling tanks	5/8	6	3¾	
Mast web stiffener.....	¾	7	5¼	
Bounding bars to tank top.....	¾	5	3¾	O. T. only

RIVETING SCHEDULE—Continued

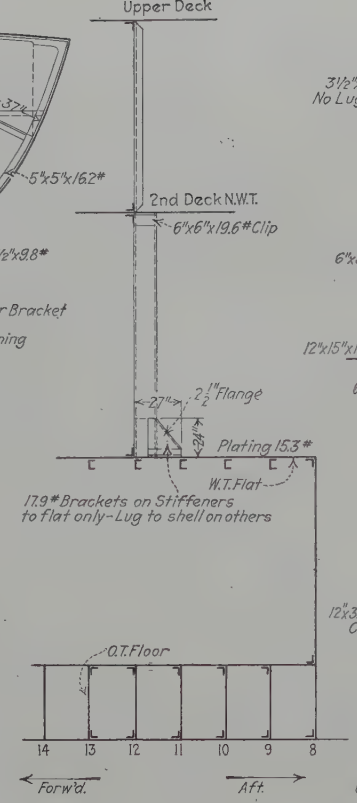
Connections	Dia. Rivet In.	Spacing Dia.	Spacing In.	Remarks
Bounding bars to tank top.....	7/8	5	4⅜	O. T. only
Bounding bars to shell.....	¾	5	3¼	
Bounding bars to shell.....	7/8	5	4⅜	
Bounding bars to shell.....	1	5	5	
In Way of O. T. Peak Tanks and Settling Tank.				
Seams 4½"	¾	3½	2⅝	
Seams 2½"	¾	3½	2⅝	
Seams 2¼"	5/8	3½	2¼	
Butts 2½"	5/8	3½	2¼	
Bounding bar	¾	5	3¾	Zig Zag
Bounding bar	¾	3½	2⅝	Single riv.

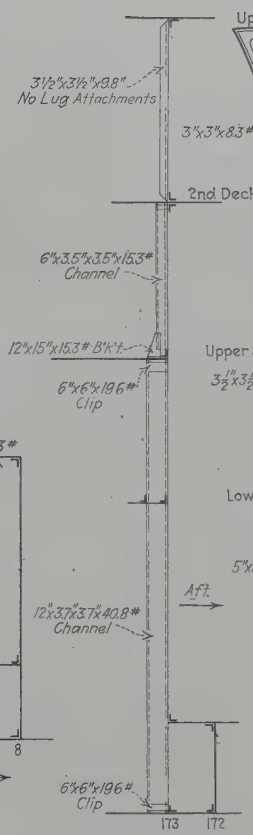
NOTES

Cut all doublers and clips ¾" short of calking edge.
Stiffeners with no end attachments and lugged stiffeners to have 4 dia. spacing for 15% of length at each end.
All W. T. floor stiffeners to overlap frame and reverse frame.

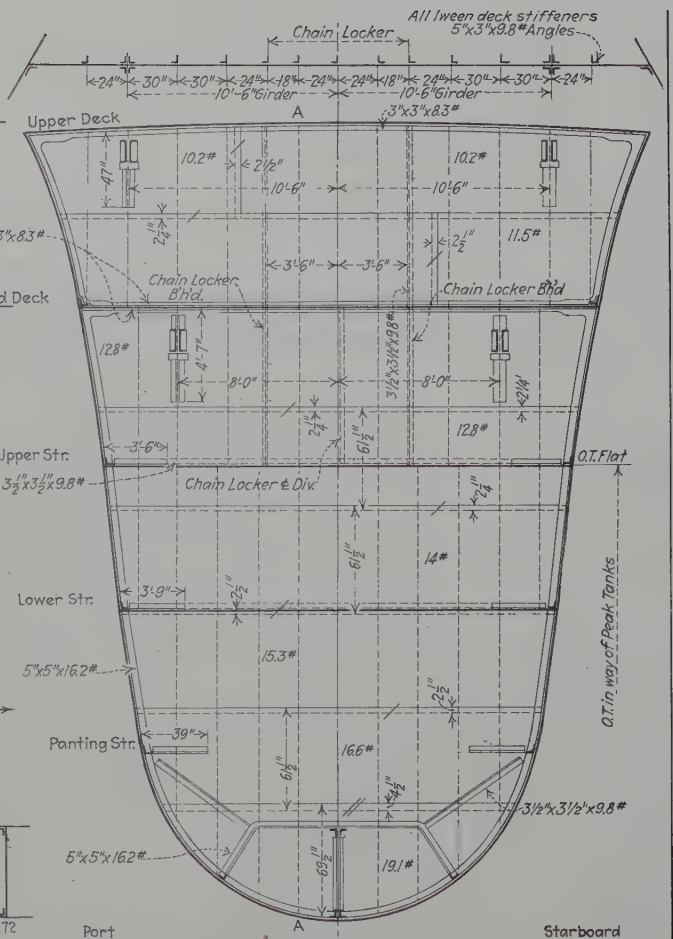


AFTER PEAK TANK BULKHEAD
Looking Aft

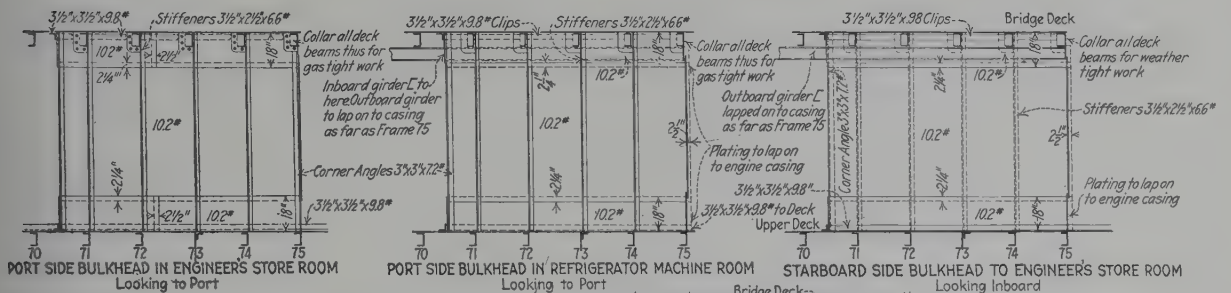




SECTION A-A
Looking Outboard



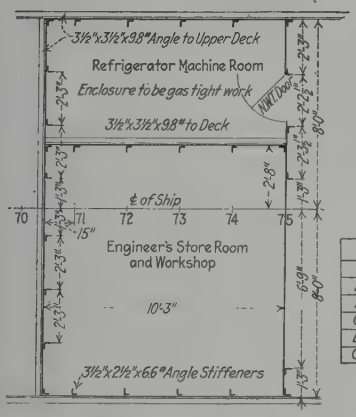
COLLISION BULKHEAD
Looking Ford


3½"x3½"x.98#
Stiffeners 3½"x2½"x.66#
Collar all deck beams thus for gas tight work
Inboard girder ℄ to here Outboard girder to lap on to casing as far as frame 75
Corner Angles 3"x3"x.72#
3½"x3½"x.98#
10.2#
2¼"
2½"
18#
70 71 72 73 74 75
3½"x3½"x.98# Clips
Plating to lap on to engine casing
3½"x3½"x.98# to Deck
Upper Deck
Bridge Deck
Outboard girder ℄ lapped on to casing as far as frame 75
Corner Angles 3"x3"x.72#
Stiffeners 3½"x2½"x.66#
Plating to lap on to engine casing

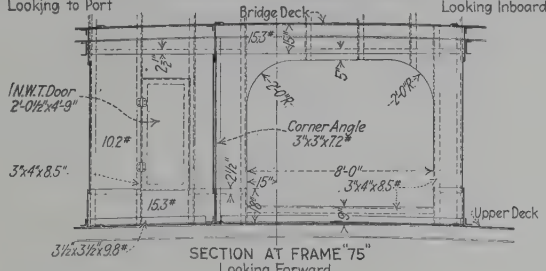
PORT SIDE BULKHEAD IN ENGINEER'S STORE ROOM
Looking to Port

PORT SIDE BULKHEAD IN REFRIGERATOR MACHINE ROOM
Looking to Port

STARBOARD SIDE BULKHEAD TO ENGINEER'S STORE ROOM
Looking Inboard

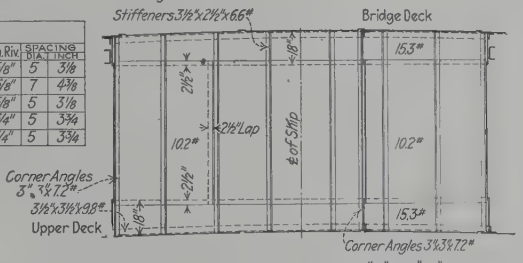


ARRANGEMENT OF ENGINEER'S STORE ROOM
On Upper Deck

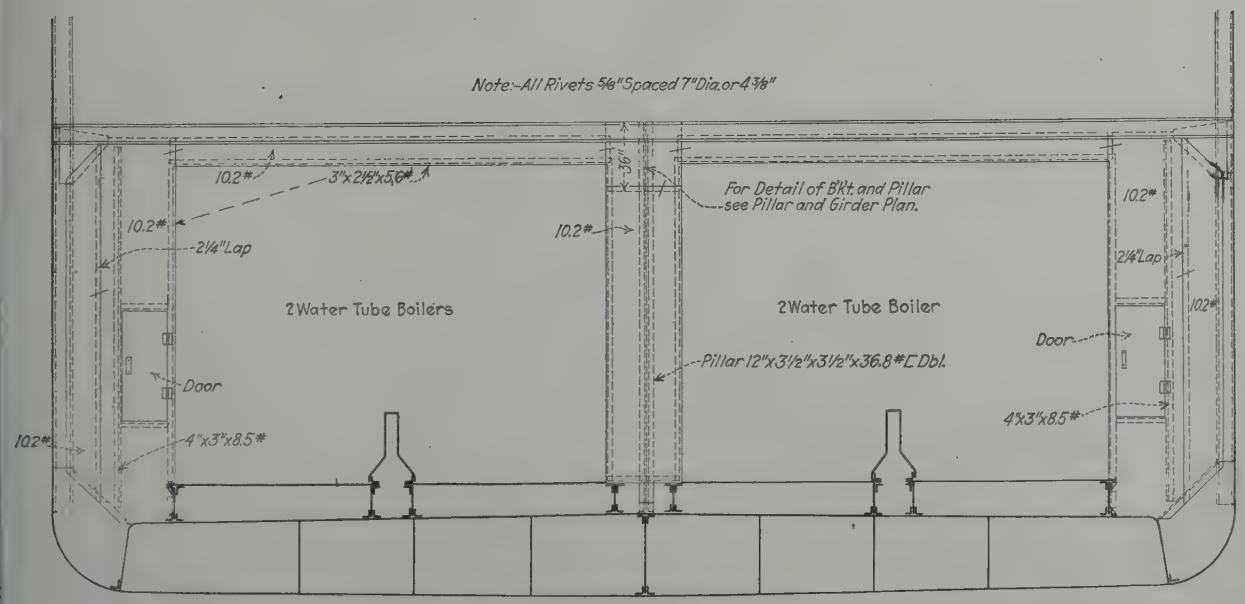


SECTION AT FRAME "75"
Looking Forward

Riveting Schedule			
Connections	Dia. Riv.	SPACING DIA.	INCH
Edge Laps - Plating	5/8"	5	3⅛
Plating to Stiffeners	5/8"	7	4⅜
Corner Angles	5/8"	5	3⅛
Bounding Angles to Deck	¾"	5	3¾
Coaming Clips to Deck	¾"	5	3¾

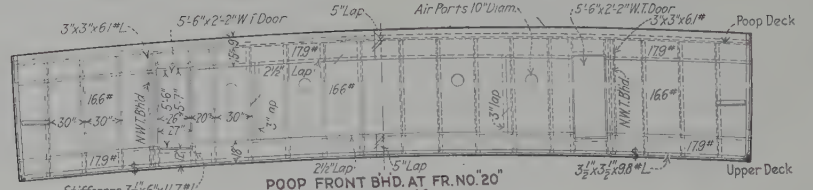


SECTION BETWEEN FRAMES "71" AND "70"
Looking Aft

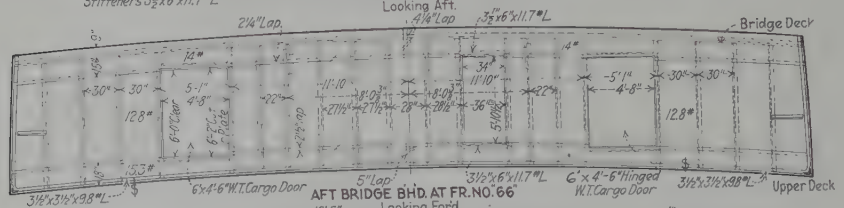


SCREEN BHD. FRAME "84"
Looking Forward

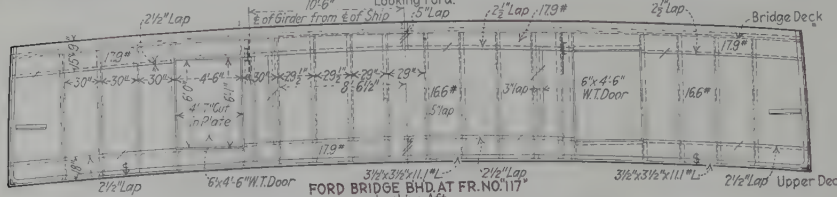
8,800-TON D. W. FREIGHTER



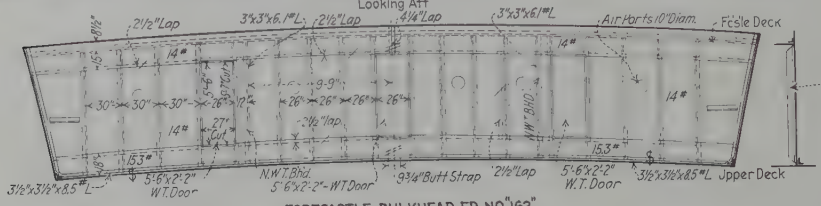
POOP FRONT BHD. AT FR. NO. "20"
Looking Aft.



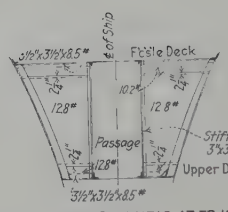
AFT BRIDGE BHD. AT FR. NO. 66
Looking Forward



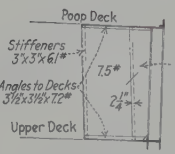
FORD BRIDGE BHD. AT FR. NO. "117"
Looking Aft



FORECASTLE BULKHEAD FR. NO. "162"
Looking Ford

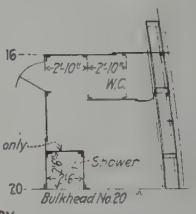


THWARTSHIP BULKHEAD AT FR. 182
Looking Forward

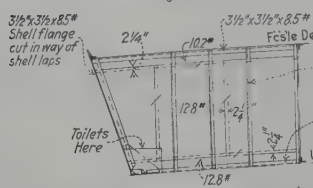


W.C. DIVISION IN LAVATORY
Port Side Looking Aft

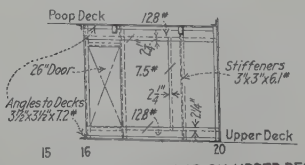
THWARTSHIP BULKHEAD NO. "16" IN LAVATORY
Port Side Looking Aft



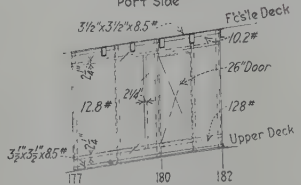
PLAN OF LAVATORY
Port Side between Upper and Poop Decks



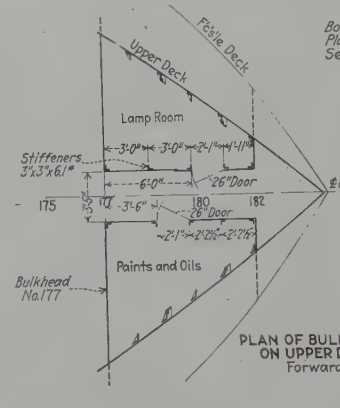
THWARTSHIP BULKHEAD-FIREMENS WASH ROOM
Port Side, Looking Forward



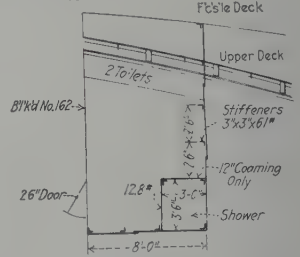
FORE AND AFT BULKHEAD ON UPPER DECK
Port Side



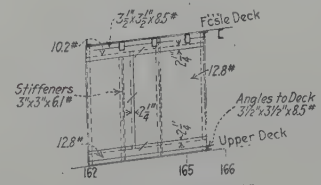
FORE AND AFT BULKHEAD TO LAMP ROOM
Looking Outboard



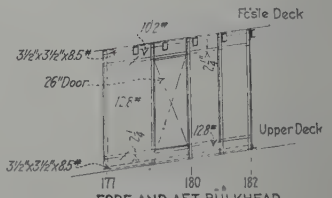
PLAN OF BULKHEADS ON UPPER DECK
Forward



PLAN OF FIREMENS WASH ROOM
Port Side

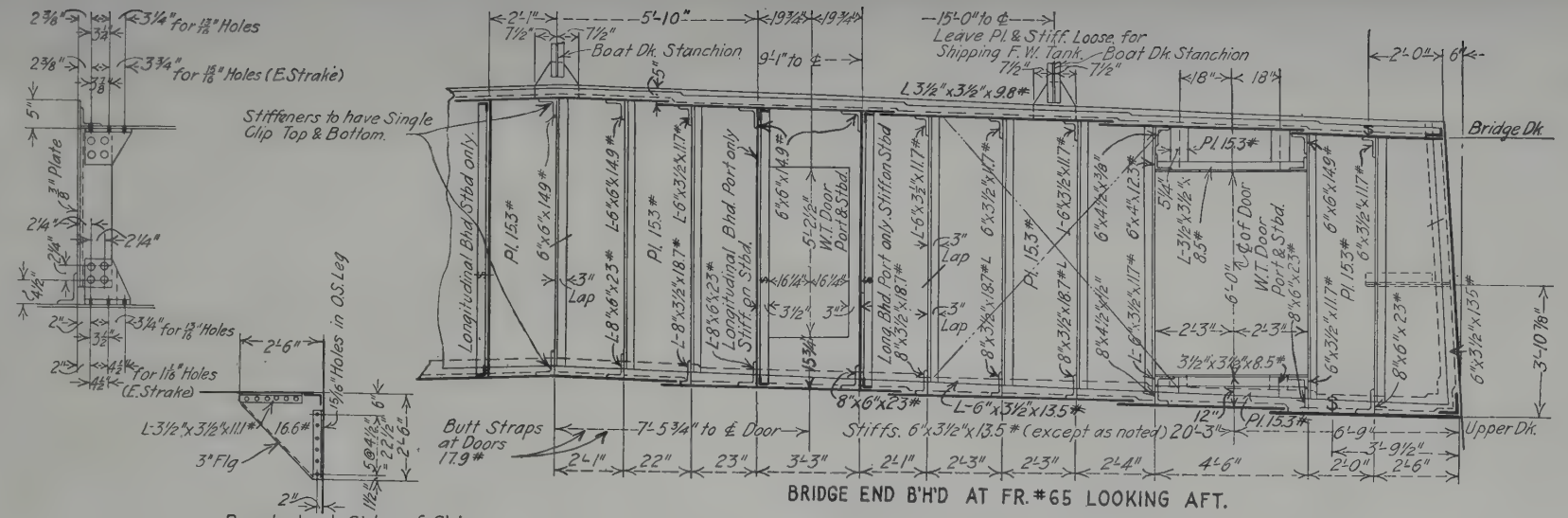


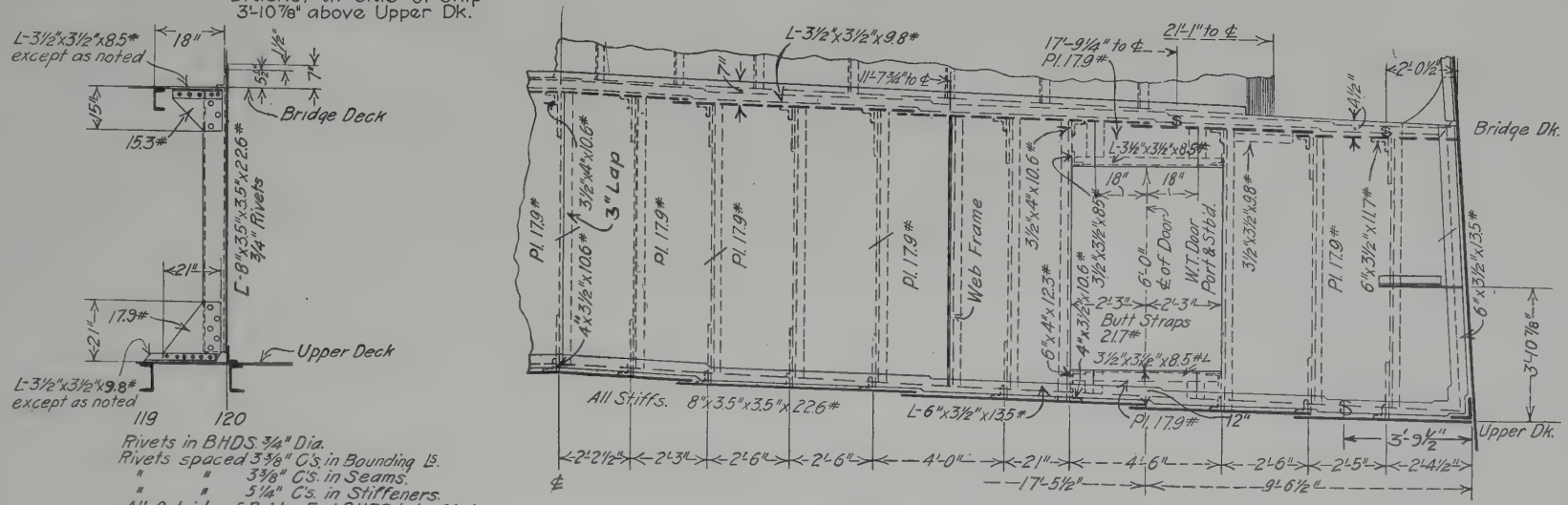
FORE AND AFT BULKHEAD-FIREMENS WASH ROOM
Port Side



FORE AND AFT BULKHEAD TO PAINT AND OIL ROOM
Looking Inboard

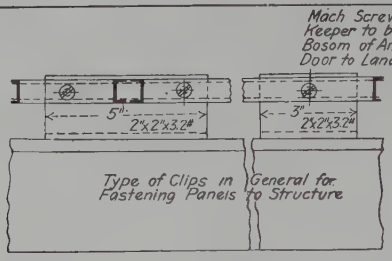
8,800-TON D. W. FREIGHTER

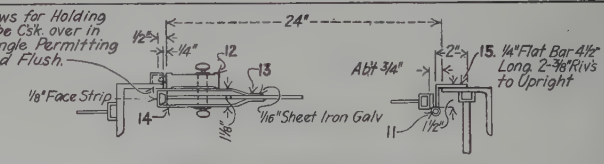

Stiffeners to have Single Clip Top & Bottom.
Longitudinal Bhd. Stbd only
Longitudinal Bhd. Port only
Stiffs. on Stbd.
Long. Bhd. Port only. Stiffs on Stbd
Boat Dk. Stanchion
Leave Pl. & Stiff. Loose for Shipping F.W. Tank
Bridge Dk.
Upper Dk.
W.T. Door Port & Stbd.
Butt Straps at Doors 17.9#
Bracket at Side of Ship 3'-10 7/8" above Upper Dk.
BRIDGE END B'H'D AT FR. #65 LOOKING AFT.


except as noted
Bridge Deck
Upper Deck
Web Frame
3" Lap
All Stiffs. 8"x3.5"x3.5"x226#
Bridge Dk.
Upper Dk.
W.T. Door Port & Stbd.
Butt Straps 21.7#
Rivets in B.HDS. 3/4" Dia.
Rivets spaced 3 3/8" C's. in Bounding Ls.
" " 3 3/8" C's. in Seams.
" " 5 1/4" C's. in Stiffeners.
All Outside of Bridge End BHDS. to be Ctsk. Except under Connections.
BRIDGE FRONT B'H'D. FR #120
PORT SIDE LOOKING AFT. ST'B'D OPP.

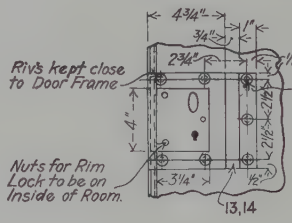
9,000-TON D. W. FREIGHTER

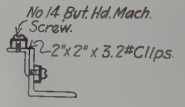
WIRE MESH BULKHEADS IN ENGINEER'S STORE ROOM

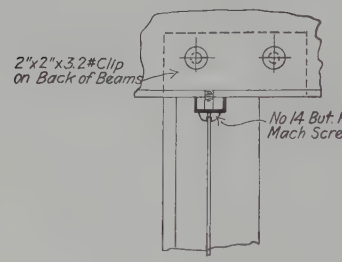




HORIZONTAL SECTION THRO DOOR

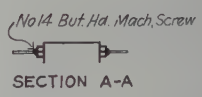




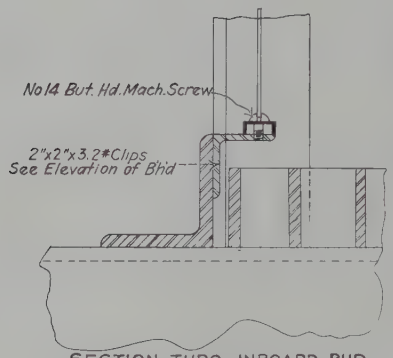


General Notes:-
All Dimensions are over Panel Frames and are to be considered approximate. They are to be checked up with Template taken from Ship.

Bill of Material				
Quantity Given for One Ship				
No. Req.	Name	Pc. No.	Material	Remarks
1	Bulkhead Panel	1	Wire Mesh	
1	" "	2	" "	
1	" "	3	" "	2" Diamond Mesh
1	" "	4	" "	1" Channel Frame
1	" "	5	" "	Mesh .192" Wire
1	" "	6	" "	galvanized
1	" "	7	" "	
1	" "	8	" "	
1	" "	9	" "	
1	Door	10	" "	1/16" Face Strip on Door Frame only
3	Hinges 2" Butt	11	W. Steel	Galv.
1	Rimlock & Keeper	12	Brass	4"x3 1/4"
1	Lock Plate	13	Sheet Iron	Galv.
1	Lock Plate	14	" "	Galv.
3	Hinge Clip	15	W. Steel	Galv.

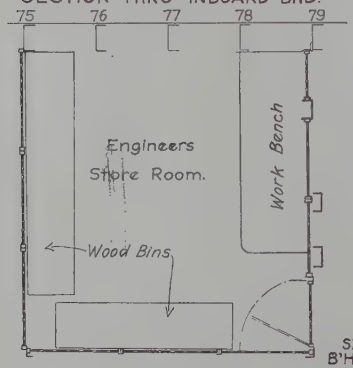


SECTION A-A

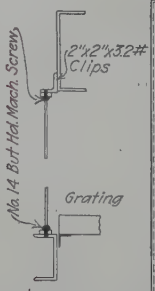


SECTION THRO INBOARD BHD.

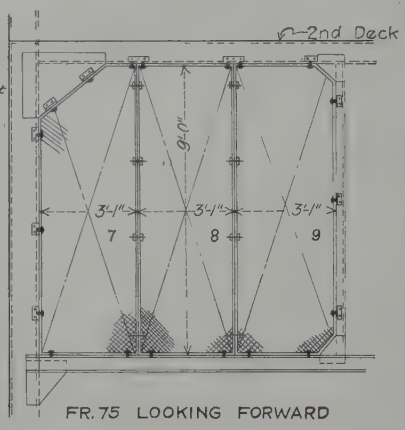
TYPICAL SECTION WHERE PANEL FRAMES ARE BOLTED TOGETHER.



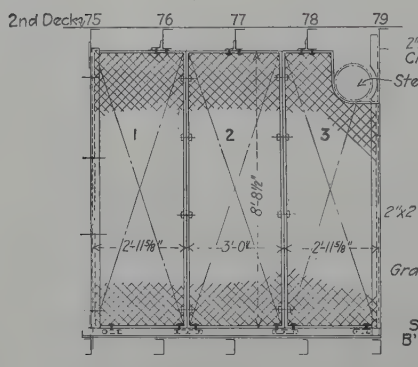
PLAN VIEW PORT SIDE ONLY



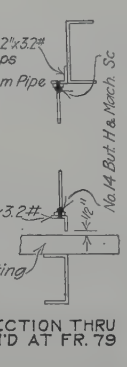
SECTION THRU B'H'D AT FR. 75



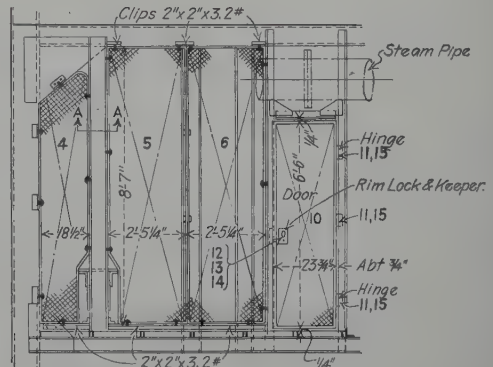
FR. 75 LOOKING FORWARD



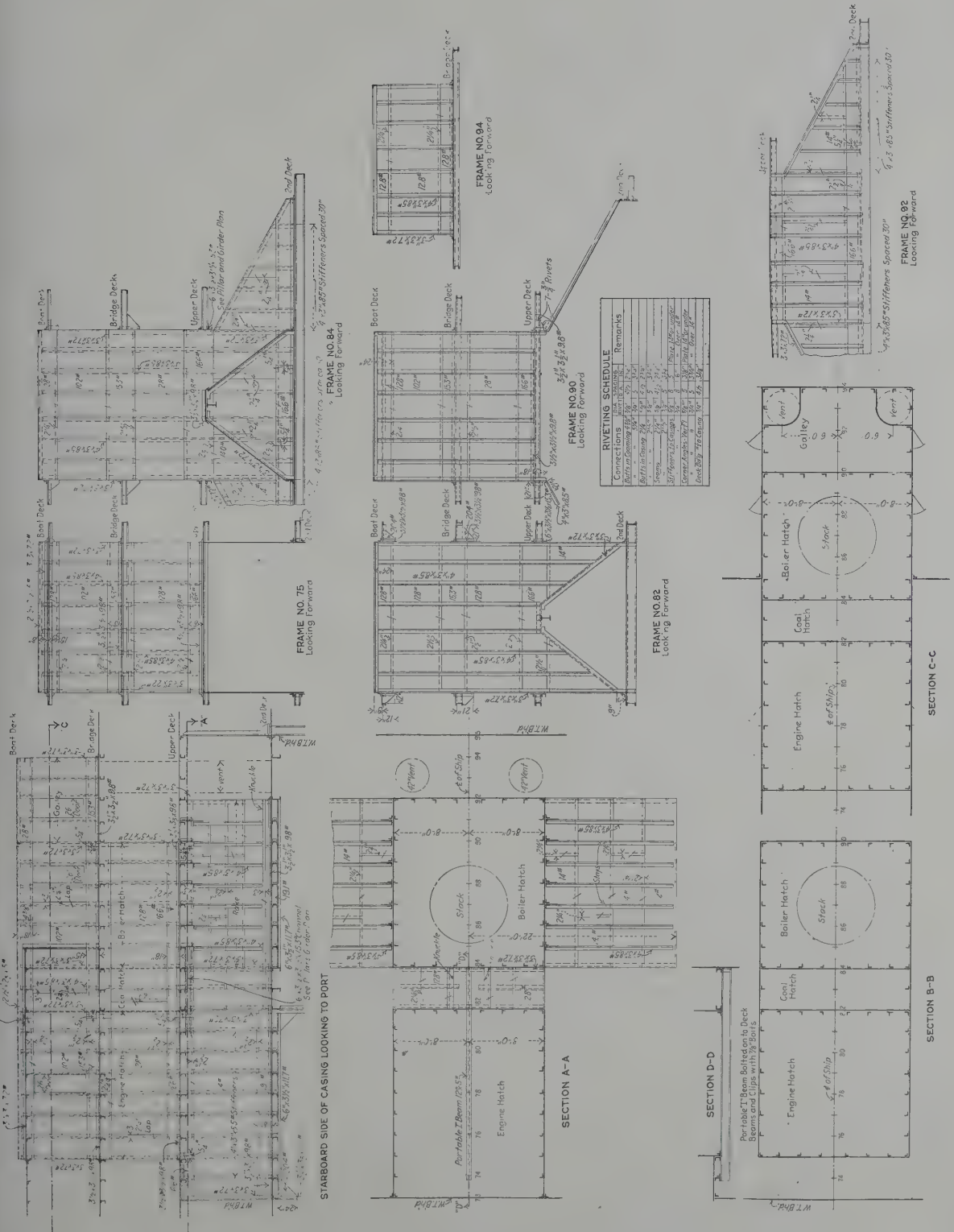
INBOARD BHD. LOOKING OUTBOARD.



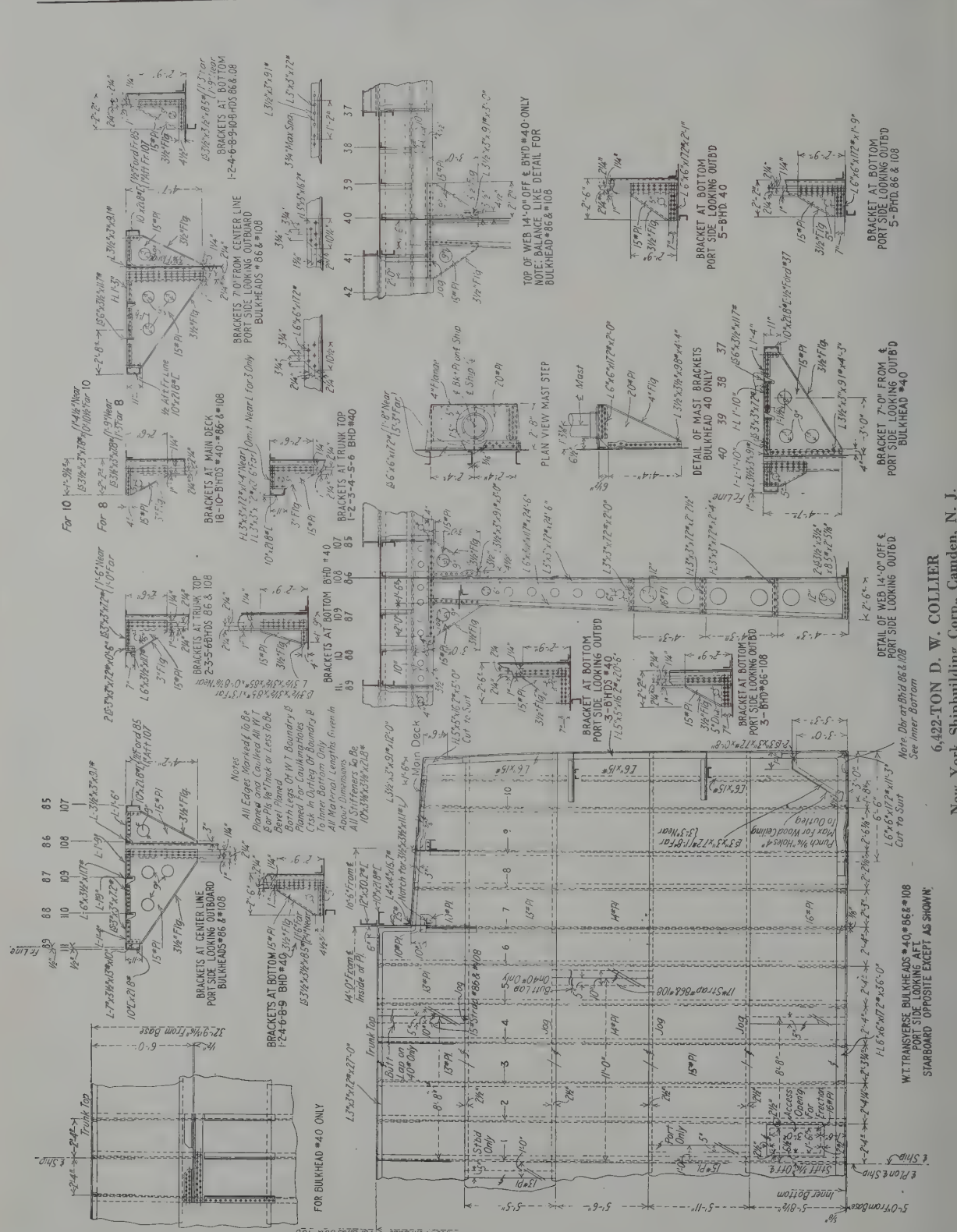
SECTION THRU B'H'D AT FR. 79

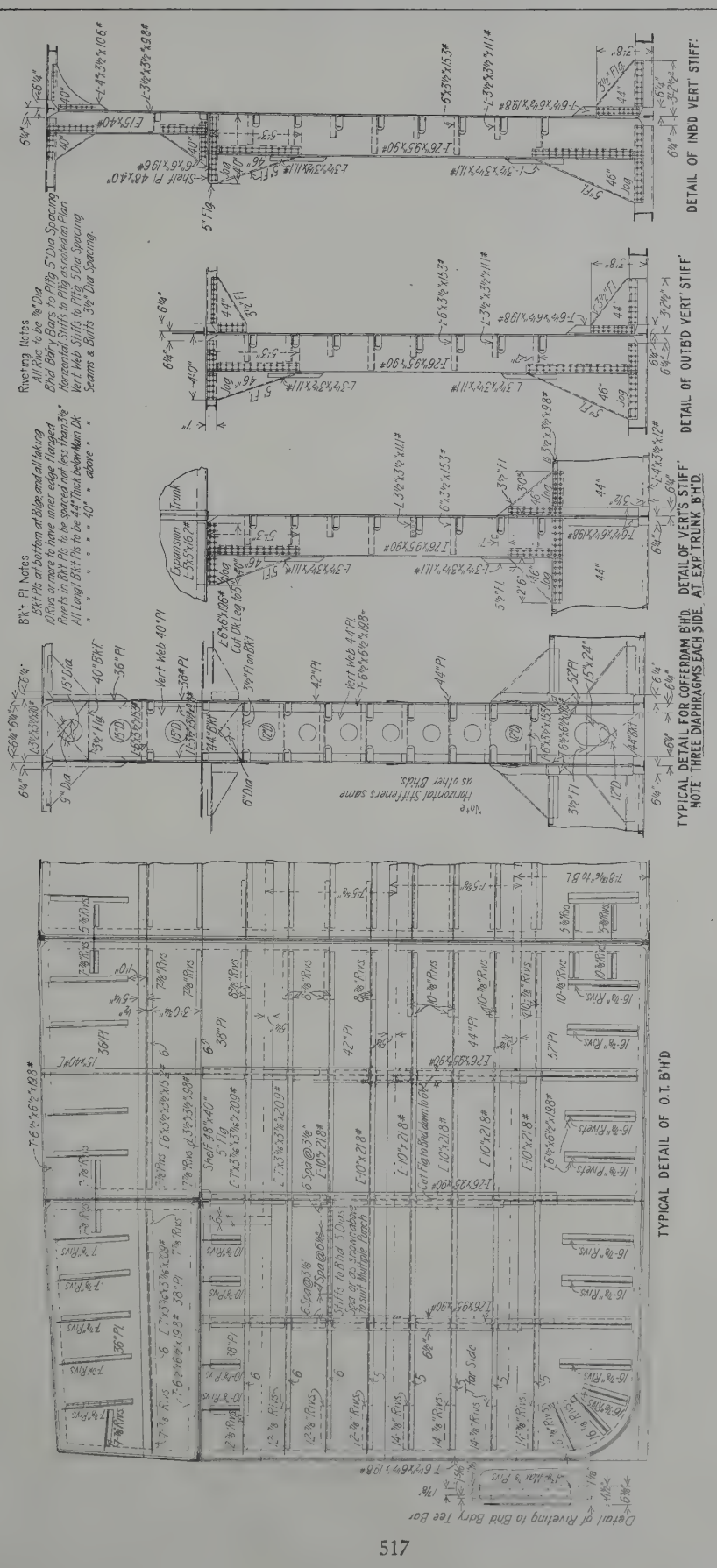


FR. 79 LOOKING FORD.

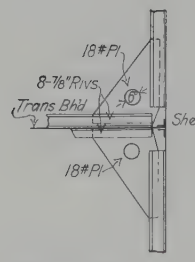


8,800-TON D. W. FREIGHTER

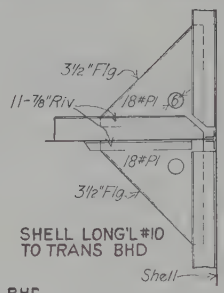

W.T. TRANSVERSE BULKHEADS #40, #86 & #108
PORT SIDE LOOKING AFT
STARBOARD OPPOSITE EXCEPT AS SHOWN
6,422-TON D. W. COLLIER
New York Shipbuilding Corp., Camden, N. J.
Main Deck
Inner Bottom
Trunk Top
BRACKETS AT BOTTOM #40 1-2-4-6-8-9
BRACKETS AT CENTER LINE PORT SIDE LOOKING OUTBOARD BULKHEADS #86 & #108
BRACKETS AT TRUNK TOP 2-3-5-6 BHDS 86 & 108
BRACKETS AT MAIN DECK 18-10-8 BHDS #40-#86 & #108
BRACKETS 70' FROM CENTER LINE PORT SIDE LOOKING OUTBOARD BULKHEADS #86 & #108
BRACKETS AT TRUNK TOP 1-2-3-4-5-6 BHD #40
BRACKETS AT BOTTOM BHD #40 107 85 108 86 109 87 110 88 111 89
BRACKET AT BOTTOM PORT SIDE LOOKING OUTBD 3-BHDS #40
BRACKET AT BOTTOM PORT SIDE LOOKING OUTBD 3-BHD #86-108
DETAIL OF WEB 14'-0" OFF & PORT SIDE LOOKING OUTBD
TOP OF WEB 14'-0" OFF & BHD #40 ONLY NOTE: BALANCE LIKE DETAIL FOR BULKHEAD #86 & #108
PLAN VIEW MAST STEP
DETAIL OF MAST BRACKETS BULKHEAD 40 ONLY
BRACKET AT BOTTOM PORT SIDE LOOKING OUTBD 5-BHD 40
BRACKET AT BOTTOM PORT SIDE LOOKING OUTBD 5-BHD. 86 & 108
BRACKET 7'-0" FROM & PORT SIDE LOOKING OUTBD BULKHEAD #40
FOR BULKHEAD #40 ONLY
Notes
All Edges Marked 10 Be Planed 2nd Caulked All W.T. Bdr Pls 18" Thick or Less to Be Bevel Planed
Both Legs Of W.T. Boundary & Planed For Caulkingnotes
Clsk In Gutter Of Boundary & To Inner Bottom Only
All Material Lengths Given In Above Dimensions
All Stiffeners To Be 10"x3 1/2"x 5/16" x 2'-0"
Punch 3/16" Holes Apart For Wood Ceiling (Outfit)
Note: Dbr at Bhd 86 & 108 See Inner Bottom
Cut To Suit


Riveting Notes
All Rivs to be ⅞" Dia
Bhd & Bdry Bars to Plate 5" Dia Spacing
Horizontal Stiffs to Plate as noted on Plan
Vert Web Stiffs to Plate 5 Dia Spacing
Seams & Butts 3½" Dia Spacing
B'k't Pl Notes
B'k't Pls at bottom at Bdry and at Hatches
10 Rivs or more to have inner edge flanged
Rivets in B'k't Pls to be spaced not less than 3½"
All Long'l B'k't Pls to be 44" Thick below Main Dk
" " " " " 40" above " "
Expansion Trunk
Cut Off Leg
Vert Web 40"Pl
Vert Web 44"Pl
Horizontal Stiffeners same as other Bhds
6" Dia
6'0 Dia
DETAIL OF INBD VERT STIFF
DETAIL OF OUTB'D VERT STIFF
TYPICAL DETAIL FOR COFFERDAM B'HD. DETAIL OF VERT'S STIFF
NOTE THREE DIAPHRAGMS EACH SIDE AT EXP TRUNK B'HD.
TYPICAL DETAIL OF O.T. B'H'D
Detail of Riveting to Bhd Bdry Tee Bar

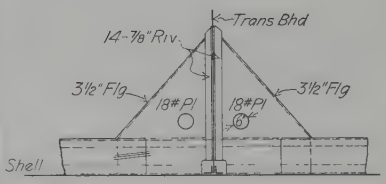
10,000-TON D. W. STANDARD TANKER
Sun Shipbuilding Co., Chester, Pa.



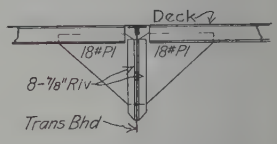
SHELL LONG'L #4 TO TRANS BHD



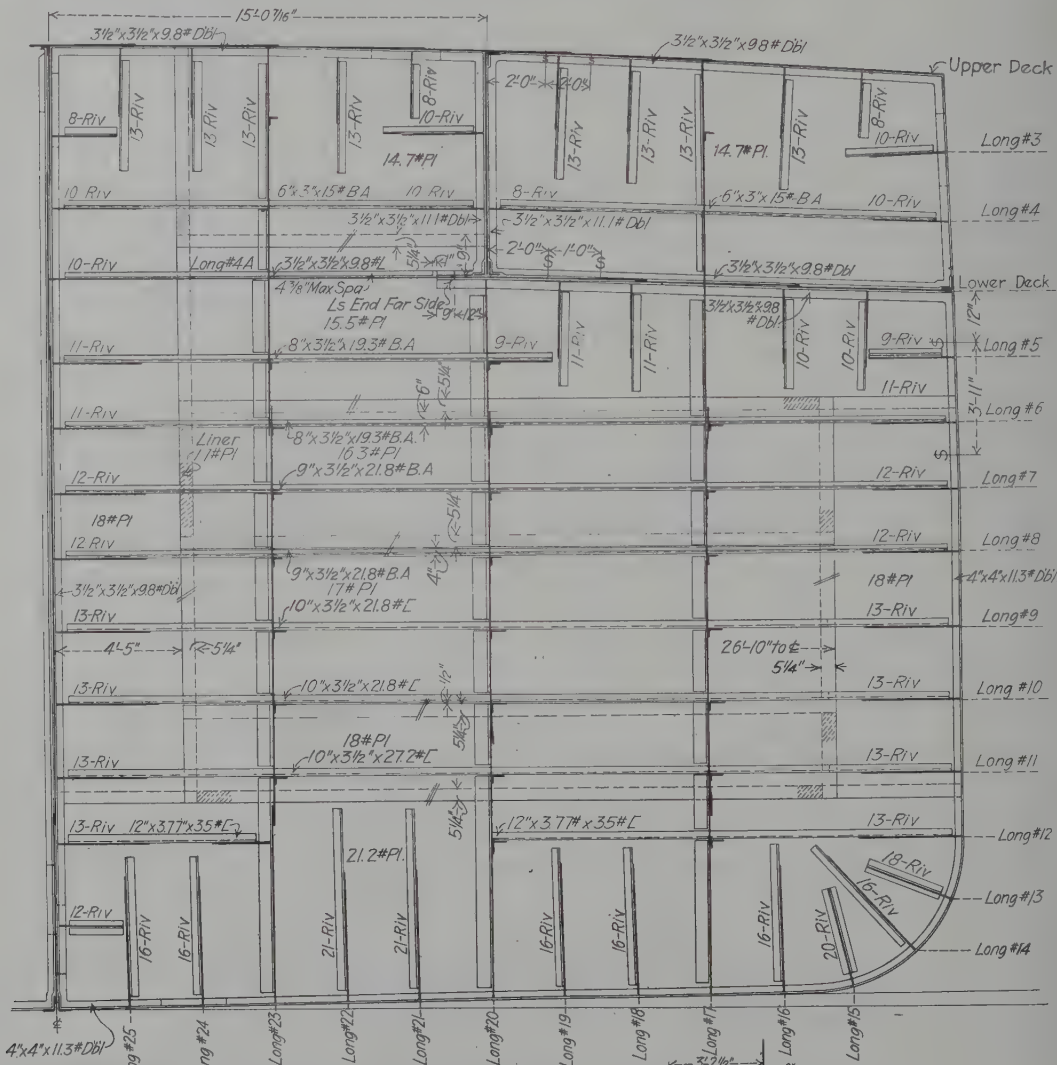
SHELL LONG'L #10 TO TRANS BHD

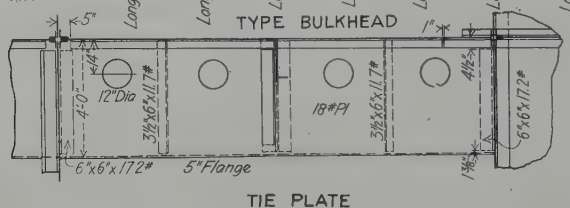


BOTTOM SHELL LONG'L TO TRANS BHD

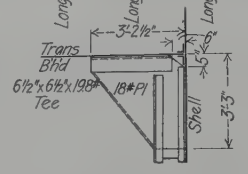


DECK LONG'L TO TRANS BHD





TIE PLATE

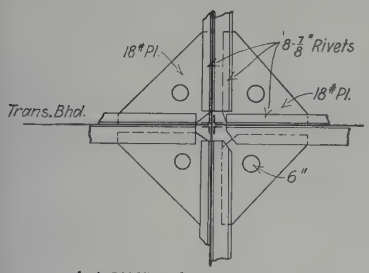


TRANS BHD TO SHELL LONG'LS #13 & 15.

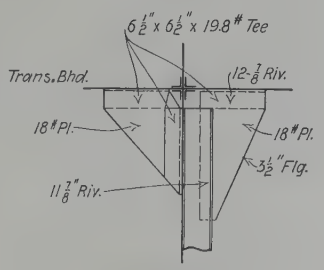
12,000-TON D. W. TANKER

Builders, Bethlehem Shipbuilding Corp.

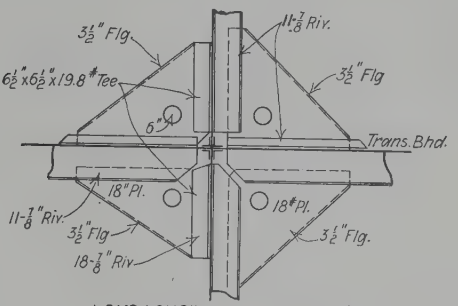
See Opposite Page



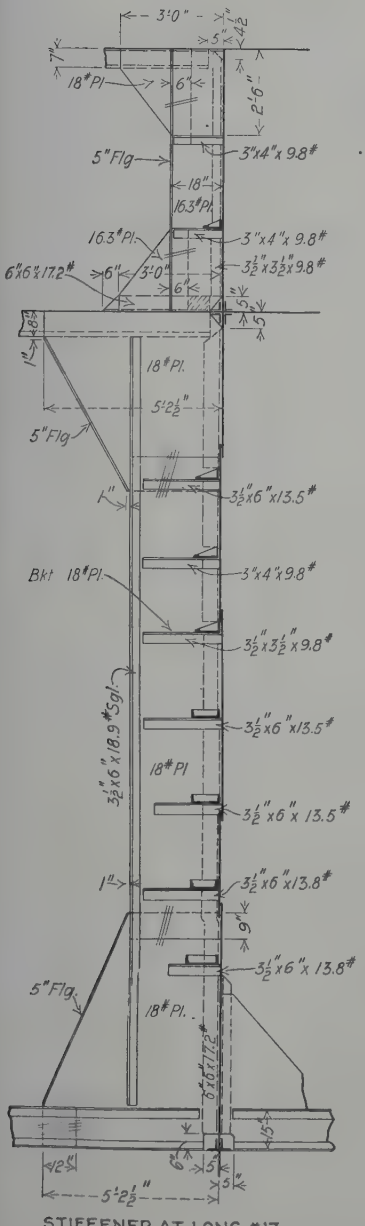
℄ LONG'L #4 TO TRAN. BHD.



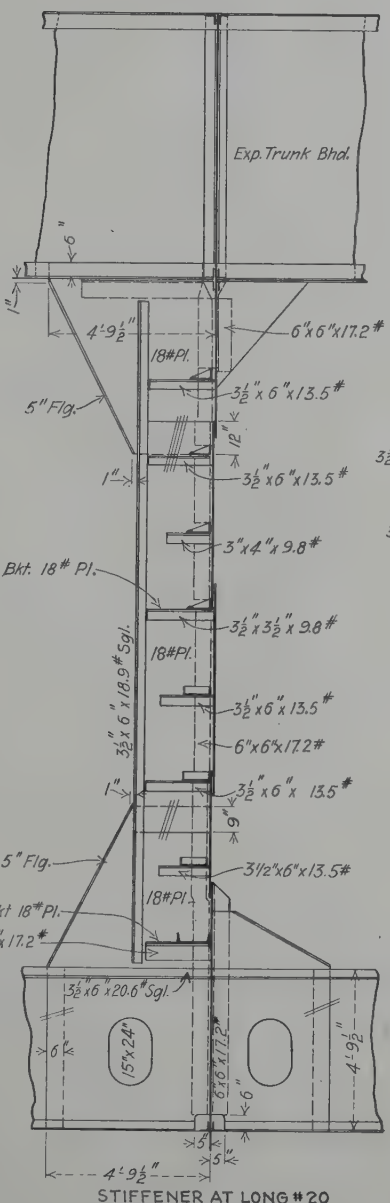
℄ LONG'L #13 TO TRANS BHD.



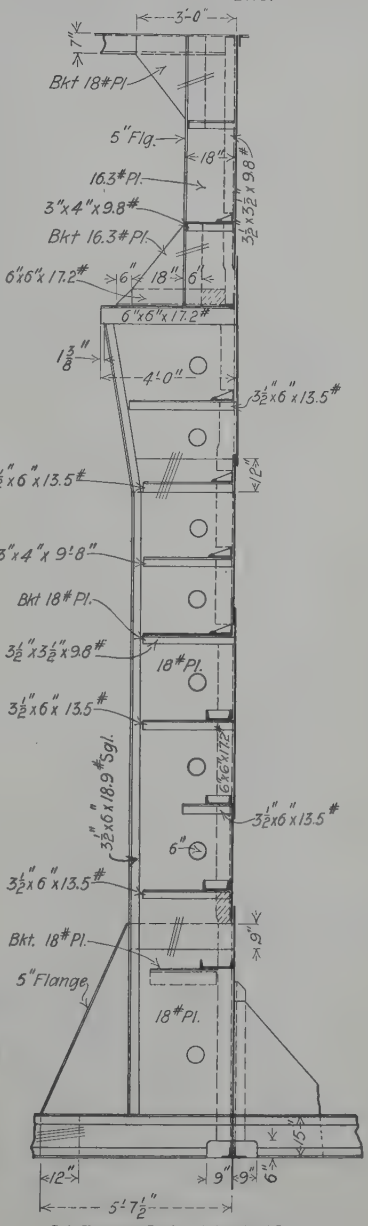
℄ BHD. LONG'L #12 TO TRANS. B'H'D.



STIFFENER AT LONG. #17



STIFFENER AT LONG #20

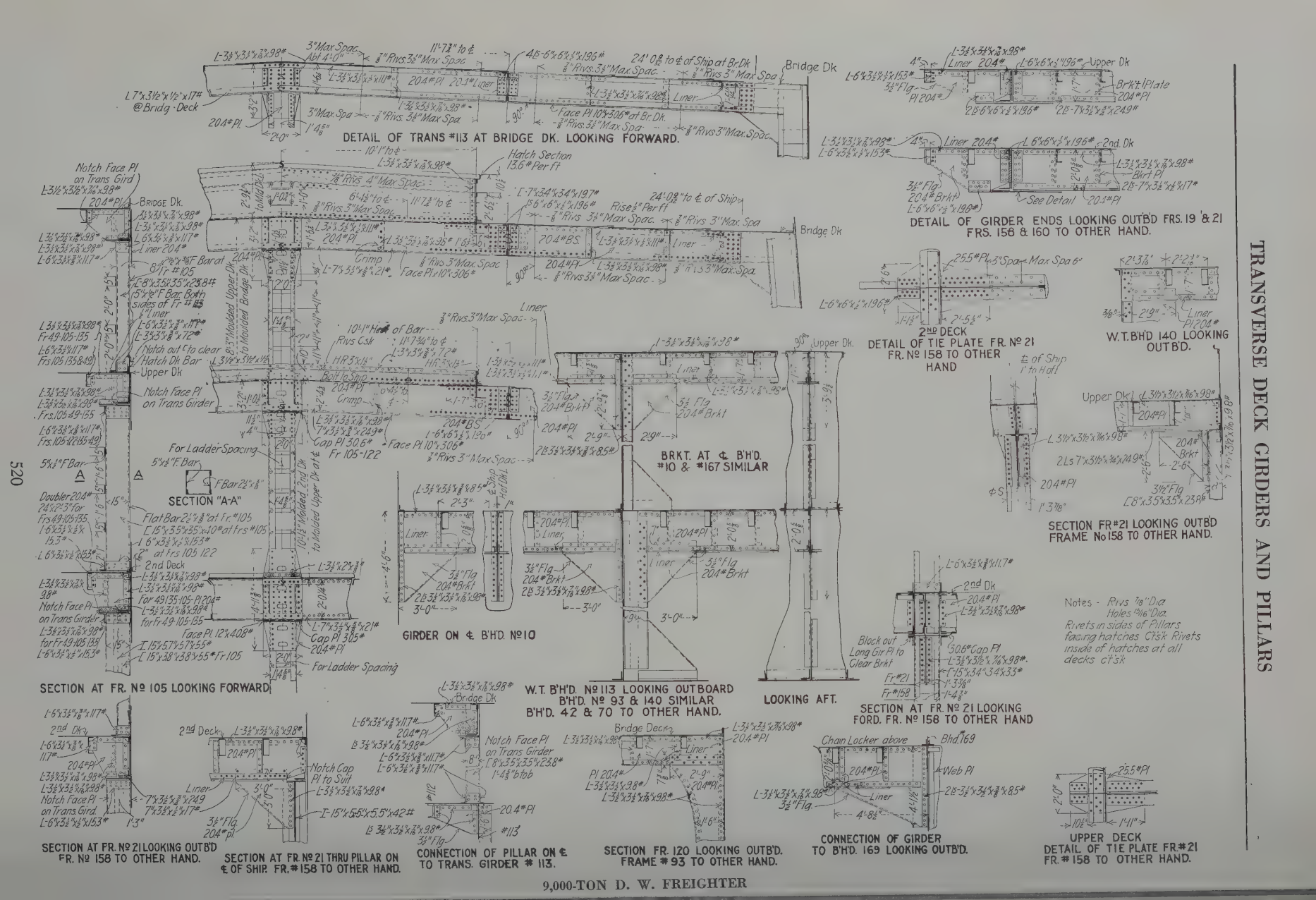


STIFFENER AT LONG. #23

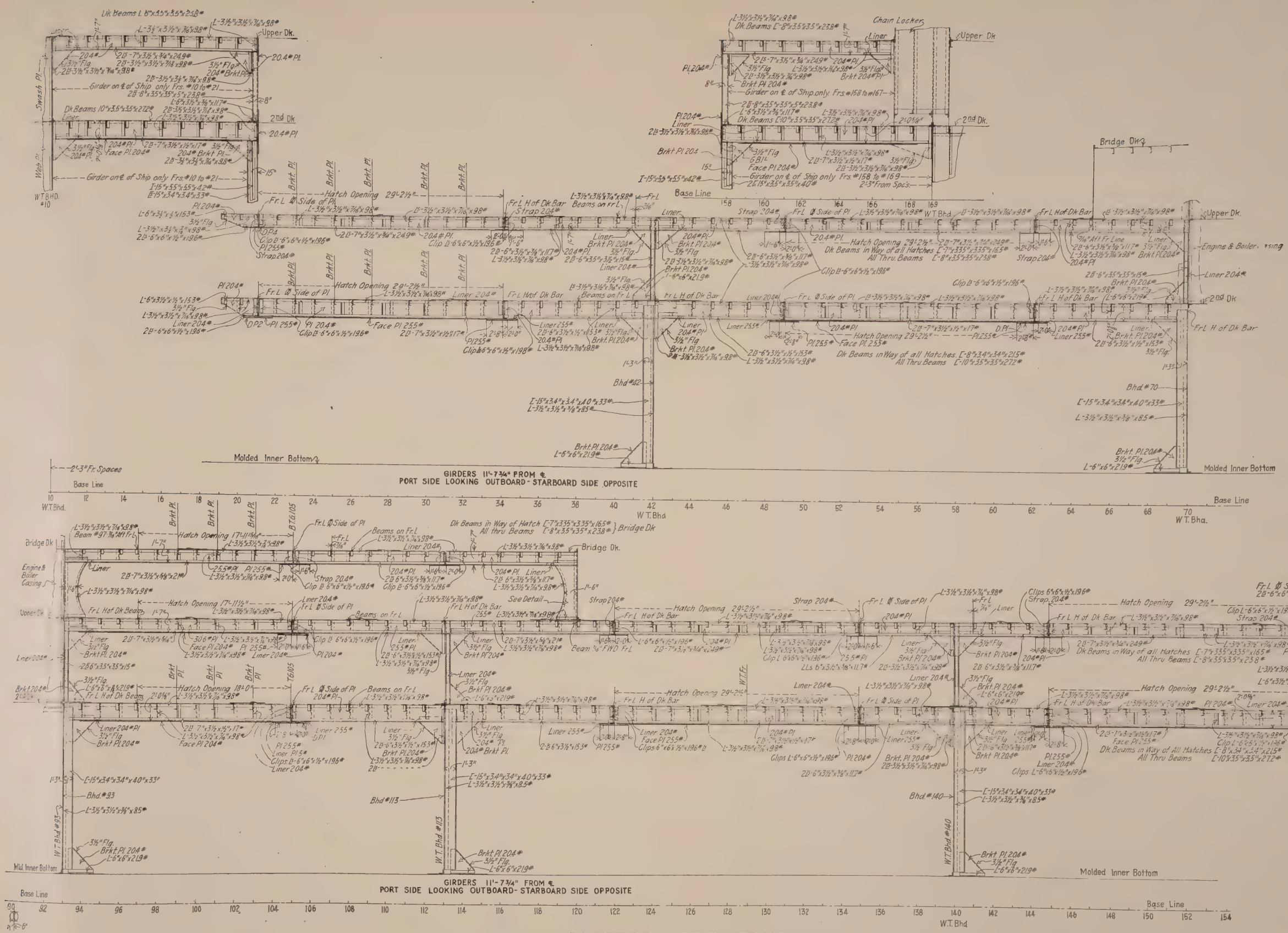
12,000-TON D. W. TANKER

Builders, Bethlehem Shipbuilding Corp.

See Opposite Page


DETAIL OF TRANS #113 AT BRIDGE DK. LOOKING FORWARD.
DETAIL OF GIRDER ENDS LOOKING OUTB'D FRS. 19 & 21 FRS. 158 & 160 TO OTHER HAND.
2ND DECK DETAIL OF TIE PLATE FR. Nº 21 FR. Nº 158 TO OTHER HAND
W.T. B'H'D 140 LOOKING OUTB'D.
SECTION FR #21 LOOKING OUTB'D FRAME No158 TO OTHER HAND.
SECTION "A-A"
BRKT. AT ℄ B'H'D. #10 & #167 SIMILAR
GIRDER ON ℄ B'H'D. Nº10
SECTION AT FR. Nº 105 LOOKING FORWARD.
W.T. B'H'D. Nº 113 LOOKING OUTBOARD B'H'D. Nº 93 & 140 SIMILAR B'H'D. 42 & 70 TO OTHER HAND.
LOOKING AFT.
SECTION AT FR. Nº 21 LOOKING FORD. FR. Nº 158 TO OTHER HAND
Notes - Rivs 7/8" Dia Holes 15/16" Dia. Rivets in sides of Pillars facing hatches Ct'sk Rivets inside of hatches at all decks ct'sk
SECTION AT FR. Nº 21 LOOKING OUTB'D FR. Nº 158 TO OTHER HAND.
SECTION AT FR. Nº 21 THRU PILLAR ON ℄ OF SHIP FR. # 158 TO OTHER HAND.
CONNECTION OF PILLAR ON ℄ TO TRANS. GIRDER # 113.
SECTION FR. 120 LOOKING OUTB'D. FRAME # 93 TO OTHER HAND.
CONNECTION OF GIRDER TO B'H'D. 169 LOOKING OUTB'D.
UPPER DECK DETAIL OF TIE PLATE FR.# 21 FR. # 158 TO OTHER HAND.

TRANSVERSE DECK GIRDERS AND PILLARS

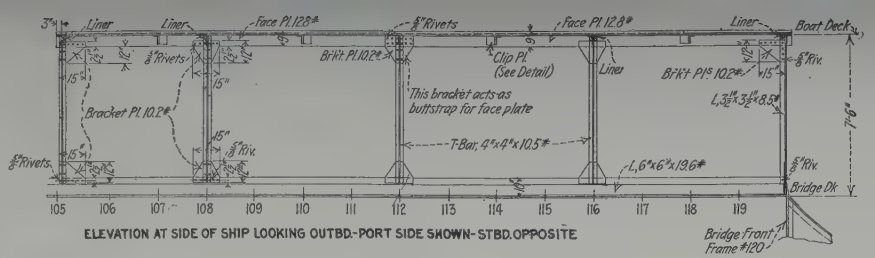


LONGITUDINAL DECK GIRDERS

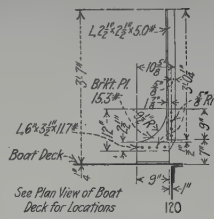
9,000-TON D. W. FREIGHTER

PLATE XXXVIII

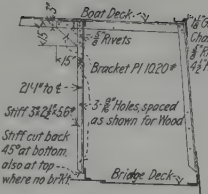
FOR'D BOAT DECK AND FOR'D MIDSHIP DECK HOUSE



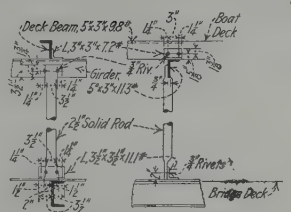
ELEVATION AT SIDE OF SHIP LOOKING OUTBD.-PORT SIDE SHOWN-STBD. OPPOSITE



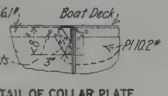
TYPICAL BOAT DECK BULWARK BRACKET 4-REQUIRED



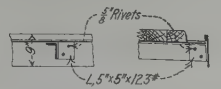
VIEW AT SIDE OF SHIP LOOKING AFT PORT SIDE SHOWN-STBD. OPPOSITE



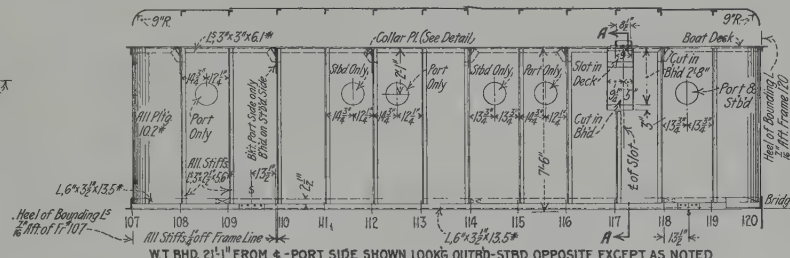
STANCHIONS UNDER BOAT DECK



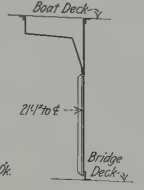
DETAIL OF COLLAR PLATE



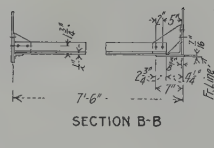
DETAIL OF CLIPS AT SIDE OF SHIP


9"R.
L 3"x3"x6.1#
Collar Pl. (See Detail)
Boat Deck
All Pltg 10.2#
Port Only
All Stiffs L 3"x2½"x5.6#
Stbd Only
Port Only
Slot in Deck
Cut in Bhd
Port & Stbd
L 6"x3½"x13.5#
Heel of Bounding L's 2" Aft of Fr. 107
All Stiffs 2" off Frame Line
Heel of Bounding L's 2" Aft of Fr. 120
Bridge Dk.
107 108 109 110 111 112 113 114 115 116 117 118 119 120

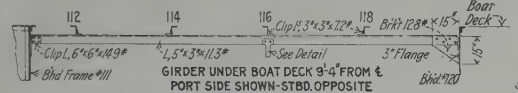
W.T. BHD. 21'-1" FROM ℄-PORT SIDE SHOWN LOOKG. OUTBD.-STBD. OPPOSITE EXCEPT AS NOTED



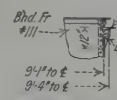
SECTION A-A



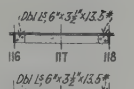
SECTION B-B



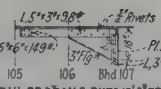
GIRDER UNDER BOAT DECK 9'-4" FROM ℄ PORT SIDE SHOWN-STBD. OPPOSITE



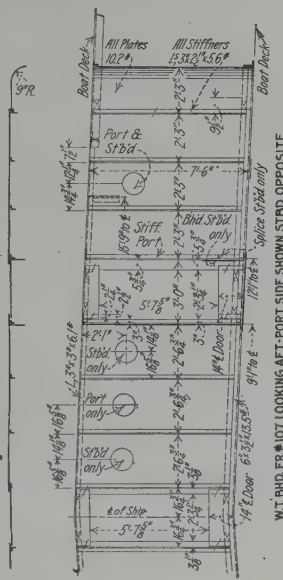
DETAIL OF BRACKET AT END OF GIRDER FR.#111-PORT SIDE SHOWN LOOKING AFT-STBD. OPPOSITE

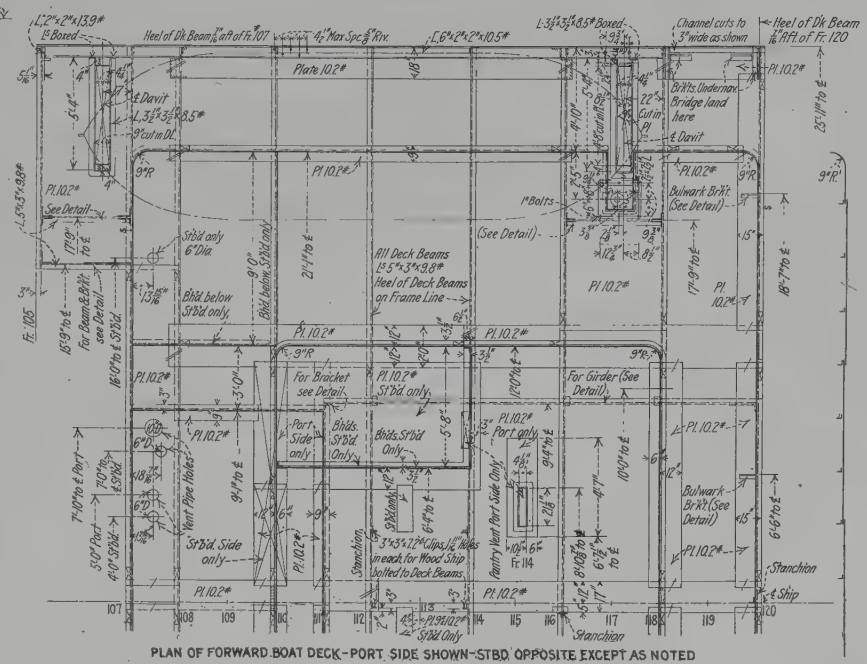


DETAIL OF HEADERS 11'-9" FROM ℄ PORT SIDE SHOWN LOOKING OUTBD. STBD. OPPOSITE

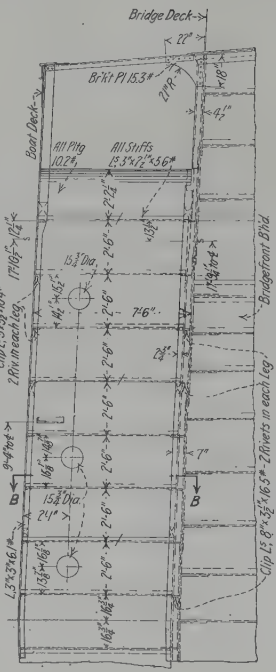


DETAIL OF BEAM & BKTS. 15'-9" FROM ℄ PORT SIDE SHOWN LOOKING OUTBD. STBD. OPP.

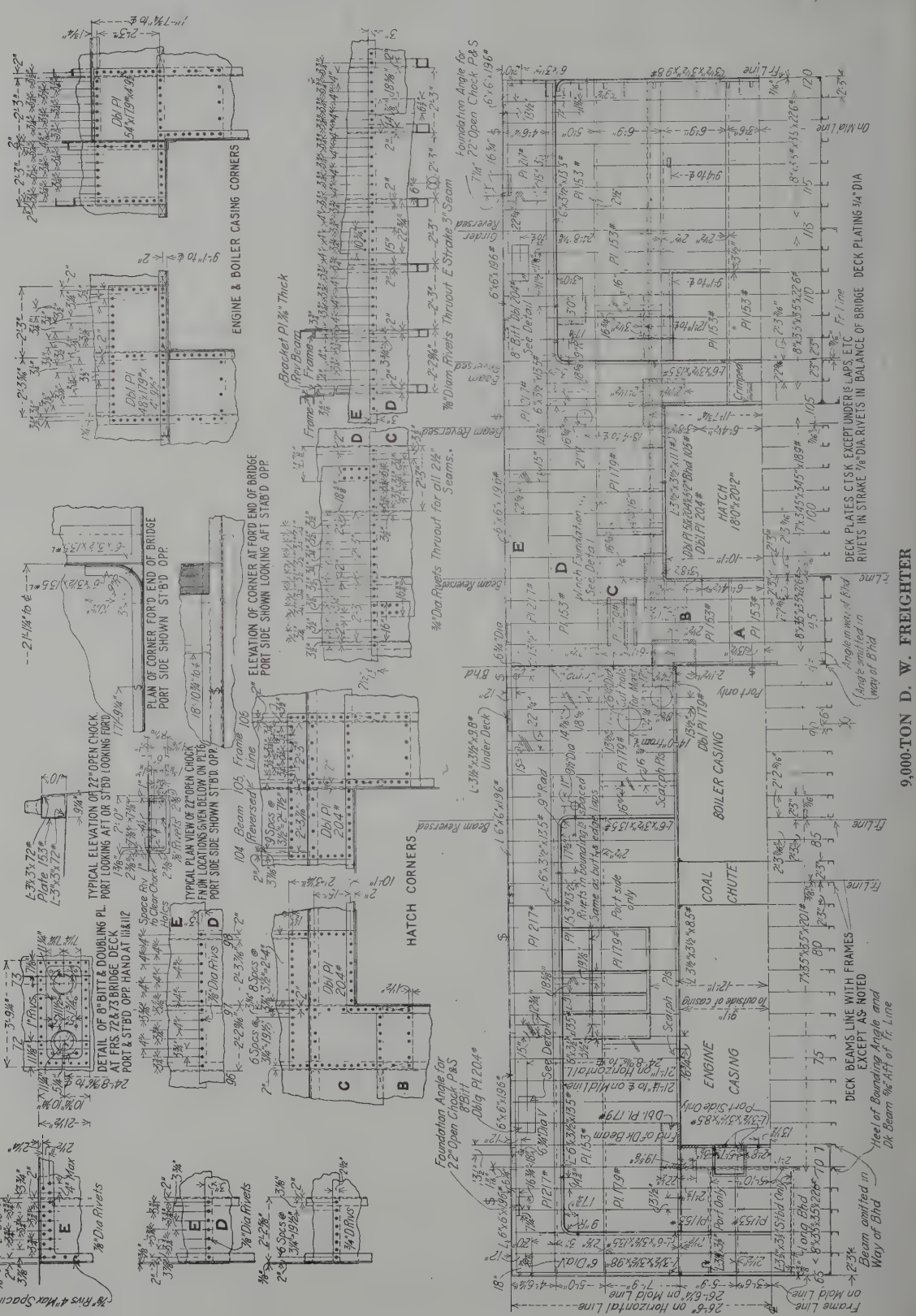


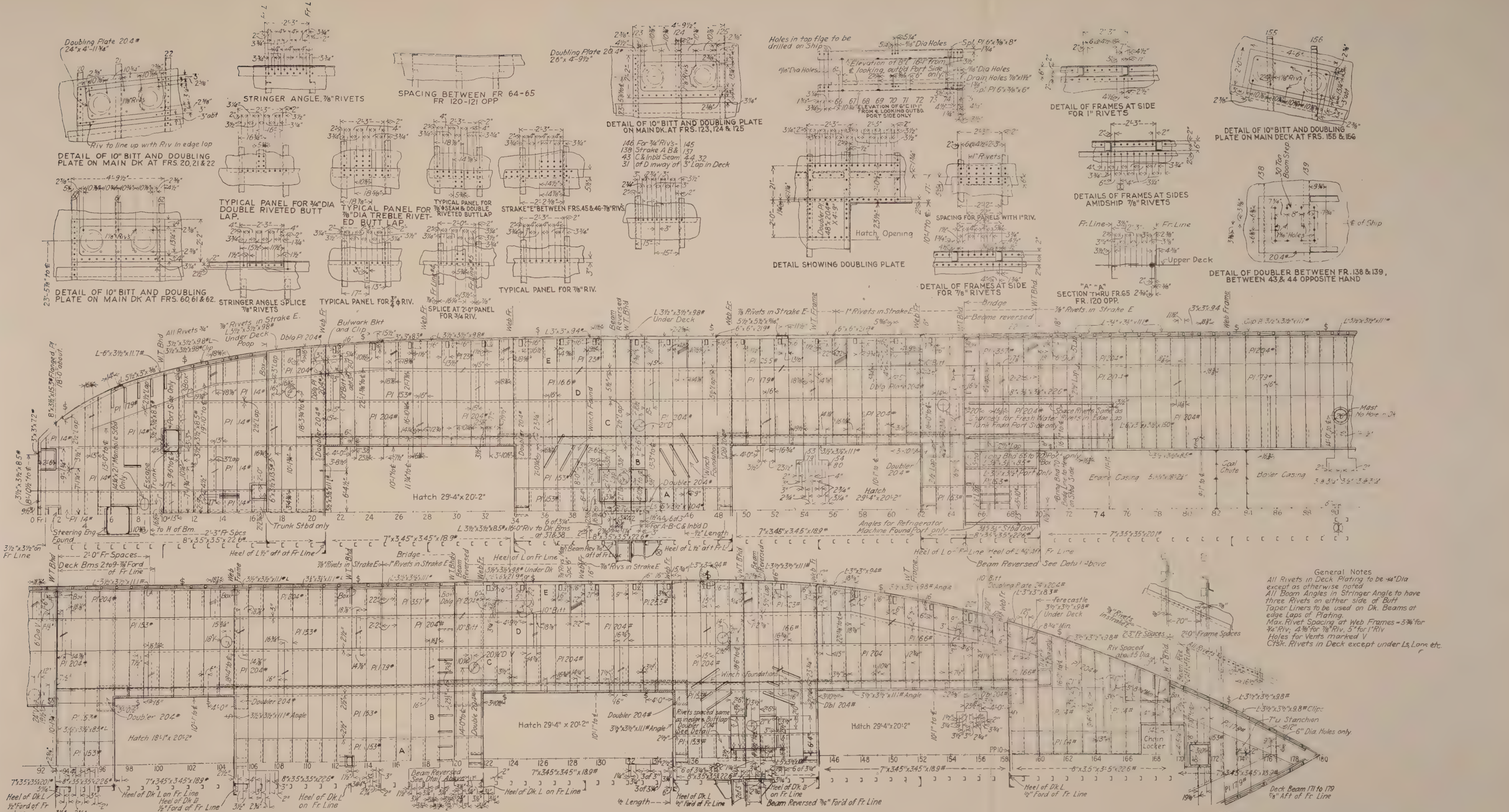

L 2"x2"x13.9# Boxed
Heel of Dk Beam 7" aft of Fr. 107
4½" Max. Spc. ⅝" Rivs.
L 6"x2"x10.5#
L 3½"x3½"x8.5# Boxed
Channel cuts to 3" wide as shown
Heel of Dk Beam 7" Aft of Fr. 120
Plate 10.2#
Brkts Underneath Bridge land here
℄ Davit
9" cut in Dk.
Pl 10.2#
Bulwark Brkt (See Detail)
All Deck Beams L 5"x3"x9.8# Heel of Deck Beams on Frame Line
Bhd. below Stbd only
Bhd. below Stbd only
For Bracket see Detail
For Girder (See Detail)
Port Side only
Bhds. Stbd Only
Vent Pipe Holes
Pantry Vent Port Side Only
Stanchion
Stbd only
Port only
Bulwark Brkt (See Detail)
Fr. 105
Fr. 114
Stanchion ℄ Ship

PLAN OF FORWARD BOAT DECK-PORT SIDE SHOWN-STBD. OPPOSITE EXCEPT AS NOTED


Bridge Deck
Brkt Pl 15.3#
Boat Deck
All Pltg 10.2#
All Stiffs L 3"x2½"x5.6#
15⅞ Dia.
Clip L 5"x3½"x10.4# 2 Riv. in each leg
Bridgefront Bhd.
Clip L 5"x3½"x16.4# 2 Rivets in each leg
W.T. BHD. FR.#120 LOOKING AFT-PORT SIDE SHOWN-STBD. OPPOSITE

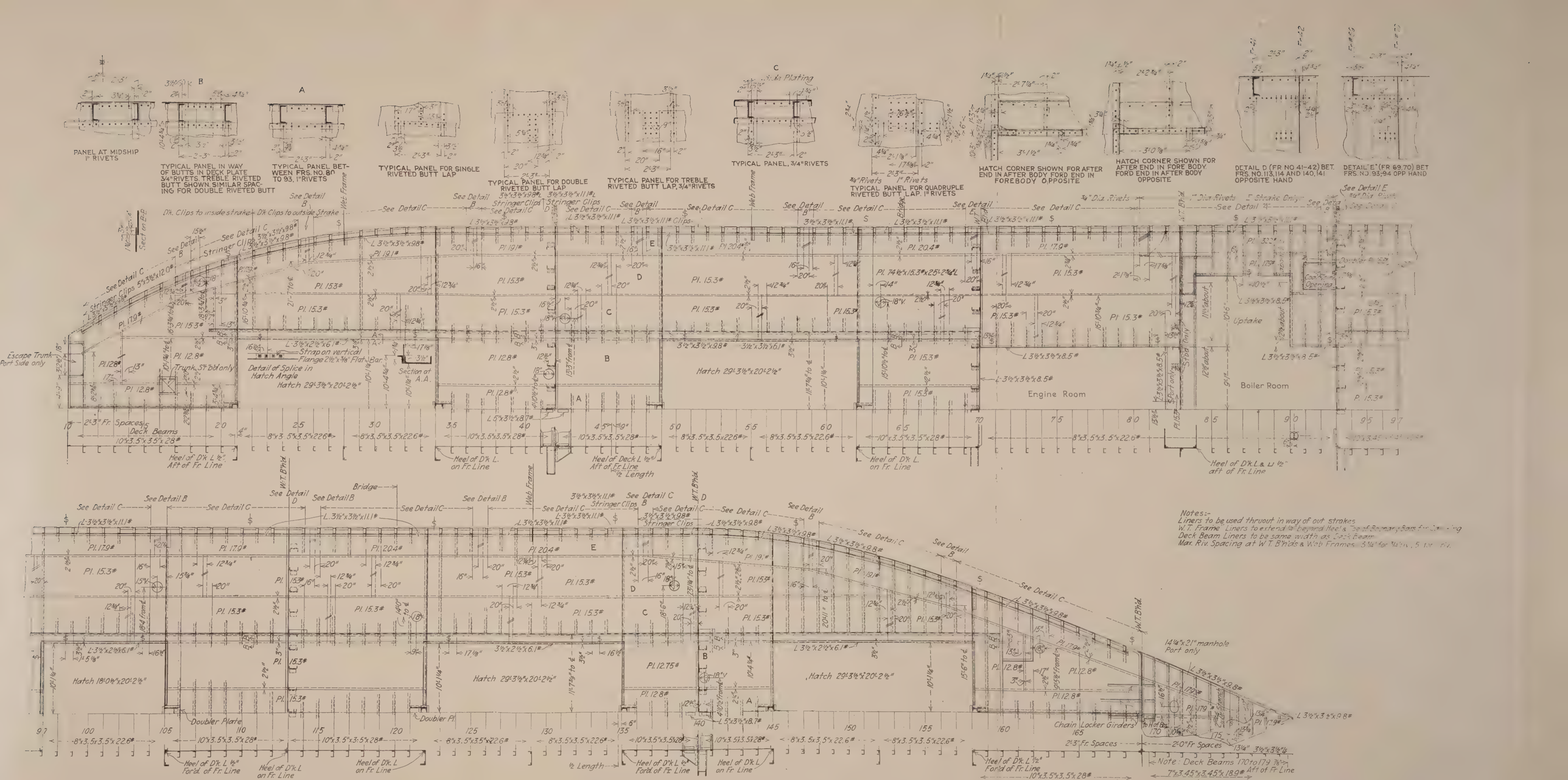
9,000-TON D. W. FREIGHTER


9,000-TON D. W. FREIGHTER
DECK BEAMS LINE WITH FRAMES EXCEPT AS NOTED
DECK PLATES CTSK EXCEPT UNDER LAPS, ETC
RIVETS IN STRAKE 7/8" DIA. RIVETS IN BALANCE OF BRIDGE DECK PLATING 3/4" DIA
ENGINE & BOILER CASING CORNERS
HATCH CORNERS
BOILER CASING
ENGINE CASING
COAL CHUTE
HATCH 180"×212"
Heel of Bounding Angle and Dk Beam ¾ A.F.T. of Fr. Line
Beam omitted in Way of Bhd
Frame Line on Mold Line
Foundation Angle for 22" Open Chock P&S
Bracket Pl ⅜" Thick
Beam Reversed
Frame 104
Frame 105
Frame 106
Under Deck
Port only
Port Side only
Same as but at edge laps
Angle omitted in way of Bhd
Scarph
Seg Detail
Block Foundation See Detail
Fr Line
On Mid Line
Deck Beam
Girder Reversed
Plan of Corner Ford End of Bridge Port Side Shown Stb'd Opp
Elevation of Corner at Ford End of Bridge Port Side Shown Looking Aft Stb'd Opp
Typical Elevation of 22" Open Chock Port Looking Aft or Stb'd Looking Ford
Typical Plan View of 22" Open Chock (For Locations Given Below on Pltg) Port Side Side Shown Stb'd Opp
Detail of 8" Bitt & Doubling Pl at Frs. 72 & 73 Bridge Deck Port & Stb'd Opp Hand at 11 & 12
¾" Dia Rivets 4" Max Spacing
¾" Dia Rivets
¾" Dia Rivets
¾" Dia Rivets


DETAIL OF 10" BITT AND DOUBLING PLATE ON MAIN DK AT FRS. 20, 21 & 22
DETAIL OF 10" BITT AND DOUBLING PLATE ON MAIN DK AT FRS. 60, 61 & 62.
STRINGER ANGLE, 7/8" RIVETS
STRINGER ANGLE SPLICE 7/8" RIVETS
SPACING BETWEEN FR 64-65 FR 120-121 OPP
TYPICAL PANEL FOR 3/4" DIA DOUBLE RIVETED BUTT LAP.
TYPICAL PANEL FOR 7/8" DIA TREBLE RIVETED BUTT LAP.
TYPICAL PANEL FOR 3/4 RIV.
TYPICAL PANEL FOR 7/8" SEAM & DOUBLE RIVETED BUTTLAP
SPLICE AT 2'-0" PANEL FOR 3/4 RIV.
STRAKE "E" BETWEEN FRS. 45 & 46-7/8" RIVS.
TYPICAL PANEL FOR 7/8 RIV.
DETAIL OF 10" BITT AND DOUBLING PLATE ON MAIN DK. AT FRS. 123, 124 & 125
DETAIL SHOWING DOUBLING PLATE
DETAIL OF FRAMES AT SIDE FOR 7/8" RIVETS
DETAIL OF FRAMES AT SIDE FOR 1" RIVETS
DETAILS OF FRAMES AT SIDES AMIDSHIP 7/8" RIVETS
"A" "A" SECTION THRU FR. 65 FR. 120 OPP.
DETAIL OF 10" BITT AND DOUBLING PLATE ON MAIN DECK AT FRS. 155 & 156
DETAIL OF DOUBLER BETWEEN FR. 138 & 139, BETWEEN 43 & 44 OPPOSITE HAND
Hatch 29'-4" x 20'-2"
Hatch 18'-1" x 20'-2"
Deck Beams 2 to 9-7/8" Ford of Fr Line
Steering Eng Found
Trunk Stbd only
Escape Trunk Port Side Only
Mast No Hole in 24
Boiler Casing
Engine Casing
Coal Chute
Chain Locker
Forecastle
Bridge
Bridge Reversed
Beam Reversed See Detail Above
Angles for Refrigerator Machine Found Port only
Space Rivets Same as Rivets for Fresh Water Tank Inboard Port Side only
Beam Reversed 7/8" Ford of Fr Line
Deck Beam 171 to 179 7/8" Aft of Fr Line
General Notes
All Rivets in Deck Plating to be 3/4" Dia except as otherwise noted
All Beam Angles in Stringer Angle to have three Rivets on either side of Butt
Taper Liners to be used on Dk. Beams at edge Laps of Plating.
Max. Rivet Spacing at Web Frames = 5 3/4" for 3/4" Riv; 4 3/8" for 7/8" Riv, 5" for 1" Riv
Holes for Vents marked V
Ctsk. Rivets in Deck except under Ls Lone etc.

UPPER DECK PLATING PLAN
9,000-TON D. W. FREIGHTER

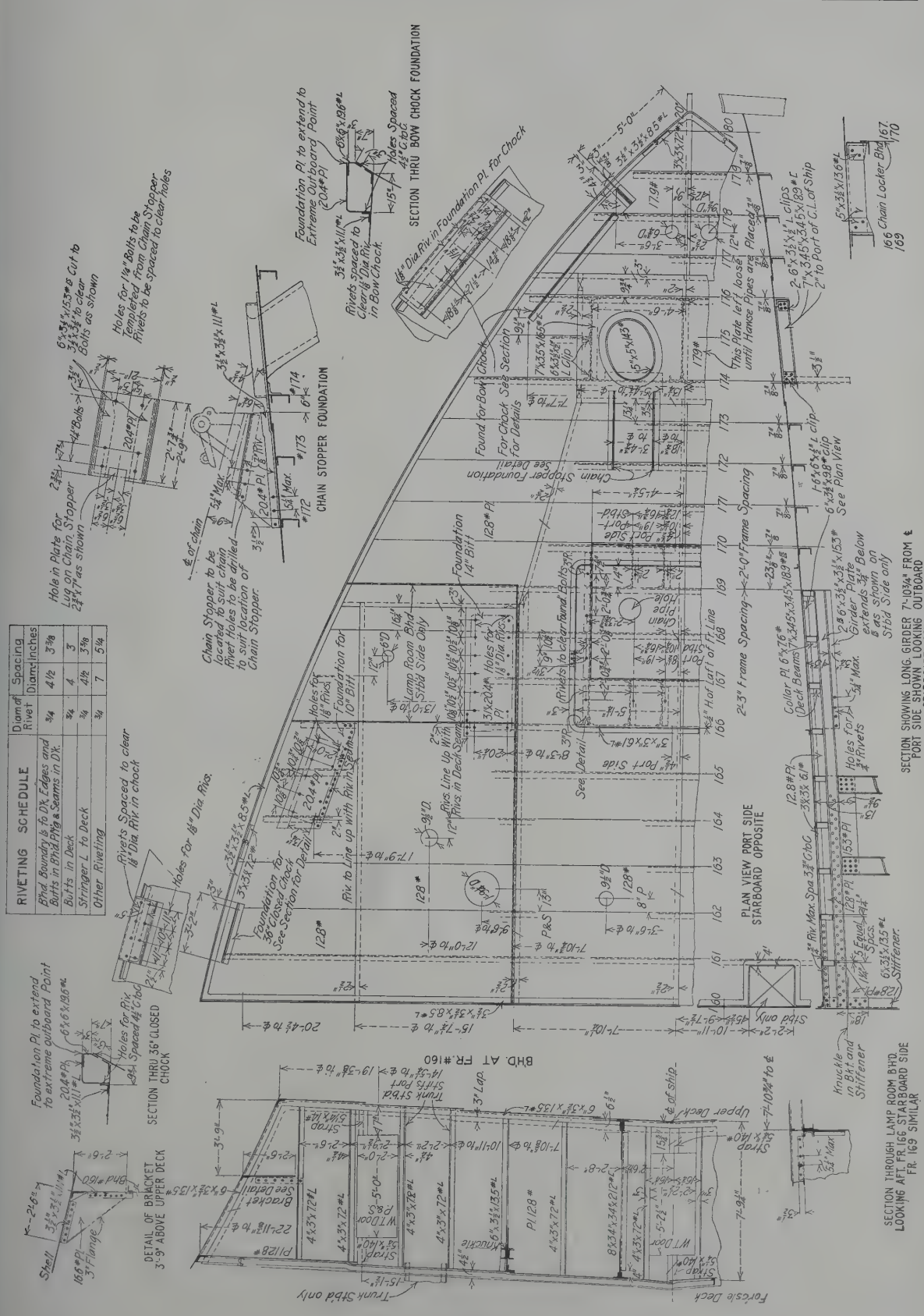
PLATE XXXIX

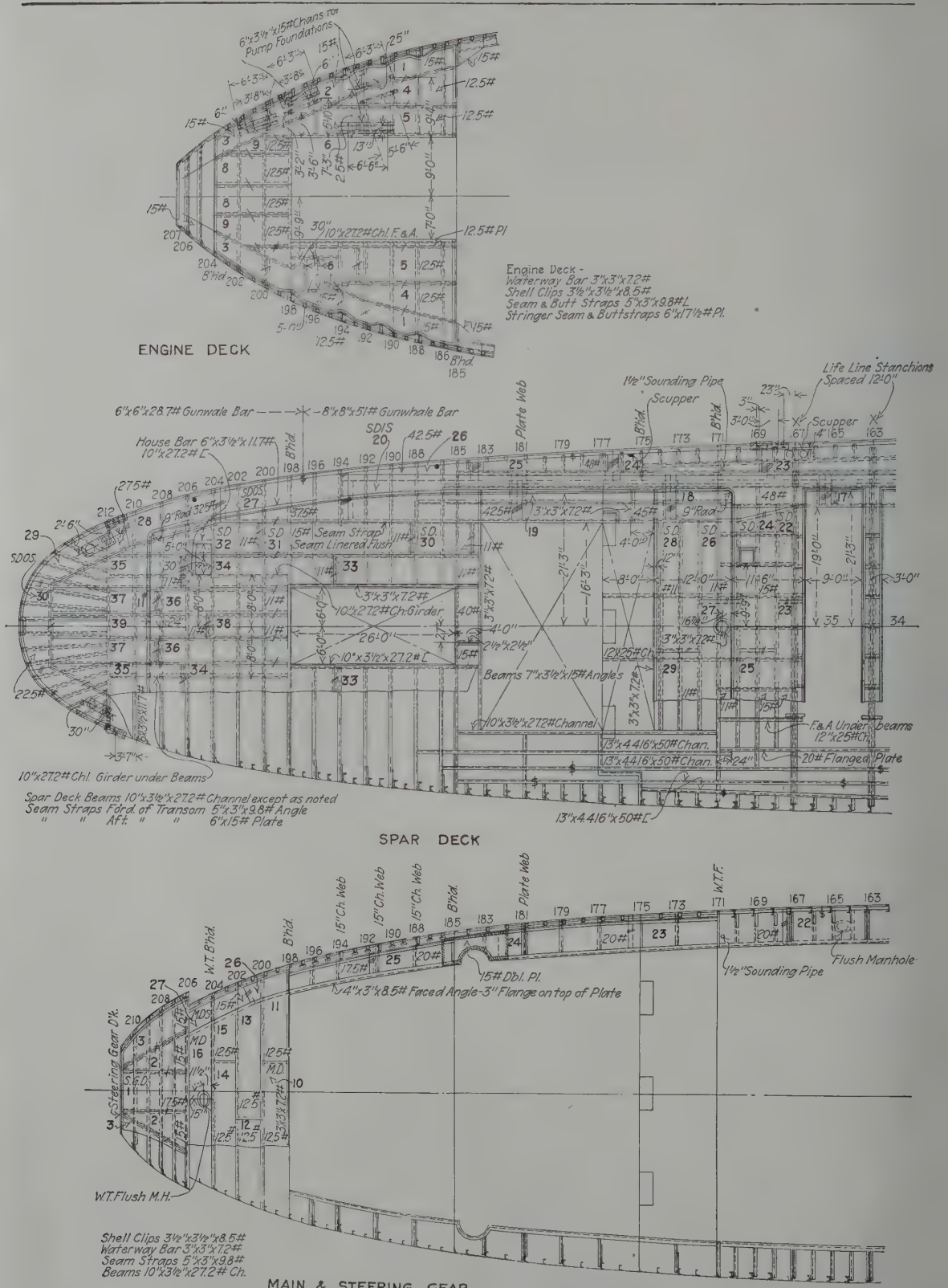

PANEL AT MIDSHIP 1" RIVETS
TYPICAL PANEL IN WAY OF BUTTS IN DECK PLATE 3/4" RIVETS, TREBLE RIVETED BUTT SHOWN, SIMILAR SPACING FOR DOUBLE RIVETED BUTT
TYPICAL PANEL BETWEEN FRS. NO. 80 TO 93, 1" RIVETS
TYPICAL PANEL FOR SINGLE RIVETED BUTT LAP
TYPICAL PANEL FOR DOUBLE RIVETED BUTT LAP
TYPICAL PANEL FOR TREBLE RIVETED BUTT LAP, 3/4" RIVETS
TYPICAL PANEL, 3/4" RIVETS
TYPICAL PANEL FOR QUADRUPLE RIVETED BUTT LAP, 1" RIVETS
HATCH CORNER SHOWN FOR AFTER END IN AFTER BODY FORD END IN FOREBODY OPPOSITE
HATCH CORNER SHOWN FOR AFTER END IN FORE BODY FORD END IN AFTER BODY OPPOSITE
DETAIL D (FR NO 41-42) BET. FRS. NO. 113, 114 AND 140, 141 OPPOSITE HAND
DETAIL "E" (FR 69.70) BET FRS. NO. 93, 94 OPP HAND
Escape Trunk Port Side only
Trunk, St'bd only
Detail of Splice in Hatch Angle
Hatch 29'-3 1/2" x 20'-2 1/2"
Engine Room
Boiler Room
Uptake
Coal Bunker Opening
Deck Beams
Heel of D'k L 1/2" Aft of Fr. Line
Heel of D'k L. on Fr. Line
Heel of Deck L 1/2" Aft of Fr. Line
1/2 Length
Heel of D'k L. & L 1/2" aft of Fr. Line
Hatch 18'-0 1/4" x 20'-2 1/2"
Doubler Plate
Heel of D'k L 1/2" Forld. of Fr. Line
Chain Locker Girders
14 1/4" x 21" manhole Port only
Note: Deck Beams 170 to 179 7/8" Aft of Fr. Line
Notes:-
Liners to be used thruout in way of out strakes
W.T. Frame Liners to extend 18" beyond Heel's Tee of Beam or Bar for Welding
Deck Beam Liners to be same width as Face of Beam
Max. Riv. Spacing at W.T. Bhds & Web Frames 5 1/4" for 3/4" Rivets, 5 1/4" for 1" Rivets

SECOND DECK PLATING PLAN
9,000-TON D. W. FREIGHTER

PLATE XL

FORECASTLE DECK PLATING PLAN

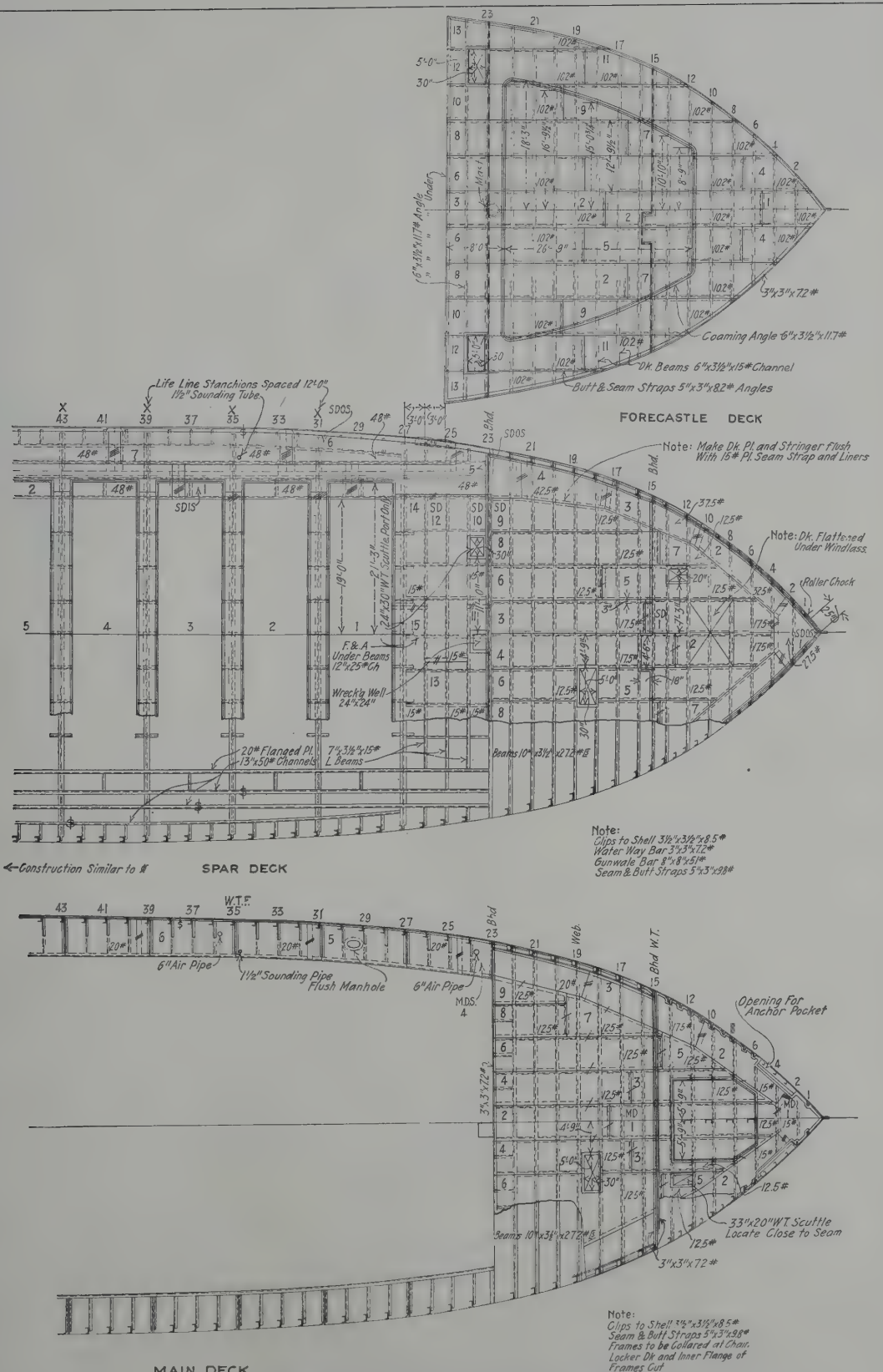

RIVETING SCHEDULE
Bhd. Boundry to Ox. Edges and Butts in Bhd. Plng. & Seams in Ox.
Butts in Deck
Stringer L to Deck
Other Riveting
Diam of Rivet
Spacing Diam-Inches
SECTION THRU BOW CHOCK FOUNDATION
CHAIN STOPPER FOUNDATION
SECTION THRU 36" CLOSED CHOCK
DETAIL OF BRACKET 3'-9" ABOVE UPPER DECK
PLAN VIEW PORT SIDE STARBOARD OPPOSITE
SECTION SHOWING LONG. GIRDER 7'-10¾" FROM ℄ PORT SIDE SHOWN LOOKING OUTBOARD STARBOARD OPPOSITE
SECTION THROUGH LAMP ROOM BHD. LOOKING AFT FR. 166 STARBOARD SIDE FR. 169 SIMILAR
9,000-TON D. W. FREIGHTER



12,300-NET TONS D. W. LAKE BULK FREIGHTER

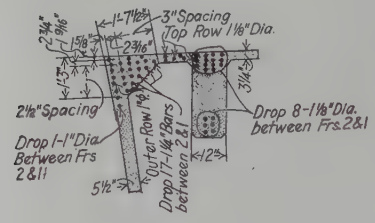
Great Lakes Engineering Works, Detroit, Mich.

See Opposite Page

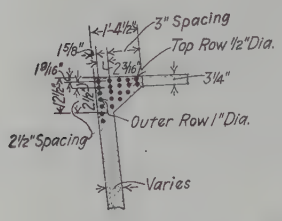


12,300-NET TONS D. W. LAKE BULK FREIGHTER
Great Lakes Engineering Works, Detroit, Mich.

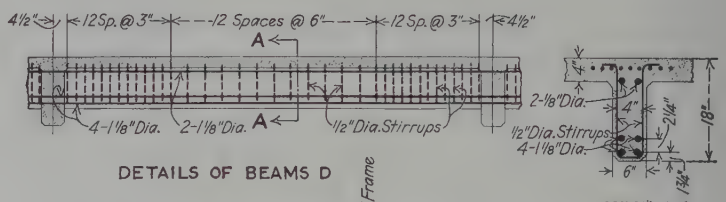
See Opposite Page


3" Spacing
Top Row 1⅛" Dia.
2½" Spacing
Drop 1-1" Dia. Between Frs 2&1
Outer Row 1" Dia.
Drop 17-1¼" Bars between 2&1
Drop 8-1⅛" Dia. between Frs 2&1

FRAME 2

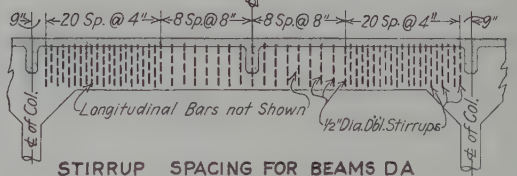


FRAME 1

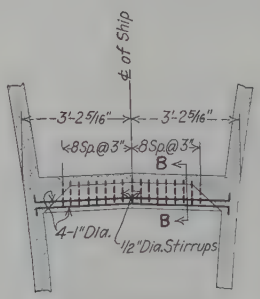


DETAILS OF BEAMS D

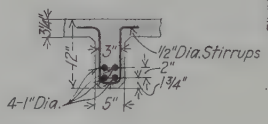
SECTION A-A



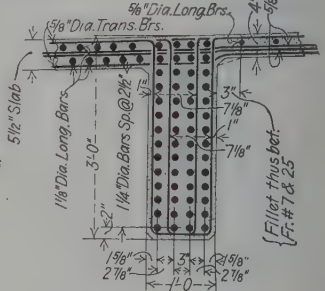
STIRRUP SPACING FOR BEAMS DA



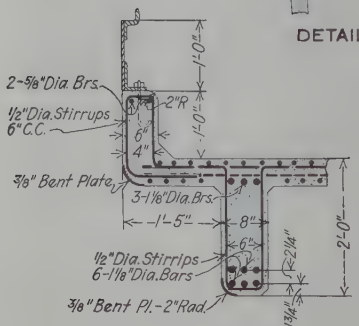
DETAIL OF BEAM DI



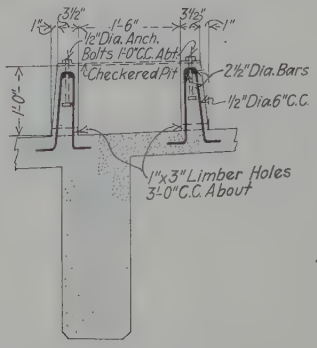
SECTION B-B



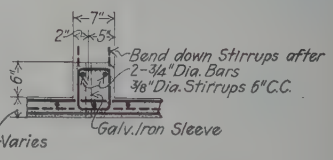
CROSS SECTION BEAMS DA AT MIDSHIP SECTION



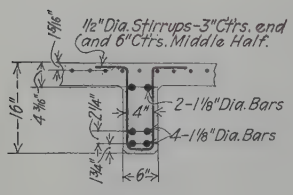
DETAIL OF HATCH COAMING



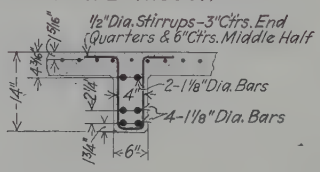
TYPICAL CROSS SECTION OF PIPE TROUGH



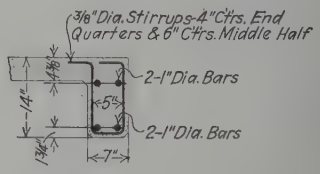
TYPICAL CROSS SECTION DECK HOUSE CURB



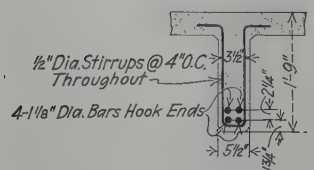
SECTION E E
(Through 6"x6" Beam)



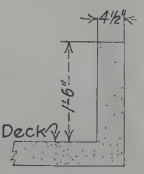
SECTION D D
(Through 6"x14" Beam)



SECTION C C
(Through 7"x14" Beam)



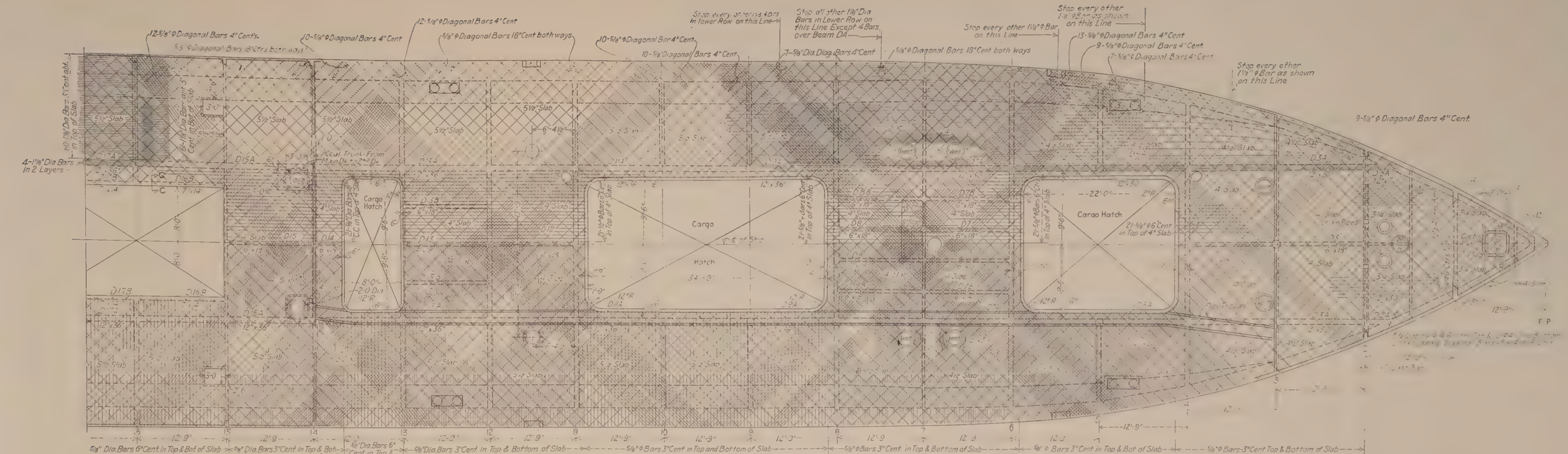
SECTION F F
(Through 5½"x21" Beam)



DETAIL OF HATCH COAMING SECTION G G

7,500-TON D. W. CONCRETE CARGO VESSEL

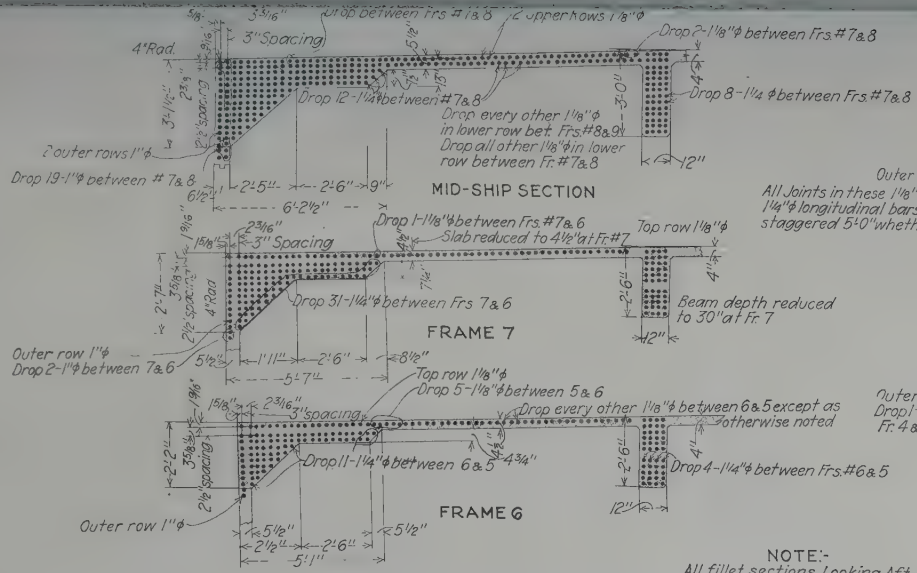
See Opposite Page


12-5/8"ϕ Diagonal Bars 4" Cent's.
10-5/8"ϕ Diagonal Bars 4" Cent
12-5/8"ϕ Diagonal Bars 4" Cent
5/8"ϕ Diagonal Bars 18" Cent both ways
10-5/8"ϕ Diagonal Bar 4" Cent
10-5/8" Diagonal Bars 4" Cent
Stop every other 1⅛" Dia Bars in lower Row on this Line
Stop all other 1⅛" Dia Bars in Lower Row on this Line Except 4 Bars over Beam DA
7-5/8" Dia Diag. Bars 4" Cent
5/8"ϕ Diagonal Bars 18" Cent both ways
Stop every other 1⅛"ϕ Bar on this Line
Stop every other 1⅛"ϕ Bars as shown on this Line
13-5/8"ϕ Diagonal Bars 4" Cent
9-5/8"ϕ Diagonal Bars 4" Cent
7-5/8"ϕ Diagonal Bars 4" Cent
Stop every other 1⅛"ϕ Bar as shown on this Line
3-5/8"ϕ Diagonal Bars 4" Cent.
40-1⅛" Dia Bars 11" Cent abt. in Top of Slab
4-1⅛" Dia Bars in 2 Layers
Cargo Hatch
Cargo Hatch
Cargo Hatch
21-5/8"ϕ Bars 6" Cent in Top of 4" Slab
5⅝" Dia Bars 6" Cent in Top & Bot of Slab
5/8" Dia Bars 3" Cent in Top & Bot of Slab
5/8" Dia Bars 6" Cent in Top & Bot of Slab
5/8" Dia Bars 3" Cent in Top & Bottom of Slab
5/8"ϕ Bars 3" Cent in Top and Bottom of Slab
5/8"ϕ Bars 3" Cent in Top & Bottom of Slab
5/8"ϕ Bars 3" Cent in Top & Bot of Slab
5/8"ϕ Bars-3" Cent Top & Bottom of Slab
UPPER DECK FORWARD
Stop 16-1⅛" Dia Bars here
Stop 10-1⅛" Dia Bars here
Stop 1-1⅛" Dia Bar here
Stop All of Bottom layer here of 1⅛" Dia Slab Bars
Stop 1-1⅛" Dia Bar here
11-5/8" Dia Diagonal Bars 4" Ctrs
12-5/8" Dia Diagonal Bars 4" Ctrs
Stop 2-1⅛" Dia Bars here
Stop 2-1⅛" Dia Bars here
11-5/8" Dia Diagonal Bars 4" Ctrs
11-5/8" Dia Diagonal Bars 4" Ctrs
8-5/8" Dia Diagonal Bars 4" Ctrs
8-1⅛" Dia Bars here
10-5/8" Dia Diagonal Bars 4" Ctrs
8-5/8" Dia Diagonal Bars 4" Ctrs
10-1⅛" Dia Diagonal Bars 4" Ctrs
12-5/8" Dia Diagonal Bars 4" Ctrs
Cargo Hatch
Cargo Hatch
5/8" Dia Bars 6" Ctrs
5/8" Dia Bars 3" CC
Slab thickened to 9" under all Bollards, 3' beyond Base Bollard
Deck House Curb
5/8" Dia. Bars 3" Ctrs Top & Bottom of Slab
5/8" Dia. Bars 3" Ctrs. Top & Bot. of Slab
5/8" Dia. Bars 3" Ctrs. Top & Bottom of Slab
5/8" Dia. Bars 6" Ctrs. Top & Bottom of Slab
5/8" Dia. Bars 3" Ctrs Top & Bottom of Slab
5/8" Dia. Bars 6" Ctrs. Top & Bottom of Slab
UPPER DECK AFT

UPPER DECK REINFORCEMENT PLAN
7,500-TON D. W. CONCRETE CARGO VESSEL

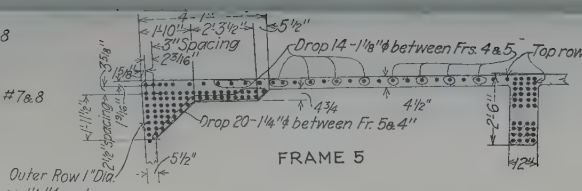
PLATE XLI

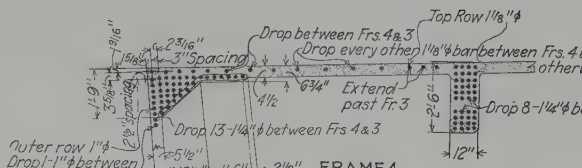
DETAILS OF UPPER DECK REINFORCEMENT

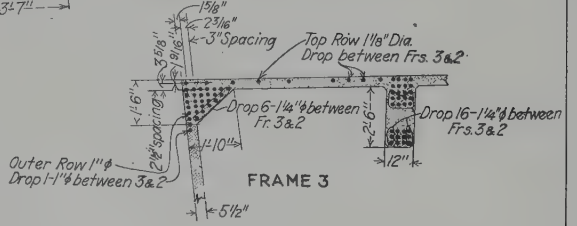

MID-SHIP SECTION
Drop between Frs #1 & 5 2 upper rows 1 1/8" ϕ
Drop 2-1 1/8" ϕ between Frs. #7 & 8
Drop 8-1 1/4 ϕ between Frs #7 & 8
Drop 12-1 1/4" between #7 & 8
Drop every other 1 1/8" ϕ in lower row bet. Frs. #8 & 9
Drop all other 1 1/8" ϕ in lower row between Fr. #7 & 8
Drop 19-1" ϕ between #7 & 8
Outer rows 1" ϕ
3" Spacing
4" Rad.
FRAME 7
Drop 1-1 1/8" ϕ between Frs. #7 & 6
Slab reduced to 4 1/2" at Fr. #7
Top row 1 1/8" ϕ
Beam depth reduced to 30" at Fr. 7
Drop 31-1 1/4" ϕ between Frs 7 & 6
Outer row 1" ϕ
Drop 2-1" ϕ between 7 & 6
FRAME 6
Top row 1 1/8" ϕ
Drop 5-1 1/8" ϕ between 5 & 6
Drop every other 1 1/8" ϕ between 6 & 5 except as otherwise noted
Drop 11-1 1/4" ϕ between 6 & 5
Drop 4-1 1/4" ϕ between Frs. #6 & 5
Outer row 1" ϕ

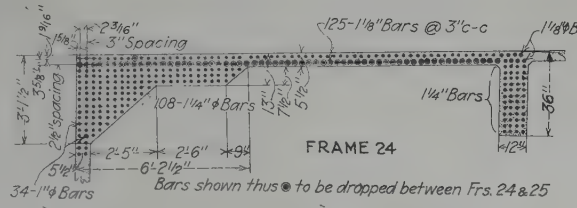
NOTE:-
All fillet sections Looking Aft.
all reinforcing bars 1 1/4" ϕ except as noted.

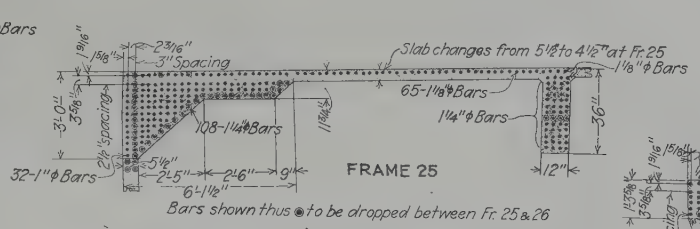
All Joints in these 1 1/8" ϕ and 1 1/4" ϕ longitudinal bars to be staggered 5'-0" whether butted or welded

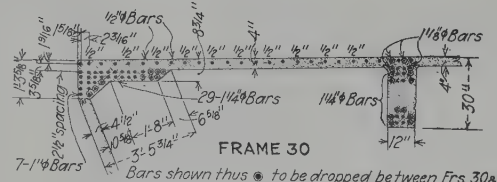


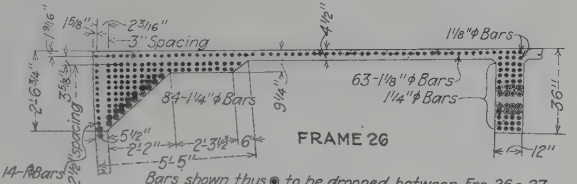

FRAME 4
Top Row 1 1/8" ϕ
Drop between Frs. 4 & 3
Drop every other 1 1/8" ϕ bar between Frs. 4 & 3 except as otherwise noted
Extend past Fr. 3
Drop 8-1 1/4" ϕ between 4 & 3
Drop 13-1 1/4" ϕ between Frs 4 & 3
Outer row 1" ϕ Drop 1-1" ϕ between Fr. 4 & 3

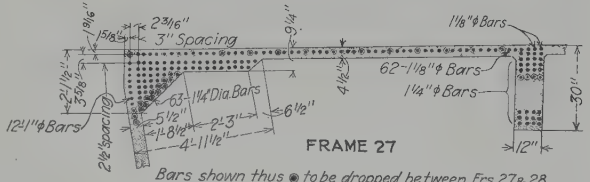

FRAME 3
Top Row 1 1/8" Dia.
Drop between Frs. 3 & 2
Drop 6-1 1/4" ϕ between Fr. 3 & 2
Drop 16-1 1/4" ϕ between Frs. 3 & 2
Outer Row 1" ϕ
Drop 1-1" ϕ between 3 & 2

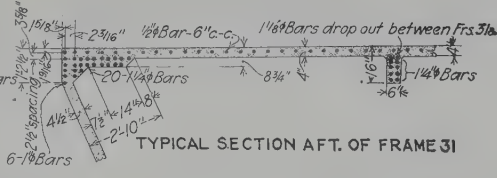


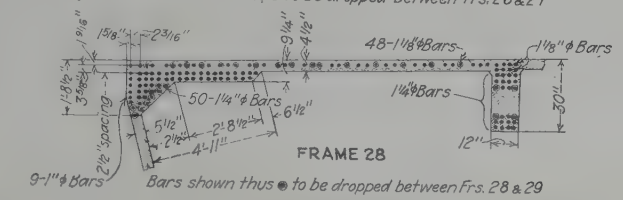

FRAME 25
Slab changes from 5 1/2" to 4 1/2" at Fr. 25
1 1/8" ϕ Bars
65-1 1/8" ϕ Bars
1 1/4" ϕ Bars
108-1 1/4" ϕ Bars
32-1" ϕ Bars
Bars shown thus ● to be dropped between Fr. 25 & 26

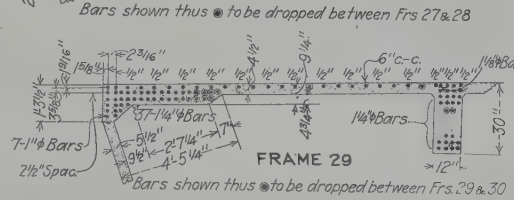






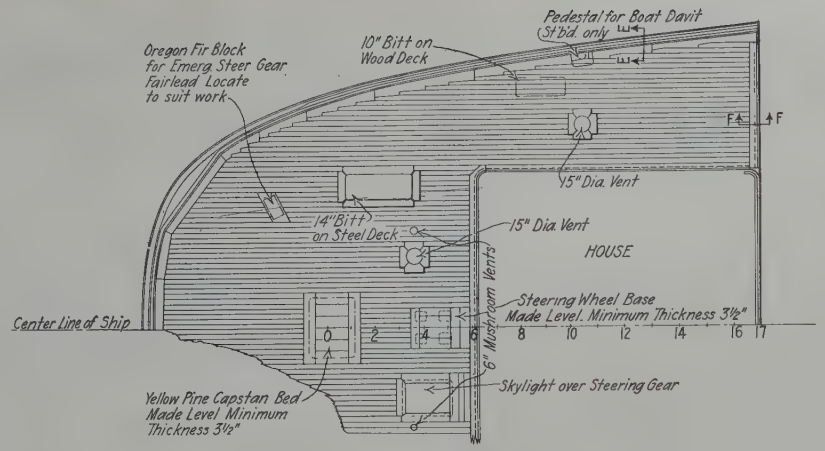


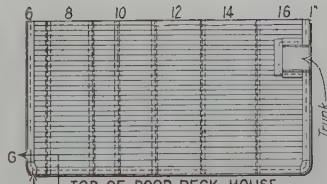


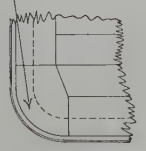


7,500-TON D. W. CONCRETE CARGO VESSEL

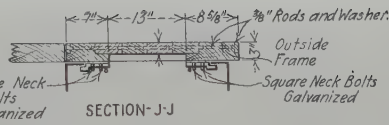
See Opposite Page

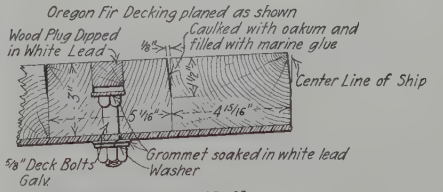

Pedestal for Boat Davit (St'bd only)
10" Bitt on Wood Deck
Oregon Fir Block for Emerg Steer Gear Fairlead Locate to suit work
15" Dia. Vent
14" Bitt on Steel Deck
15" Dia Vent
HOUSE
6" Mushroom Vents
Steering Wheel Base Made Level. Minimum Thickness 3½"
Center Line of Ship
Skylight over Steering Gear
Yellow Pine Capstan Bed Made Level Minimum Thickness 3½"
POOP DECK
3"x 5 1/16" (FINISHED) OREGON FIR

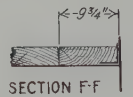

TOP OF POOP DECK HOUSE
3"x 5 1/16" (FINISHED) OREGON FIR
Trunk


DETAIL OF CORNER

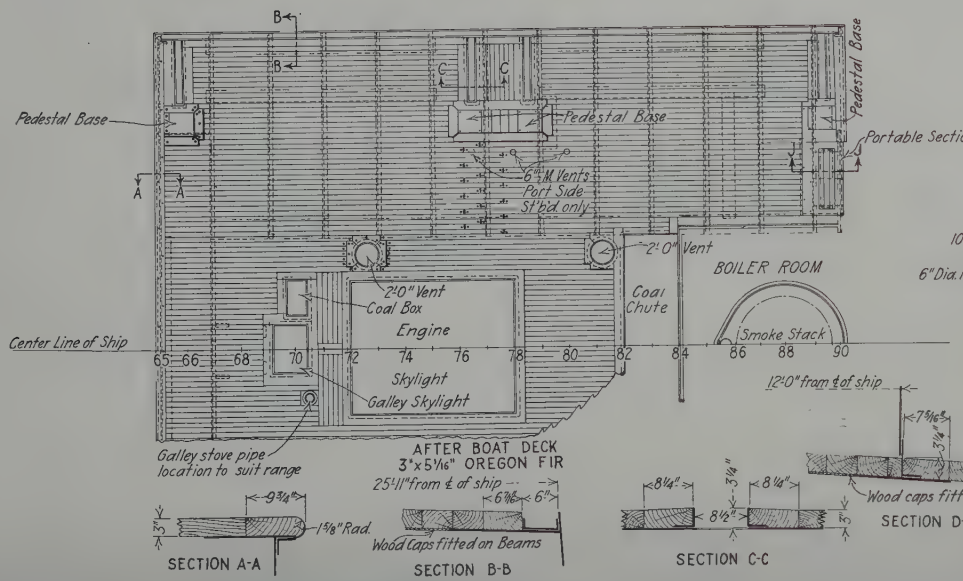
SECTION G-G

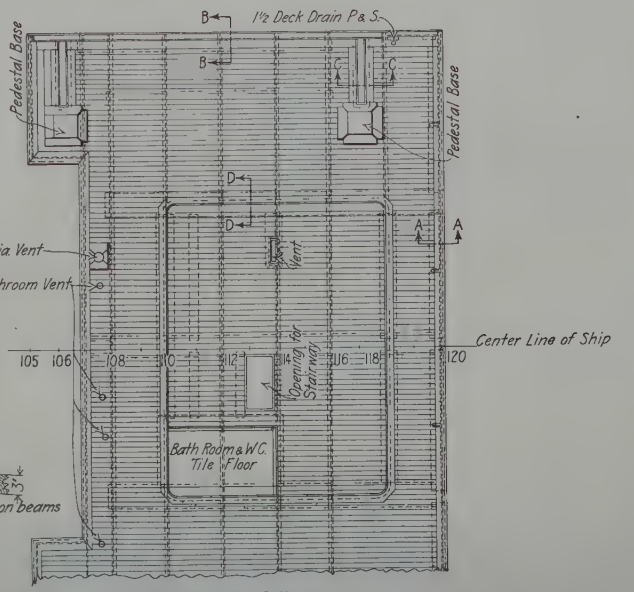

⅜" Rods and Washer
Outside Frame
Square Neck Bolts Galvanized
Square Neck Bolts Galvanized
SECTION J-J

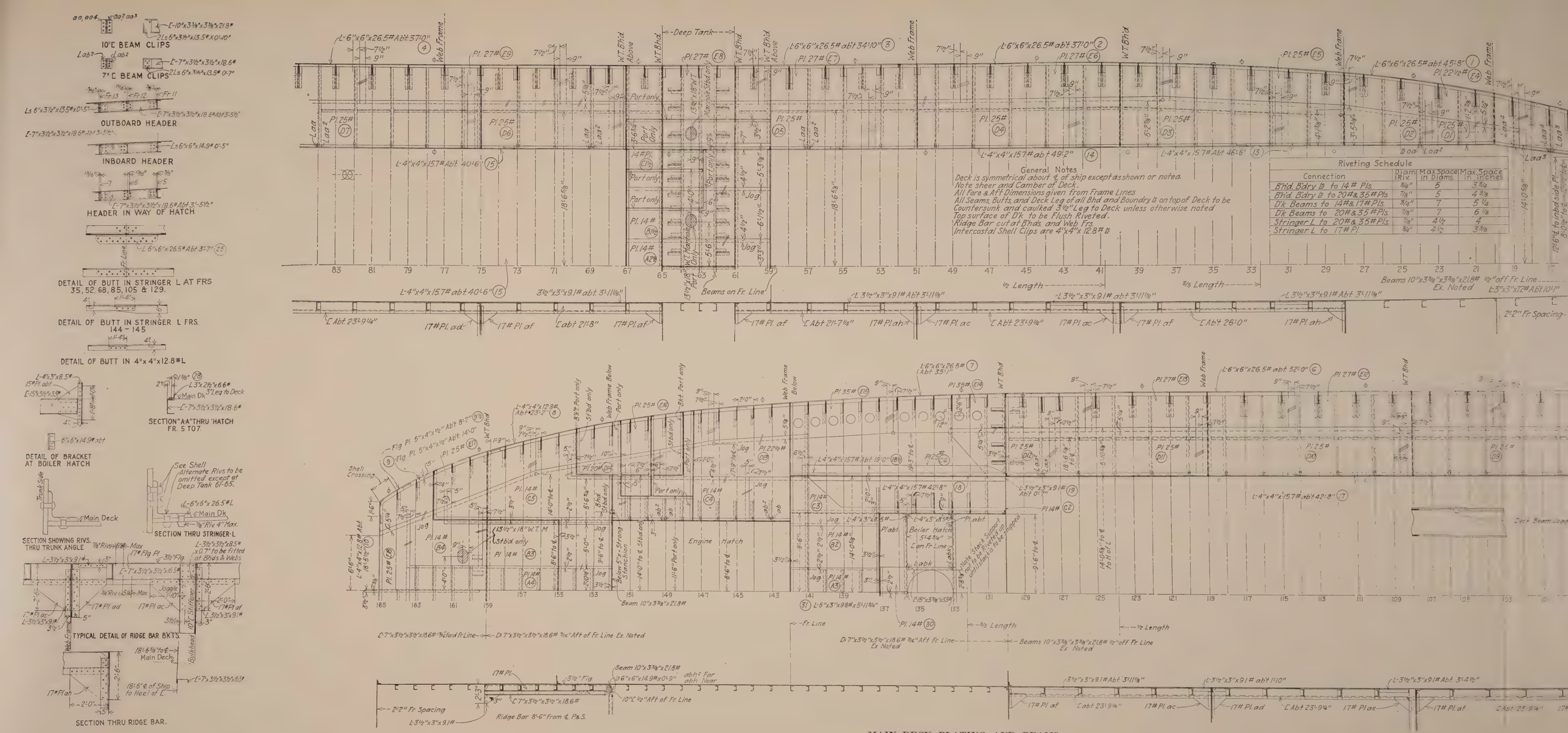

Oregon Fir Decking planed as shown
Caulked with oakum and filled with marine glue
Wood Plug Dipped in White Lead
Center Line of Ship
Grommet soaked in white lead
Washer
⅝" Deck Bolts Galv.
SECTION SHOWING METHOD OF SECURING DECK PLANKING


SECTION F-F

SECTION E-E


Pedestal Base
Portable Section
6" M Vents Port Side St'bd only
2'0" Vent
BOILER ROOM
Coal Box
Engine
Coal Chute
Smoke Stack
Center Line of Ship
Skylight
Galley Skylight
Galley stove pipe location to suit range
AFTER BOAT DECK
3"x 5 1/16" OREGON FIR
25'4 1/2" from ℄ of ship
Wood Caps fitted on Beams
SECTION A-A
SECTION B-B
SECTION C-C
12'0" from ℄ of ship
Wood caps fitted on beams
SECTION D-D

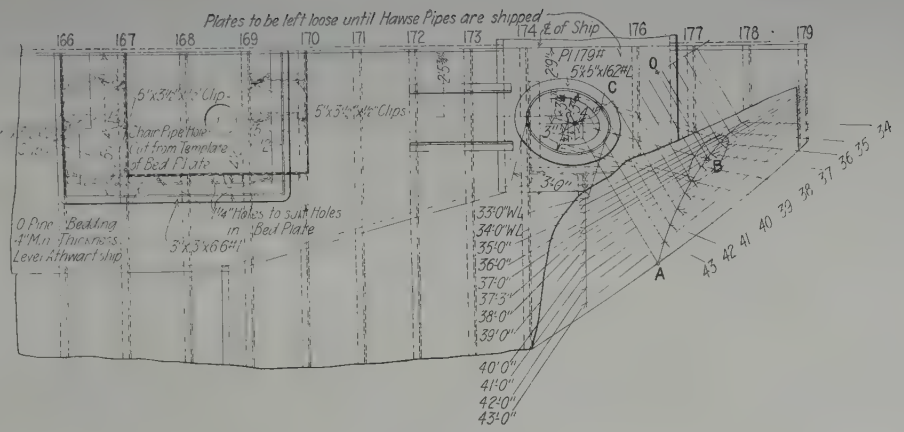

1½ Deck Drain P & S
Pedestal Base
10" Dia. Vent
6" Dia. Mushroom Vent
Vent
Opening for Stairway
Center Line of Ship
Bath Room & W.C. Tile Floor
FORWARD BOAT DECK
3"x 5 1/16" (FINISHED) OREGON FIR

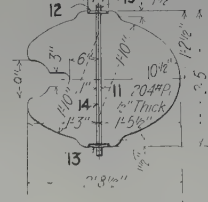

10"C BEAM CLIPS
7"C BEAM CLIPS
OUTBOARD HEADER
INBOARD HEADER
HEADER IN WAY OF HATCH
DETAIL OF BUTT IN STRINGER L AT FRS 35, 52, 68, 85, 105 & 129.
DETAIL OF BUTT IN STRINGER L FRS. 144 - 145
DETAIL OF BUTT IN 4"x 4"x12.8#L
DETAIL OF BRACKET AT BOILER HATCH
SECTION "AA" THRU HATCH FR. 5 TO 7.
SECTION THRU STRINGER-L
SECTION SHOWING RIVS. THRU TRUNK ANGLE
TYPICAL DETAIL OF RIDGE BAR BKT'S
SECTION THRU RIDGE BAR.
Deep Tank
Web Frame
W.T. Bhd
W.T. Bhd Above
Port only
Stbd only
Manhole
Engine Hatch
Boiler Hatch
Deck Beam Load
Beams on Fr. Line
½ Length
⅜ Length
Fr. Line
Riveting Schedule
Connection | Diam Riv. | Max Space in Diams. | Max. Space in Inches
B'hd. B'dry ℄ to 14# Pls. | ¾" | 5 | 3¾
B'hd. B'dry ℄ to 20# & 35# Pls | ⅞" | 5 | 4 ⅜
Dk. Beams to 14# & 17# Pls. | ⅞" | 7 | 5 ¼
Dk Beams to 20# & 35# Pls. | ⅞" | 7 | 6 ⅛
Stringer L to 20# & 35# Pls. | ⅞" | 4½ | 4
Stringer L to 17# Pl. | ¾" | 4½ | 3⅜
General Notes
Deck is symmetrical about ℄ of ship except as shown or noted.
Note sheer and Camber of Deck.
All Fore & Aft Dimensions given from Frame Lines
All Seams, Butts, and Deck Leg of all Bhd and Boundry ℄s on top of Deck to be Countersunk and caulked 3½" Leg to Deck unless otherwise noted
Top surface of D'k to be Flush Riveted.
Ridge Bar cut at B'hds and Web Frs.
Intercostal Shell Clips are 4"x4"x 12.8# ℔s

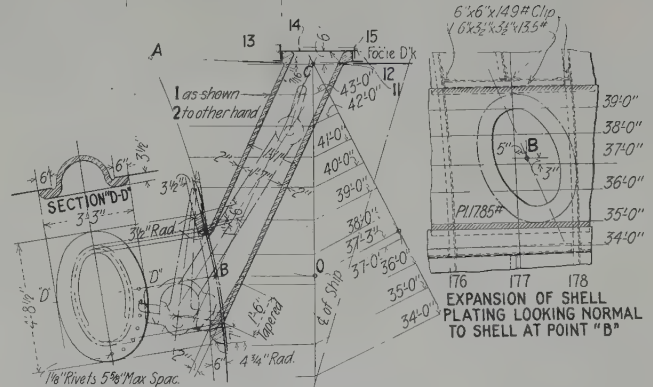
MAIN DECK PLATING AND BEAMS

6,422-TON D. W. COLLIER

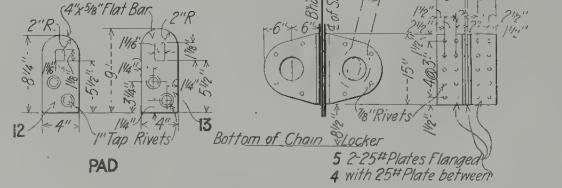
New York Shipbuilding Corp., Camden, N. J.

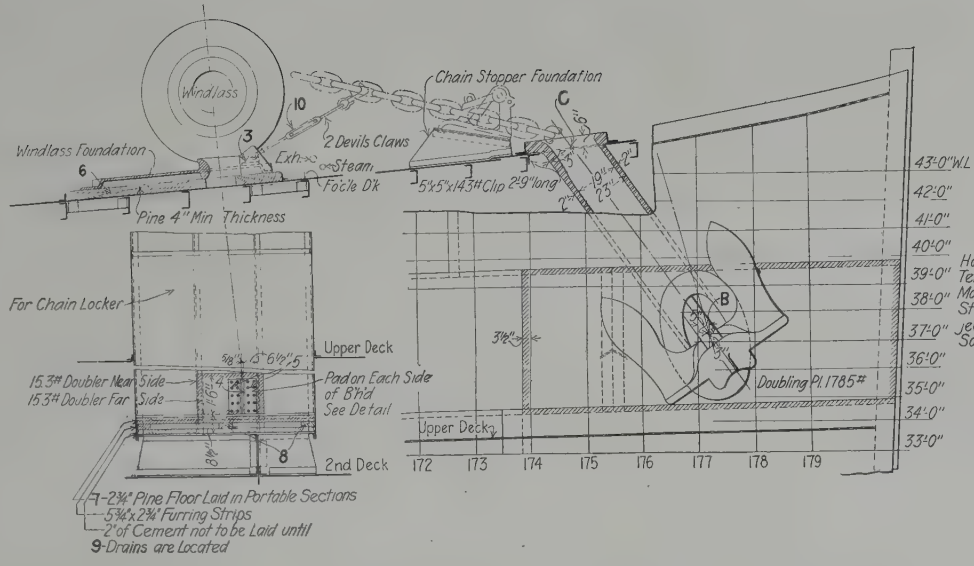






SECTION SHOWING TRUE LENGTH OF HAWSE PIPE STARB'D SHOWN LOOKING AFT. PORT SIDE TO OTHER HAND.



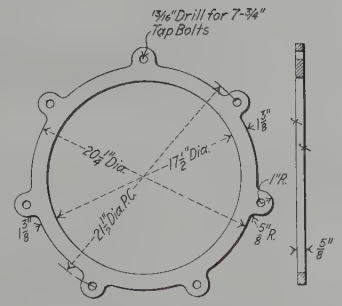


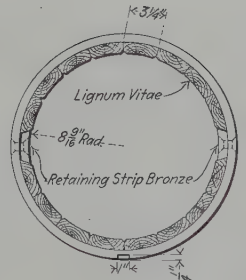
1-2¾" Pine Floor Laid in Portable Sections
5¾"x2¾" Furring Strips
2" of Cement not to be Laid until 9-Drains are Located

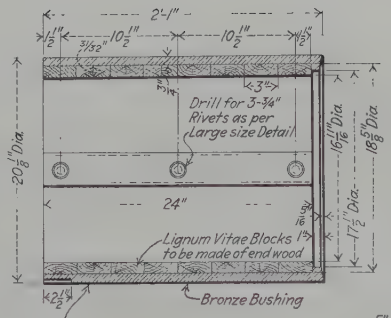
General Notes
Hawse Pipe to be made from Template furnished by Mold Loft
Steel Castings to be subject to Hammer Tests for Soundness

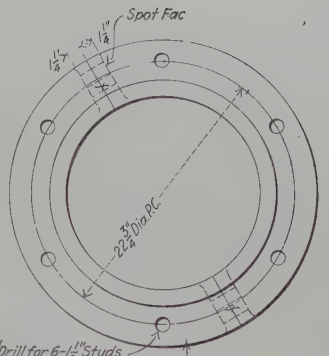
Bill of Material
Amounts Given for One Ship

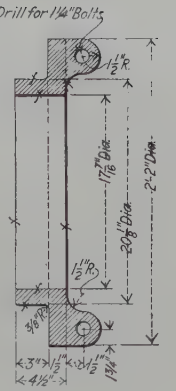
Pc. No	No Req	Name	Material	Remarks
1	1	Hawse Pipe	C Iron	As Drawn
2	1	Hawse Pipe	C Iron	To other Hand
3	2	Pads	C Steel	
4	2	Plates	S Plate	Fitted in Pc No 5
5	4	Flange Plate	S Plate	
6		Windlass Bed	Y Pine	
7		Chain Locker Floor	Y Pine	
8		Furring Strips	Y Pine	
9		Cement	Cement	
10	2	Devils Claws	W Steel	
11	2	Cover Plates	S Plate	20 4# Pl
12	2	Locking Bar Pads	S Plate	4'x⅝" Flat Bar
13	2	Locking Bar Pads	S Plate	" " " "
14	2	Locking Bar	S Bar	
15	2	Split Pin -1¼"	Wrot Steel	

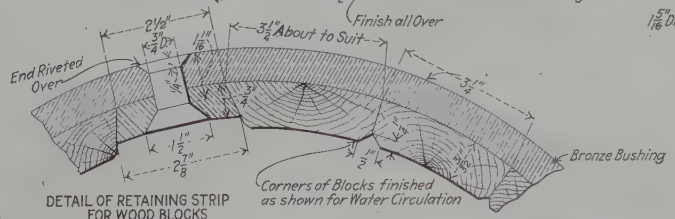

13/16"Drill for 7-3/4" Tap Bolts
20-1/4"Dia.
17-1/2"Dia.
21-1/2"Dia.P.C.
1"R.
5/8"R.
5/8"
1-1/8"
END PLATE

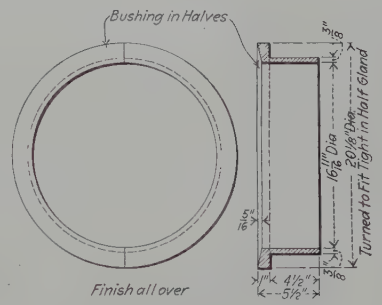

3-1/4"
Lignum Vitae
8-9/16"Rad.
Retaining Strip Bronze
1/4"

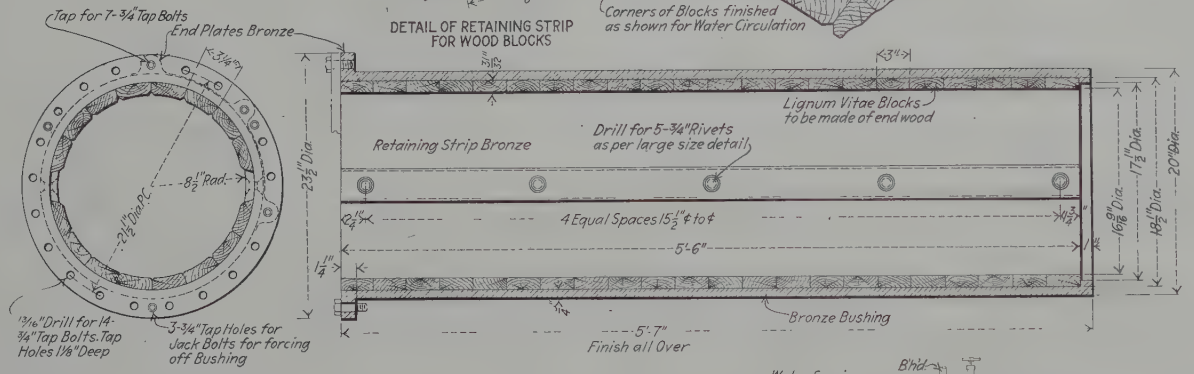

2'-1"
1/2"
10-1/2"
10-1/2"
1/2"
3-1/32"
3"
3"
Drill for 3-3/4" Rivets as per Large size Detail
20-1/8"Dia.
16-11/16"Dia.
17-1/2"Dia.
18-5/8"Dia.
24"
Lignum Vitae Blocks 1-3/4" to be made of end wood
2-1/2"
Finish all Over
Bronze Bushing

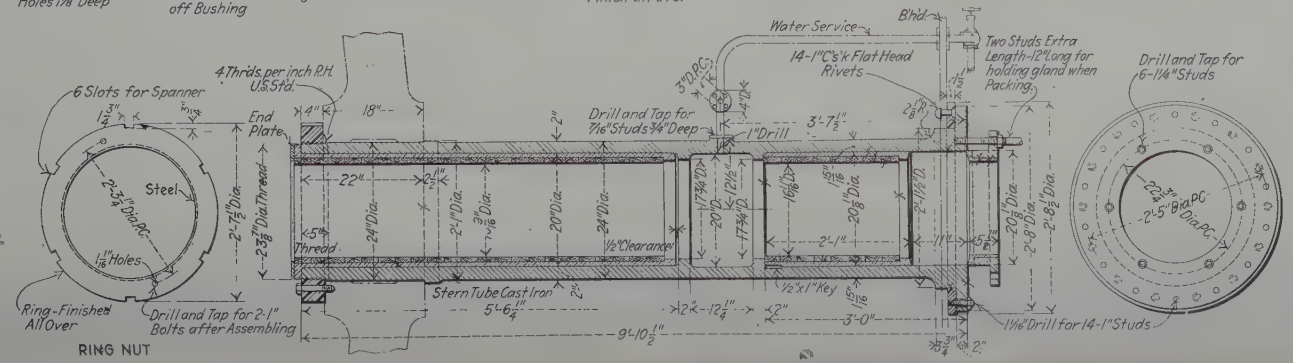

Spot Fac
1"
1-1/4"
22-3/4"Dia.P.C.
1-5/16"Drill for 6-1-1/4"Studs
HALF GLAND
Cast Iron

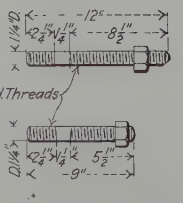

1-5/16"Drill for 1-1/4"Bolts
1-1/2"R.
1-7/16"Dia.
20-1/8"Dia.
2'-2"Dia.
1-1/2"R.
3/8"R.
3"
1-1/4"
1-1/2"
4-1/2"
1-3/4"

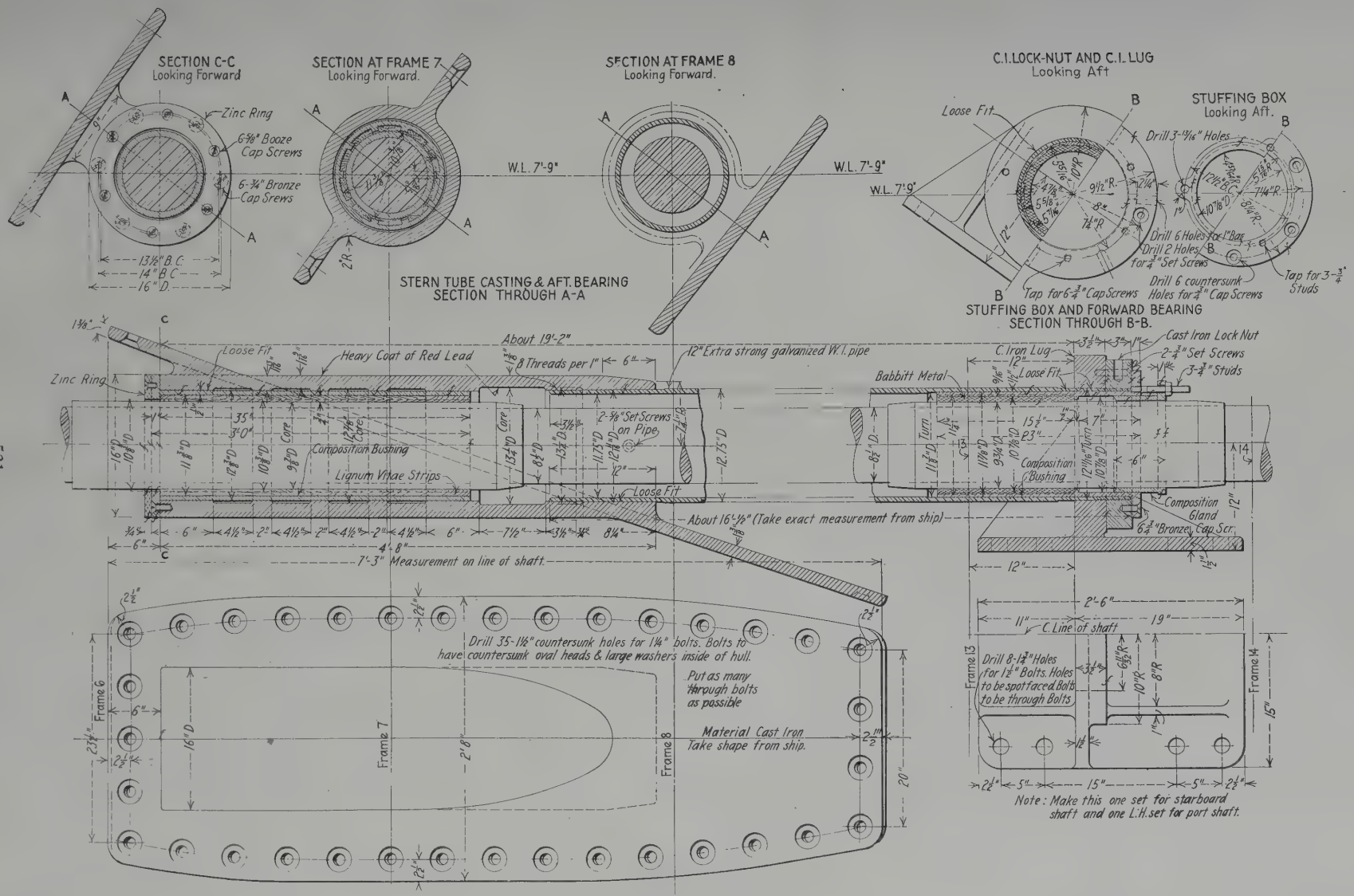

2-1/2"
3/4"Dia.
3-1/8"About to Suit
3-1/4"
End Riveted Over
1-1/2"
2-7/8"
1"
3/4"
Bronze Bushing
Corners of Blocks finished as shown for Water Circulation
DETAIL OF RETAINING STRIP FOR WOOD BLOCKS


Bushing in Halves
16-9/16"Dia.
17-1/2"Dia.
20"Dia.
Turned to Fit Tight in Half Gland
1"
4-1/2"
5-1/2"
Finish all over
HALF BUSHING
Bronze

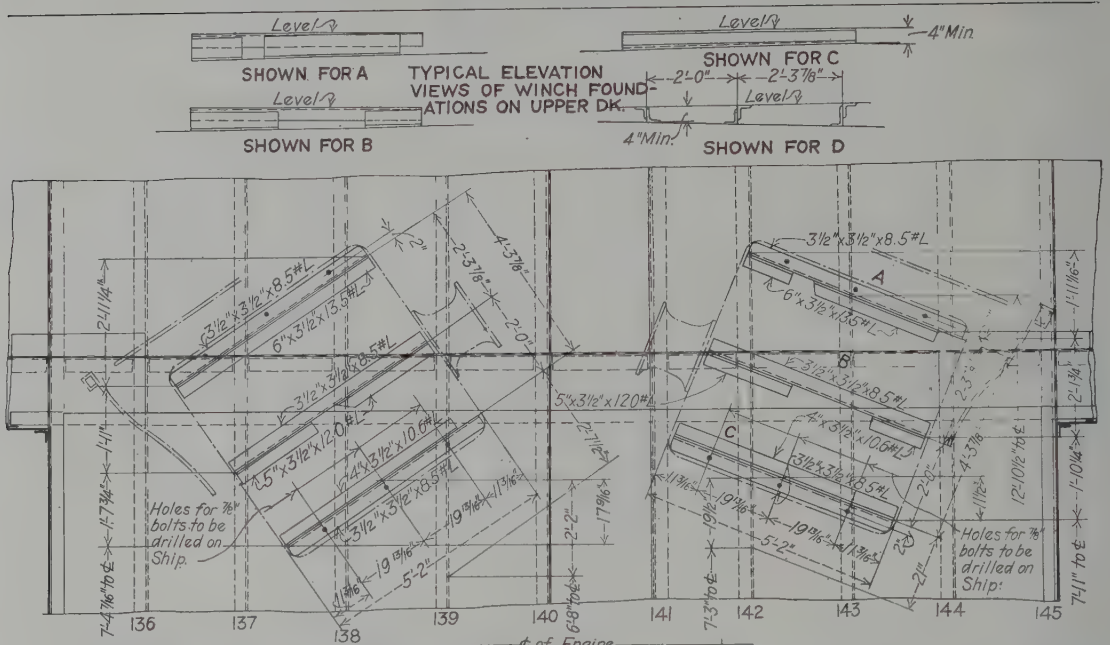

Tap for 7-3/4"Tap Bolts
End Plates Bronze
3-1/4"R.
23-1/2"Dia.
8-1/2"Rad.
21-1/2"Dia.P.C.
13/16"Drill for 14-3/4"Tap Bolts. Tap Holes 1-1/8"Deep
3-3/4"Tap Holes for Jack Bolts for forcing off Bushing
3"
Lignum Vitae Blocks to be made of end wood
Retaining Strip Bronze
Drill for 5-3/4"Rivets as per large size detail
4 Equal Spaces 15-1/2" c to c
5'-6"
2-1/4"
1-1/4"
16-9/16"Dia.
17-1/2"Dia.
18-1/2"Dia.
20"Dia.
Bronze Bushing
5'-7"
Finish all Over

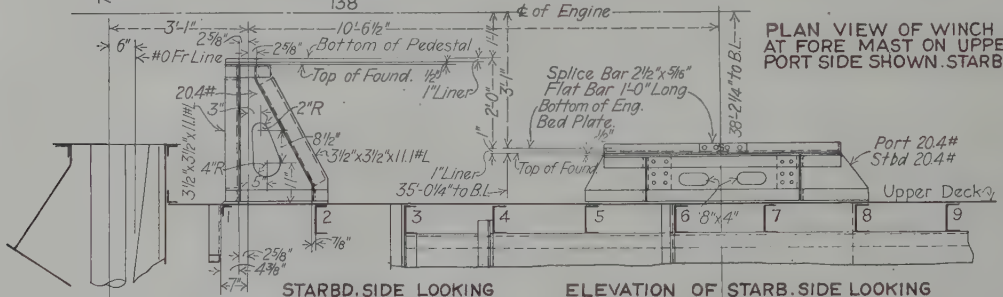

Water Service
B'hd
Two Studs Extra Length-12"Long for holding gland when Packing.
14-1"C'S'k Flat Head Rivets
3"D.P.C.
4 Thrds. per inch R.H. U.S.Std.
6 Slots for Spanner
End Plate
4"
18"
2"
Drill and Tap for 7/16"Studs 3/4"Deep
1"Drill
3'-7-1/2"
2-7/8"
1-1/2"
Drill and Tap for 6-1-1/4"Studs
22-3/4"B'd P.C.
2'-5"B'd P.C.
Steel
2'-5-1/2"Dia.P.C.
1-1/16"Holes
2'-7-1/2"Dia.
2'-8-1/2"Dia.Thread
5"Thread
22"
2-1/4"
24"Dia.
2'-1"Dia.
3"
7/16"Dia.
20"Dia.
24"Dia.
1/2"Clearance
17-3/4"D.
20"D.
12-1/2"D.
16-1/16"D.
20-1/8"Dia.
2'-1"
2'-1/2"D.
2'-8-1/2"Dia.
1/2"x1"Key
5-1/16"
5-1/2"
Stern Tube Cast Iron
2"
5'-6-1/4"
12-1/4"-12-1/4"
3'-0"
9'-10-1/2"
3/4"
2"
1/16"Drill for 14-1"Studs
RING NUT
Ring-Finished All Over
Drill and Tap for 2-1" Bolts after Assembling


1-1/4"D.
12"
2-1/4"
1-3/4"
1-1/4"
8-1/2"
U.S.Std.Threads
2-1/4"
1-3/4"
5-1/2"
9"

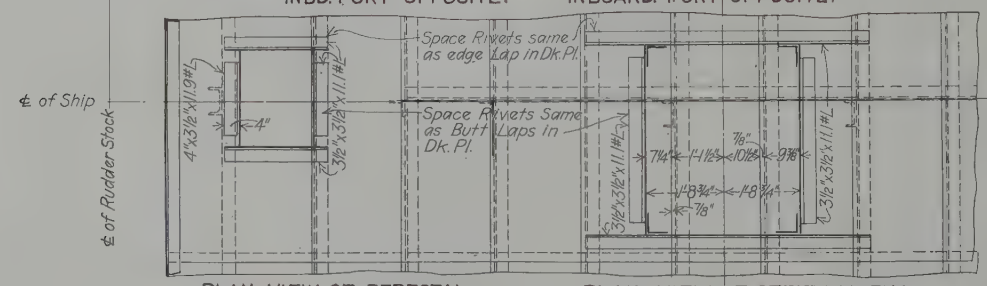

SECTION C-C
Looking Forward
Zinc Ring
6-5/8" Booze Cap Screws
6-3/4" Bronze Cap Srews
13½" B.C.
14" B.C.
16" D.
SECTION AT FRAME 7
Looking Forward.
SECTION AT FRAME 8
Looking Forward.
W.L. 7'-9"
STERN TUBE CASTING & AFT. BEARING
SECTION THROUGH A-A
C.I. LOCK-NUT AND C.I. LUG
Looking Aft
STUFFING BOX
Looking Aft.
Loose Fit
Drill 3-13/16" Holes
Drill 6 Holes for 1" Bag
Drill 2 Holes for 1/4" Set Screws
Drill 6 countersunk Holes for 3/4" Cap Screws
Tap for 6-3/4" Cap Screws
Tap for 3-3/4" Studs
STUFFING BOX AND FORWARD BEARING
SECTION THROUGH B-B.
About 19'-2"
12" Extra strong galvanized W.I. pipe
8 Threads per 1"
Heavy Coat of Red Lead
Zinc Ring
Loose Fit
Composition Bushing
Lignum Vitae Strips
2-7/8" Set Screws on Pipe
About 16'-½" (Take exact measurement from ship)
7'-3" Measurement on line of shaft.
Babbitt Metal
C. Iron Lug
Cast Iron Lock Nut
2-3/4" Set Screws
3-3/4" Studs
Composition Gland
6-3/4" Bronze Cap Scr.
Drill 35-1½" countersunk holes for 1¼" bolts. Bolts to have countersunk oval heads & large washers inside of hull.
Put as many through bolts as possible
Material Cast Iron
Take shape from ship.
Frame 6
Frame 7
Frame 8
Frame 13
Frame 14
C. Line of shaft
Drill 8-1¾" Holes for 1¼" Bolts. Holes to be spot faced. Bolts to be through Bolts
Note: Make this one set for starboard shaft and one L.H. set for port shaft.

WOODEN MOTOR SHIP
Designed by Cox & Stevens, New York City



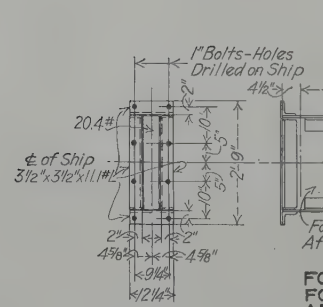


PLAN VIEW OF WINCH FOUNDATIONS AT FORE MAST ON UPPER DECK. PORT SIDE SHOWN. STARB. OPPOSITE.

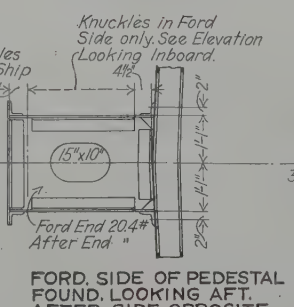


PLAN VIEW OF PEDESTAL FOUND. AT UPPER DECK.

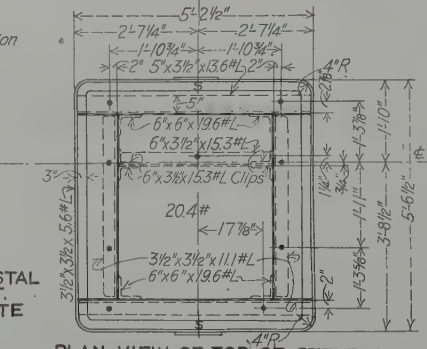
PLAN VIEW OF STEERING ENG. FOUND. AT UPPER DECK.



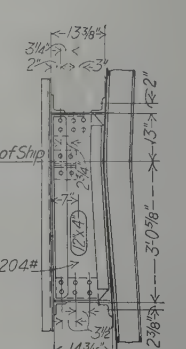
PLAN VIEW AT TOP OF PEDESTAL FOUND.



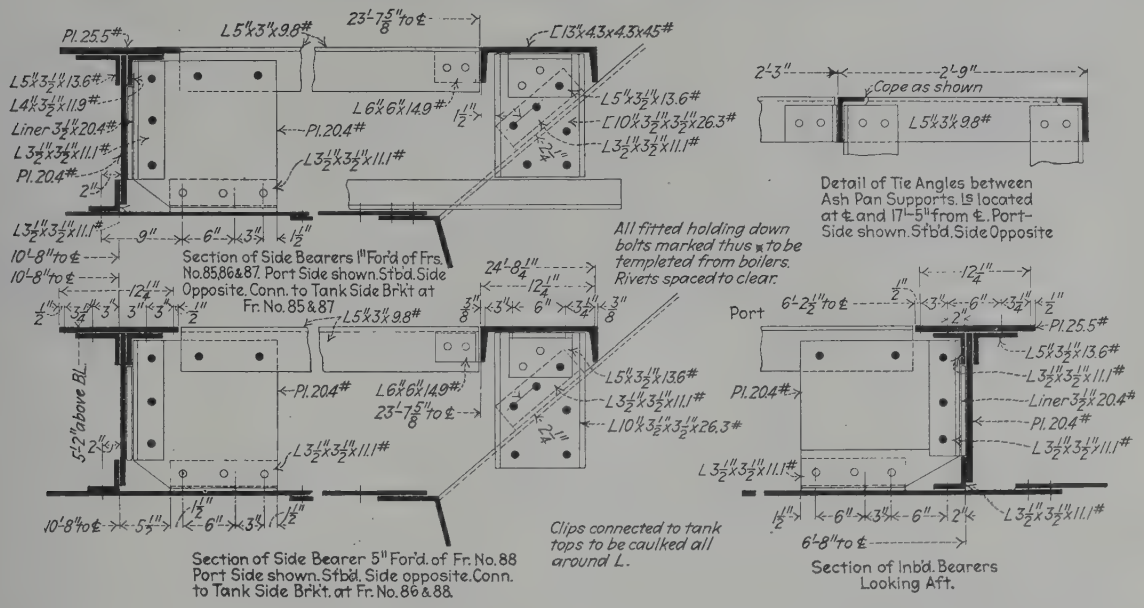
FORD. SIDE OF PEDESTAL FOUND. LOOKING AFT. AFTER SIDE OPPOSITE EXCEPT AS NOTED.

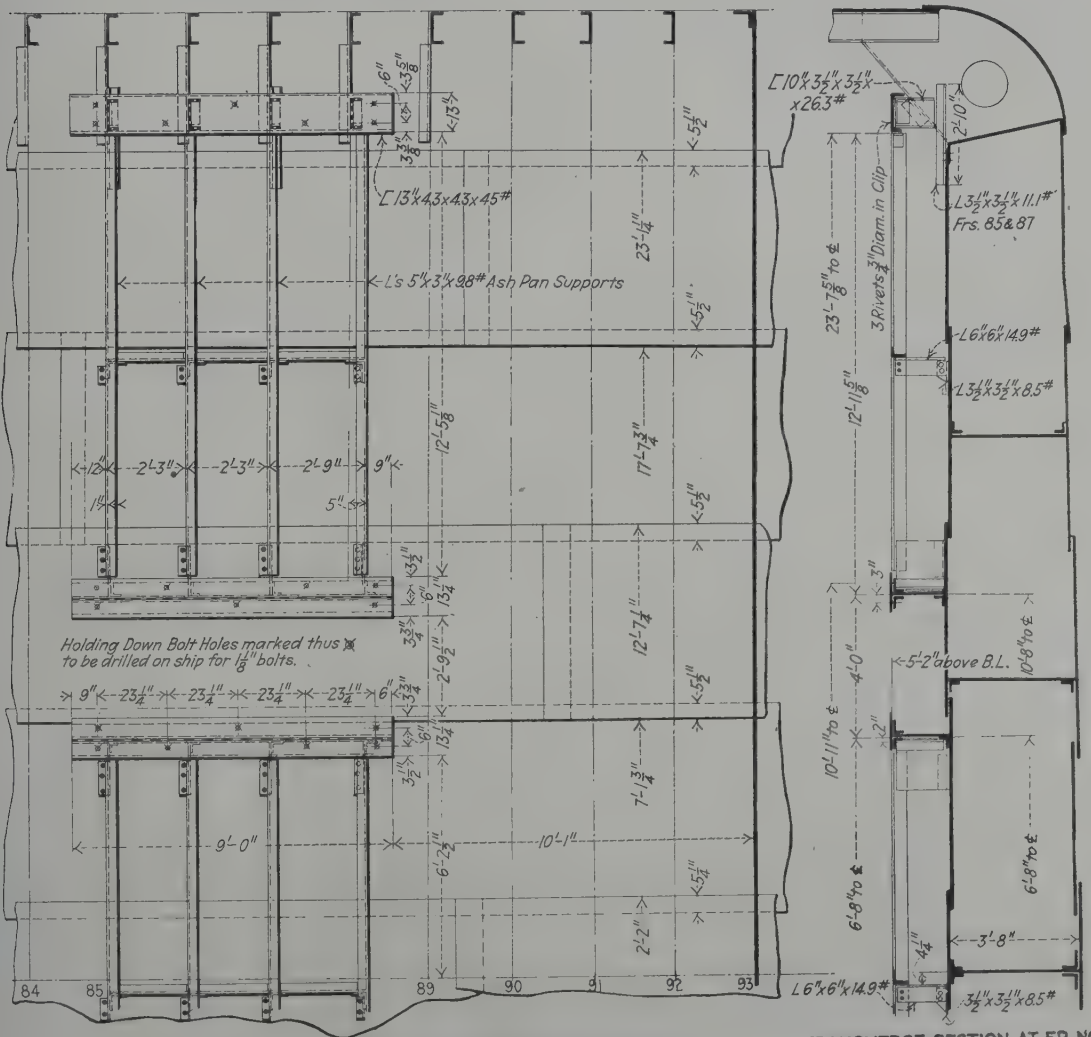


PLAN VIEW OF TOP OF STEERING ENG. FOUND. ALL HOLES SHOWN ARE FOR 1" FOUND. BOLTS. HOLES TO BE DRILLED ON SHIP.



ELEVATION OF FORD END. ENG. FOUND. AFTER END OPPOSITE.


Pl. 25.5#
L 5"x3"x9.8#
23'-7 5/8" to ℄
C 13"x4.3x4.3x45#
L 5"x3 1/2"x13.6#
L 4"x3 1/2"x11.9#
Liner 3 1/2"x20.4#
L 3 1/2"x3 1/2"x11.1#
Pl. 20.4#
L 6"x6"x14.9#
1 1/2"
C 10"x3 1/2"x3 1/2"x26.3#
L 3 1/2"x3 1/2"x11.1#
2 1/2"
9"
6"
3"
1 1/2"
10'-8" to ℄
Section of Side Bearers 1" For'd of Frs. No.85,86&87. Port Side shown. Stb'd. Side Opposite. Conn. to Tank Side Brk't at Fr. No. 85 & 87
12 1/4"
1/2"
3/4"
1"
5'-2" above BL
24'-8 1/4"
All fitted holding down bolts marked thus ✱ to be templeted from boilers. Rivets spaced to clear.
Section of Side Bearer 5" For'd. of Fr. No. 88 Port Side shown. Stb'd. Side opposite. Conn. to Tank Side Brk't. at Fr. No. 86 & 88.
Clips connected to tank tops to be caulked all around L.
2'-3"
2'-9"
Cope as shown
Detail of Tie Angles between Ash Pan Supports. Ls located at ℄ and 17'-5" from ℄. Port-Side shown. Stb'd. Side Opposite
Port
6'-2 1/2" to ℄
Liner 3 1/2"x20.4#
6'-8" to ℄
Section of Inb'd. Bearers Looking Aft.



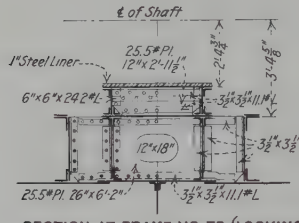
PLAN VIEW OF BOILER FOUNDATION
Port Side shown - Stb'd. Side Opposite

TRANSVERSE SECTION AT FR. NO. 86
Port Side shown Looking Aft.
Stb'd. Side Opposite

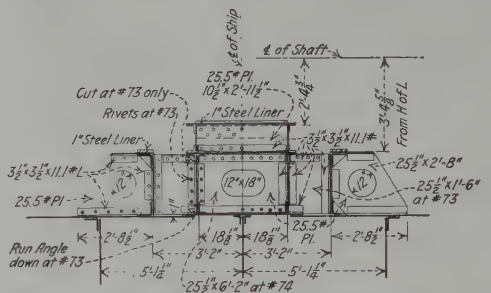
DETAILS OF 2,500 S. H. P. TURBINE FOUNDATION

NOTES

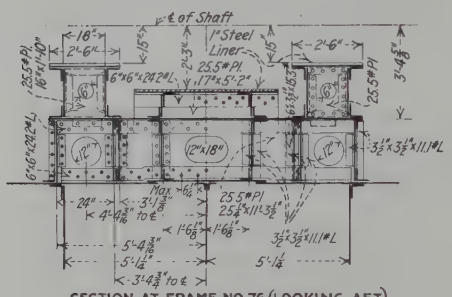
Base plate for turbine & reduction gear casing will come in blank holes for holding down bolts shown thus ⊕, these holes to be drilled to match base plates.
Rivet holes spaced to clear
All rivets in top of foundation to be countersunk.
Rivets ⅞" except where connecting to TB strake of tank top where rivets are ¾"
Clips to tank top caulked all around, before balance of foundation is erected



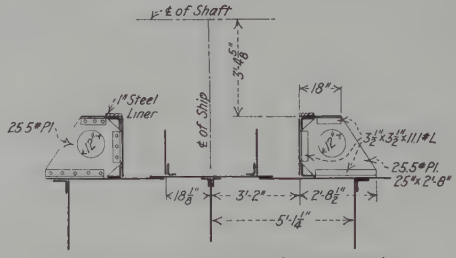
SECTION AT FRAME NO. 72 (LOOKING AFT)



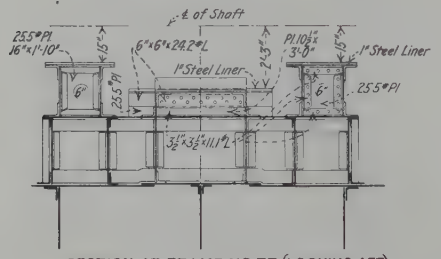
SECTION AT FRAME NO. 73 & 74 (LOOKING AFT)



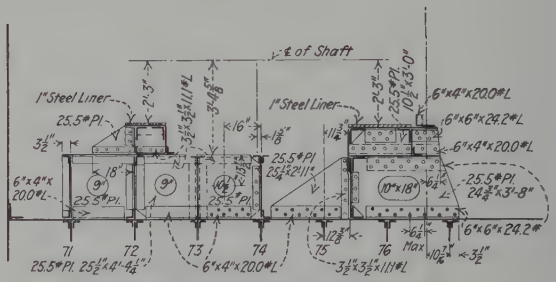
SECTION AT FRAME NO. 76 (LOOKING AFT)



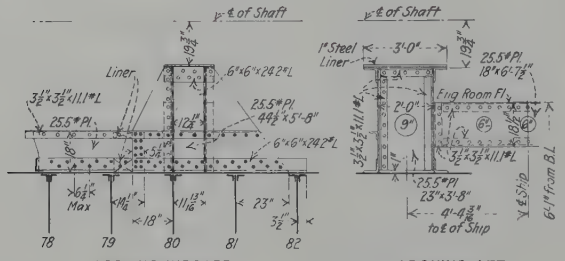
SECTION AT FRAME NO. 75 (LOOKING AFT)



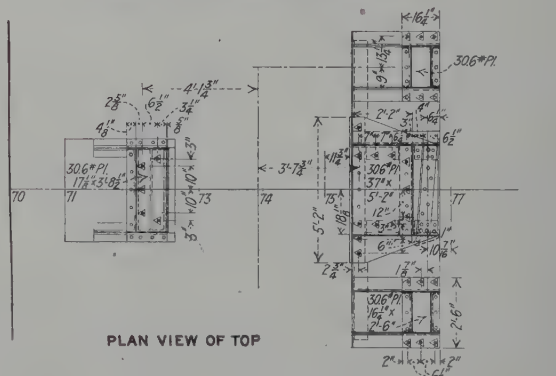
SECTION AT FRAME NO. 77 (LOOKING AFT)



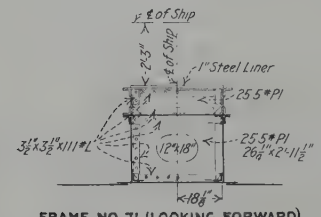
GIRDER 1'-6⅛" FROM CENTER LINE OF SHIP



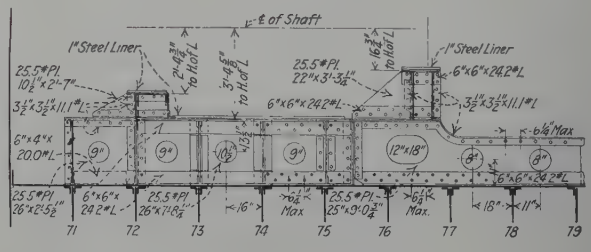
LOOKING INBOARD LOOKING AFT



PLAN VIEW OF TOP

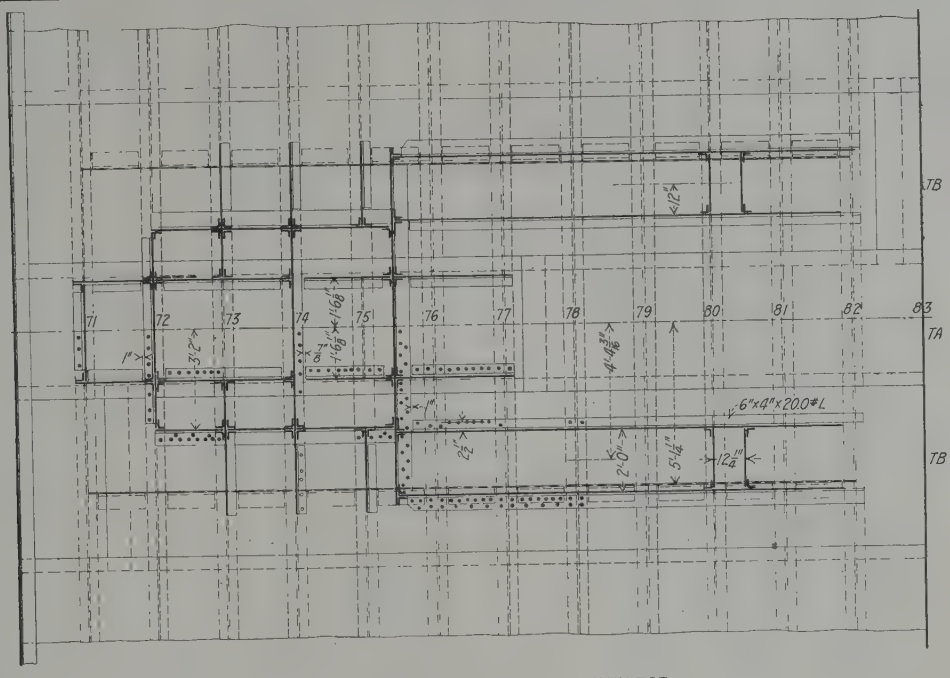


FRAME NO. 71 (LOOKING FORWARD)

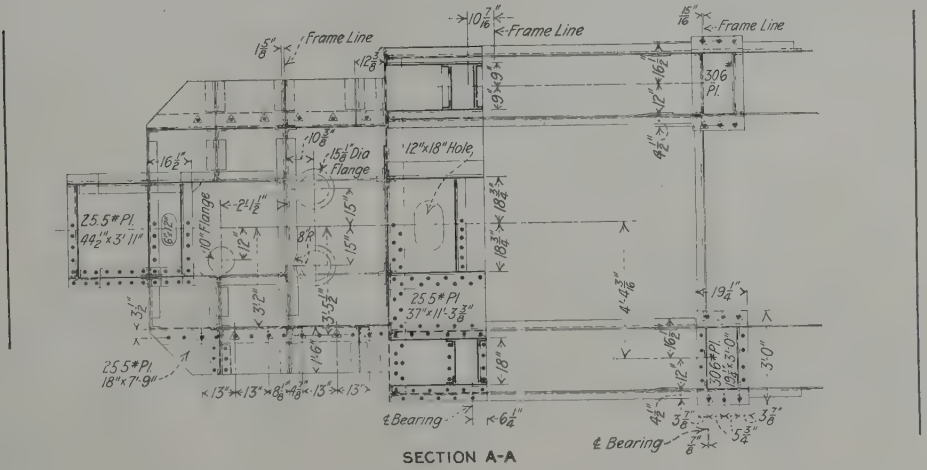


LOOKING INBOARD

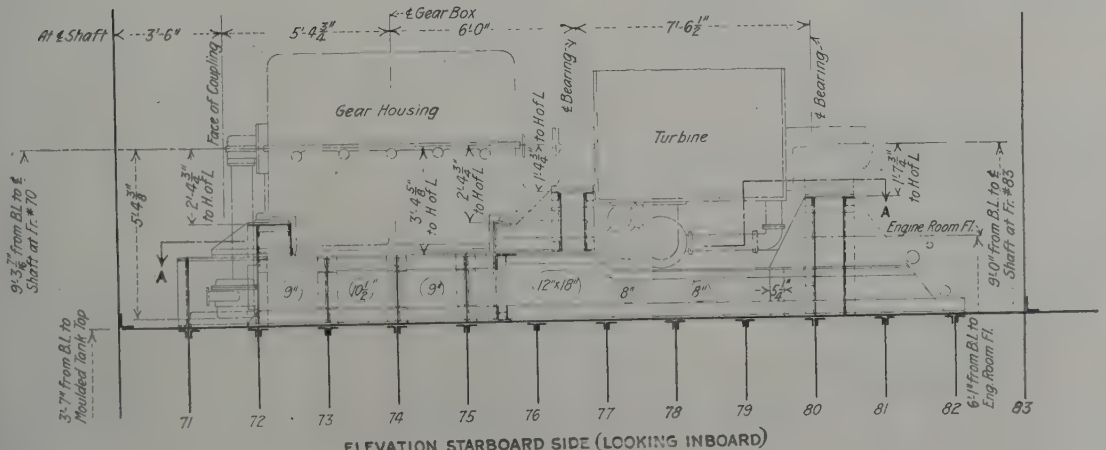
See Opposite Page



PLAN VIEW SHOWING CONNECTION TO TANK TOP

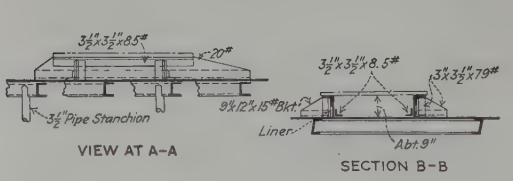


SECTION A-A



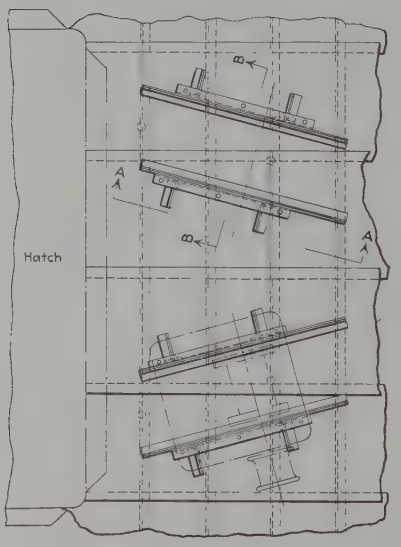
ELEVATION STARBOARD SIDE (LOOKING INBOARD)

See Opposite Page

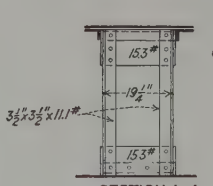


VIEW AT A-A

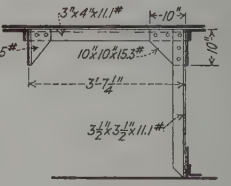
SECTION B-B



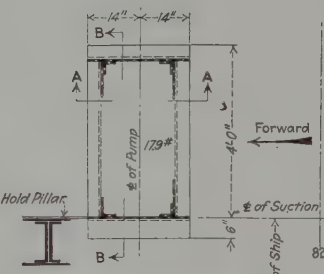
WINCH FOUNDATION



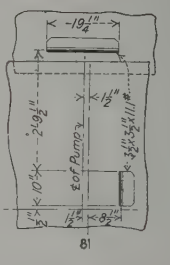
SECTION A-A
Looking Outboard



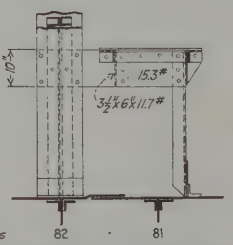
SECTION B-B
Looking Forward



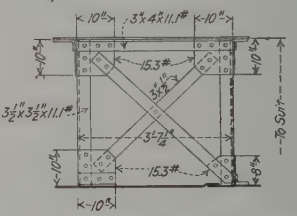
PLAN OF FOUNDATION



PLAN AT TANK TOP



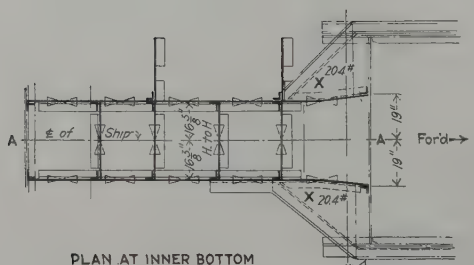
ELEVATION OF INBOARD END
Looking Outboard



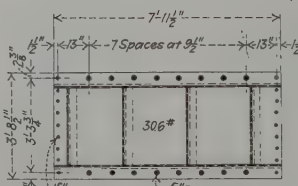
ELEVATION LOOKING FORWARD

X NOTE: These brackets and angles to form rigid connection to engine foundation and at the same level as the top of engine foundation.

FOUNDATION FOR LUBRICATING OIL COOLING PUMP

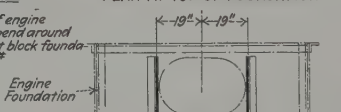


PLAN AT INNER BOTTOM

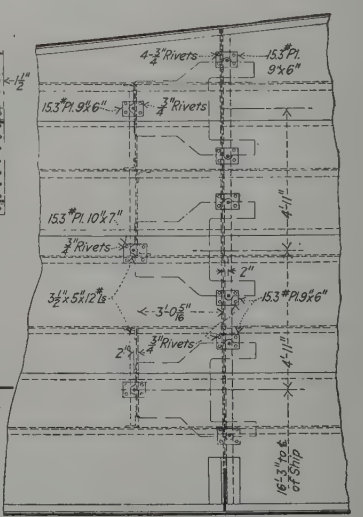


PLAN AT TOP OF FOUNDATION

Angle at top of engine foundation to bend around to side of thrust block foundation 5"x3½"x12.8#



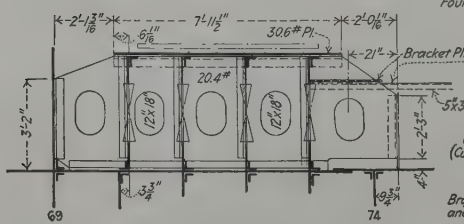
SECTION AT FR. NO. 74
Looking Forward



NOTE: All clip ls 5"x3½"x12.8# L All holes marked thus * are for holding down bolts and are to be drilled on ship to suit generator. Holding down bolts to be provided by engine department

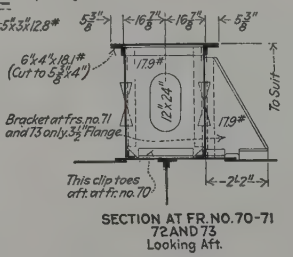
PLAN VIEW OF "D" DECK
Port Side Only

TURBO-GENERATOR FOUNDATION

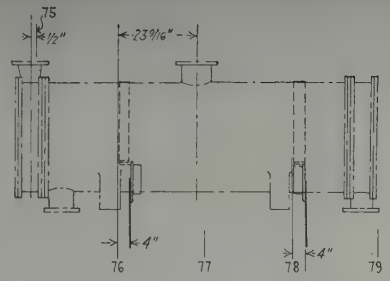


SECTION A-A
Looking to Port

THRUST BLOCK FOUNDATION



SECTION AT FR. NO. 70-71
72 AND 73
Looking Aft.

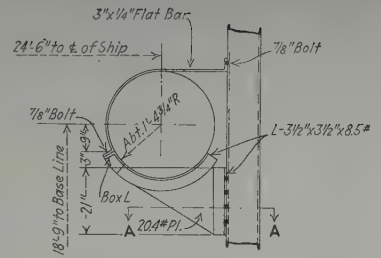


ELEVATION - LOOKING INBD.

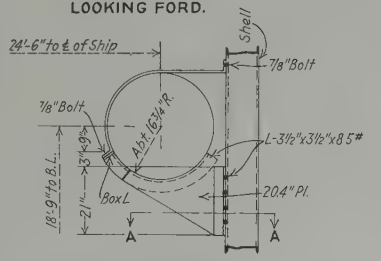
SECTION A-A

Note:- Br't and strap to be fitted to con and holes in frs drilled when con is in place.

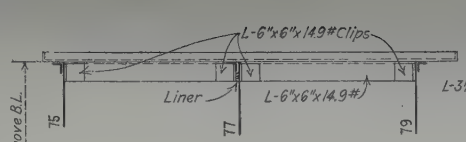
AUXILIARY CONDENSER
STBD ONLY



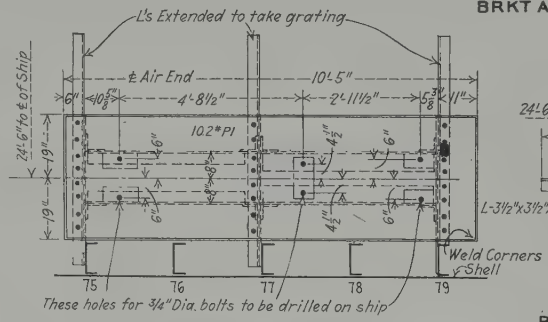
BRKT AT FR. #78
LOOKING FORD.



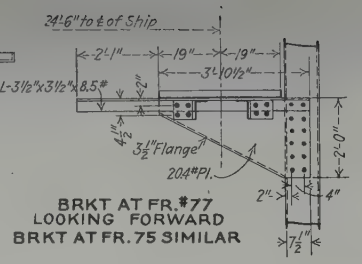
BRKT AT FR. #76
LOOKING FORD.



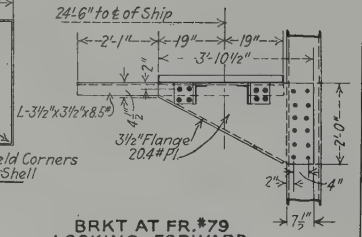
ELEVATION - LOOKING INBD.



PLAN AT BASE

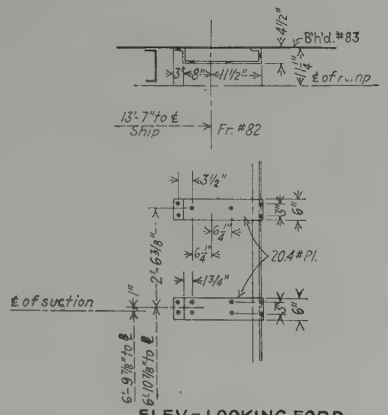


BRKT AT FR. #77
LOOKING FORWARD
BRKT AT FR. 75 SIMILAR



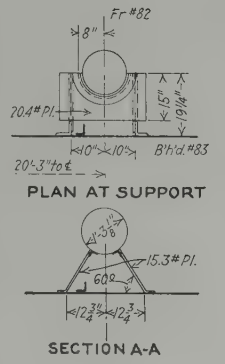
BRKT AT FR. #79
LOOKING FORWARD

AUXILIARY CIRCULATING PUMP
STAR. ONLY



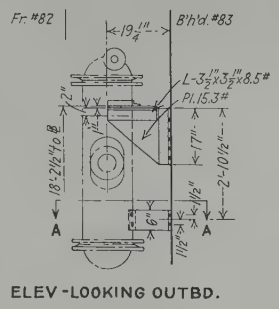
ELEV - LOOKING FORD

ENGINE ROOM BILGE PUMP
STBD ONLY



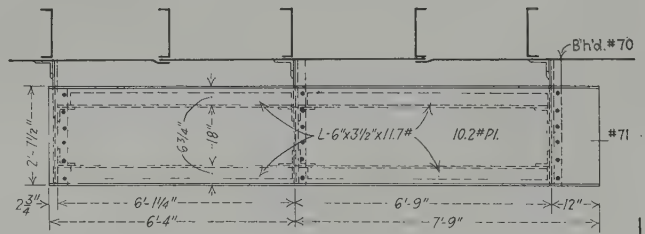
PLAN AT SUPPORT

SECTION A-A

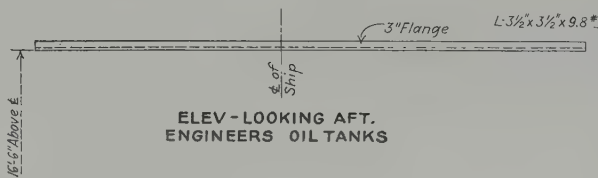


ELEV - LOOKING OUTBD.

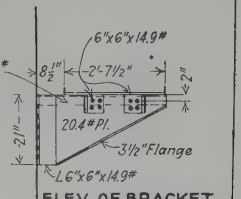
FEED WATER HEATER
PORT ONLY



PLAN

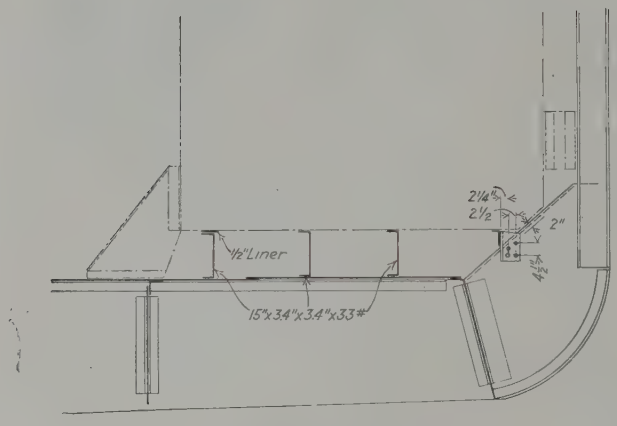


ELEV - LOOKING AFT.
ENGINEERS OIL TANKS

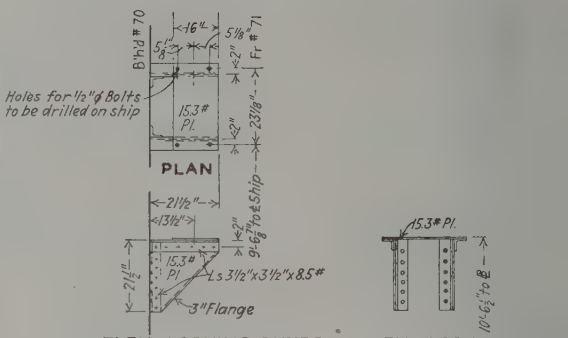


ELEV OF BRACKET
1/2" FROM ℄ SHIP.

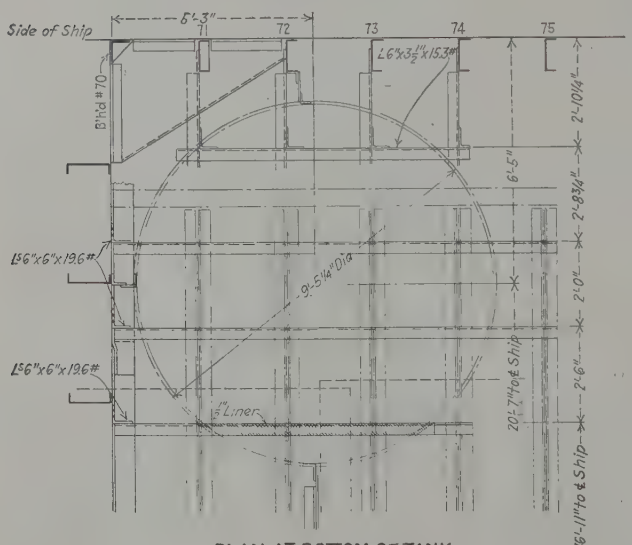
9,000-TON D. W. FREIGHTER



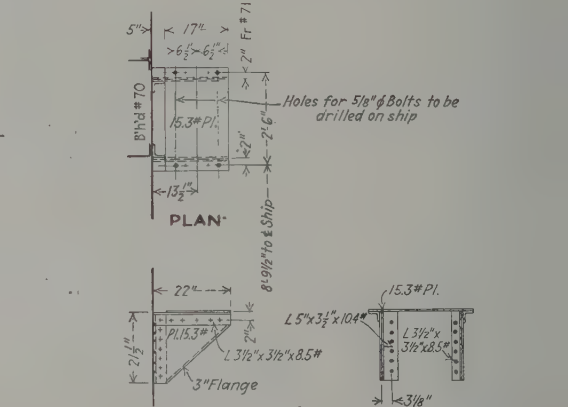
SECTION THRU TANK SUPPORTS
LOOKING AFT.



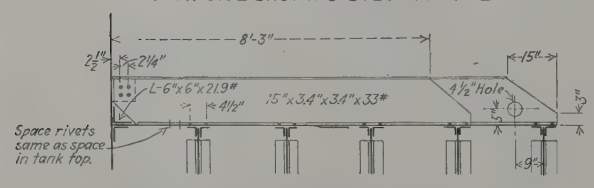
FRESH WATER PUMP
PORT ONLY.



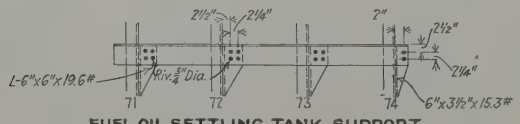
PLAN AT BOTTOM OF TANK
PORT SIDE SHOWING-STBD OPPOSITE



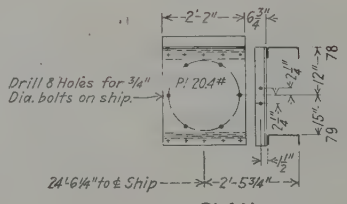
SANITARY PUMP
PORT ONLY.



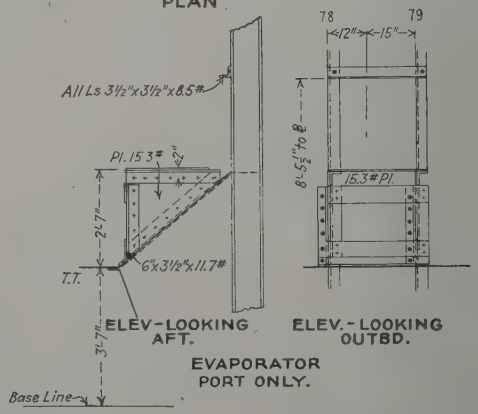
ELEV. TANK SUPPORTS-16'-11" TO ℄ - LOOKING OUTBD.
PORT SIDE SHOWING STBD OPP.
SUPPORTS 19'-5" & 21'-5" TO ℄ SIMILAR



FUEL OIL SETTLING TANK SUPPORT
PORT & STBD. SIDES.

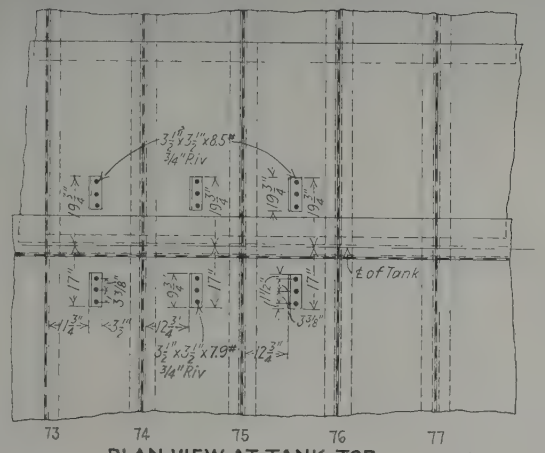


PLAN

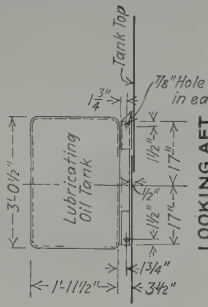


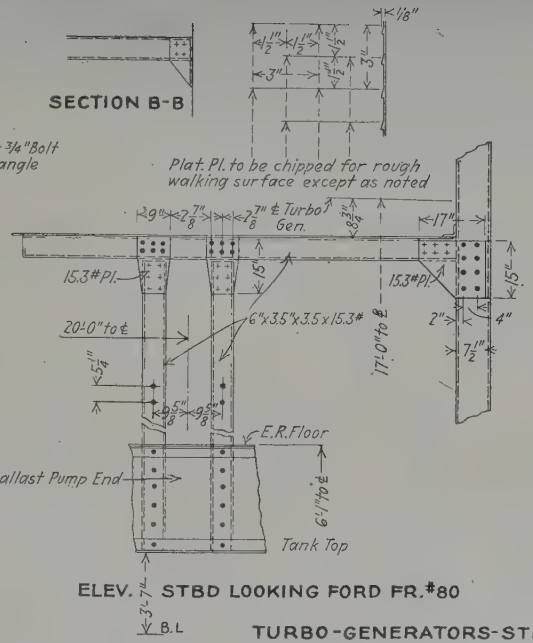
EVAPORATOR
PORT ONLY.

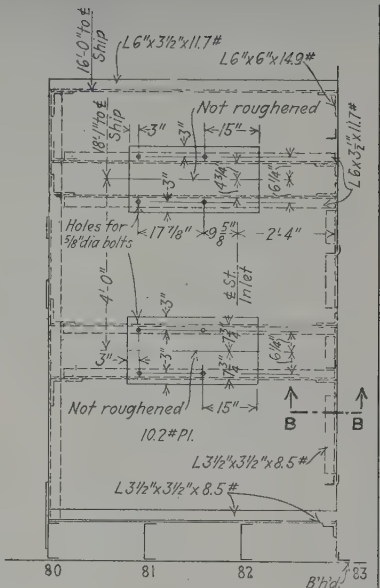
9,000-TON D. W. FREIGHTER



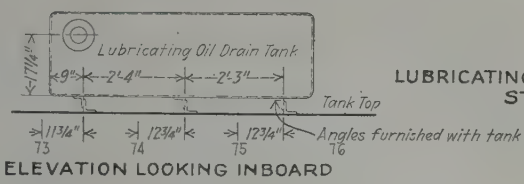
PLAN VIEW AT TANK TOP







PLAN AT BASE

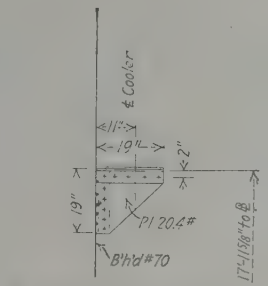


ELEVATION LOOKING INBOARD

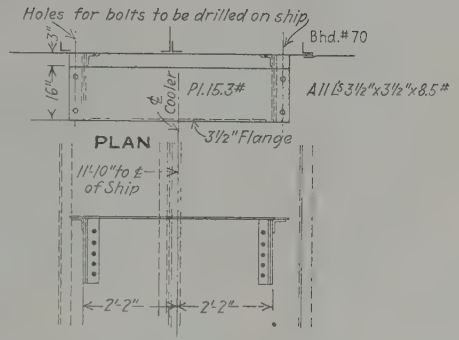
LUBRICATING OIL DRAIN TANK FOUND. STBD SIDE ONLY.

ELEV. STBD LOOKING FORD FR.#80

TURBO-GENERATORS-STBD ONLY

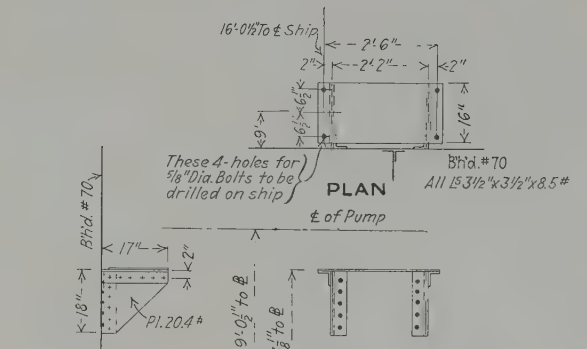


ELEV-LOOKING OUTBD



ELEV - LOOKING AFT.

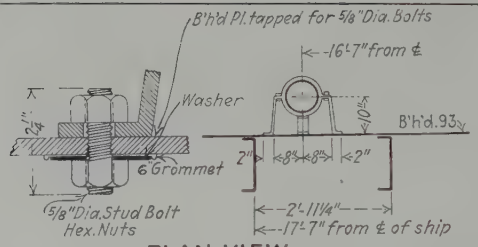
LUBRICATING OIL COOLER - PORT ONLY



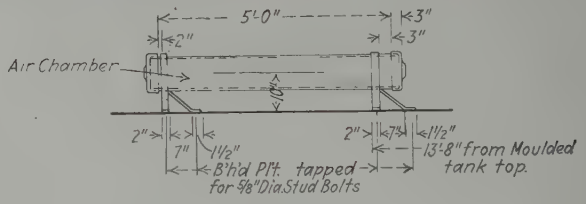
ELEV.-LOOKING INBD

ELEV.-LOOKING FORD

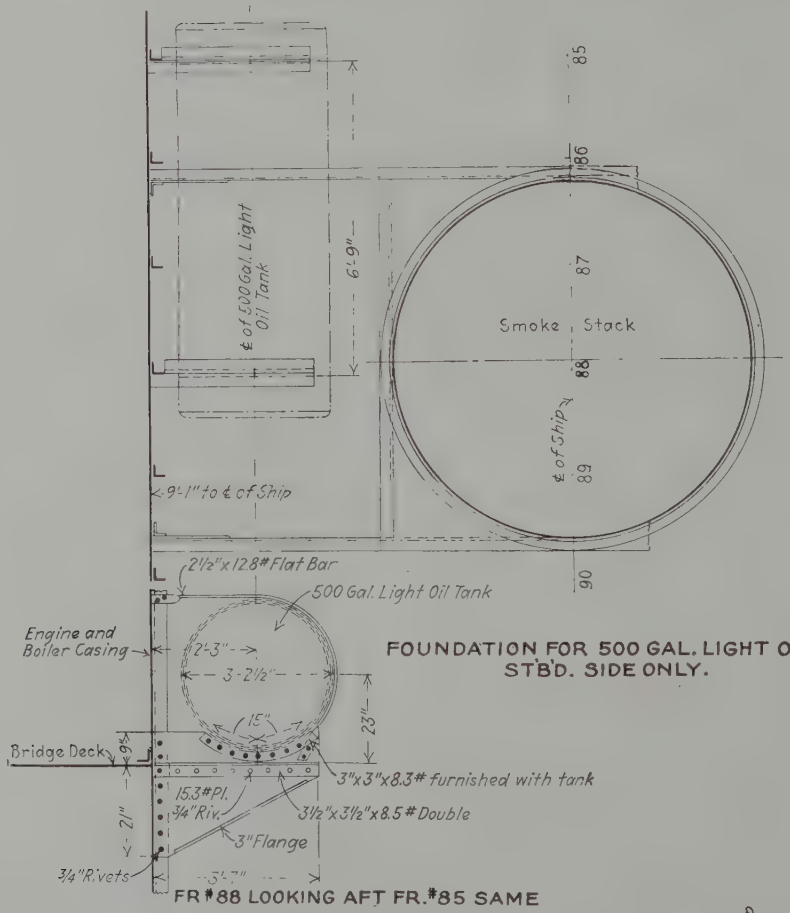
LUBRICATING OIL PUMP STBD ONLY



PLAN VIEW

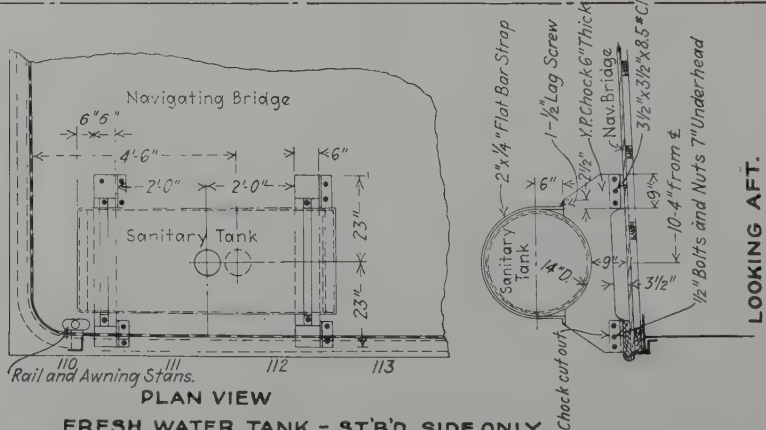


LOCATION OF AIR CHAMBER BRACKETS



FOUNDATION FOR 500 GAL. LIGHT OIL TANK ST'B'D. SIDE ONLY.

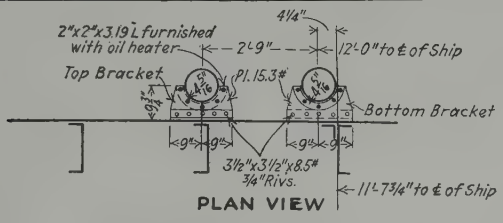
FR.#88 LOOKING AFT FR.#85 SAME



PLAN VIEW

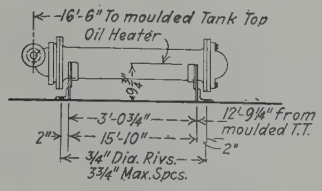
FRESH WATER TANK - ST'B'D. SIDE ONLY

9,000-TON D. W. FREIGHTER

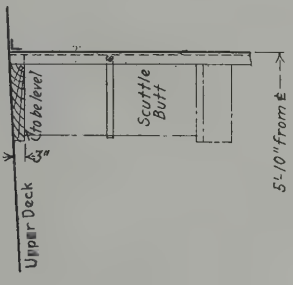


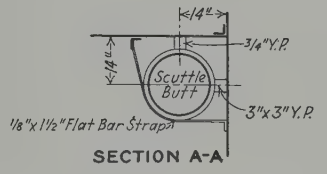
PLAN VIEW

OIL HEATER BRACKETS TO BHD #93
STBD SIDE ONLY

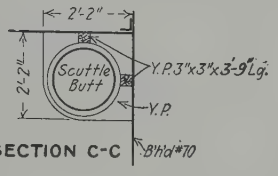


LOOKING OUTBOARD

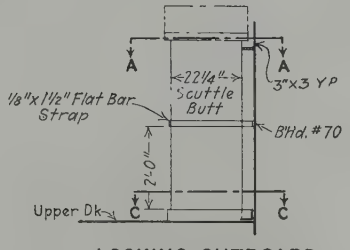




SECTION A-A

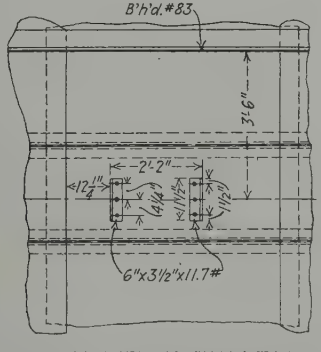


SECTION C-C

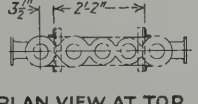


LOOKING OUTBOARD

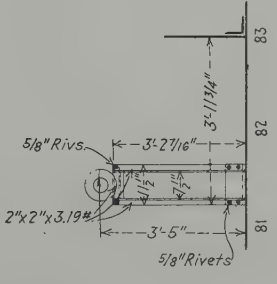
SCUTTLE BUTT FOUNDATION
PORT SIDE ONLY



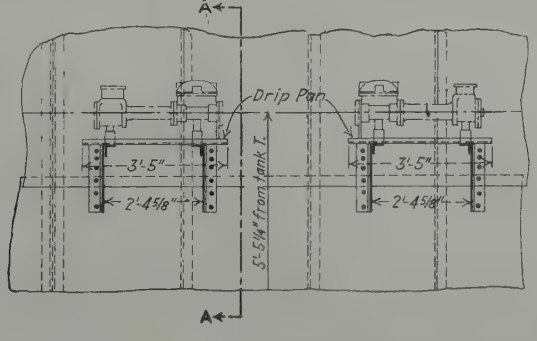
PLAN VIEW AT TANK TOP

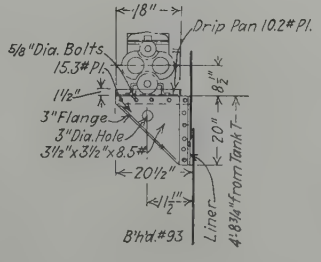


PLAN VIEW AT TOP

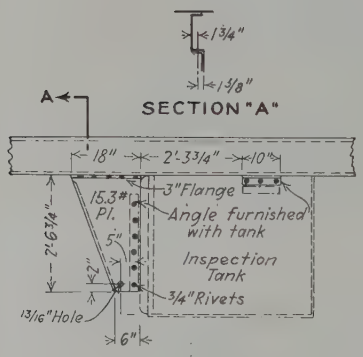


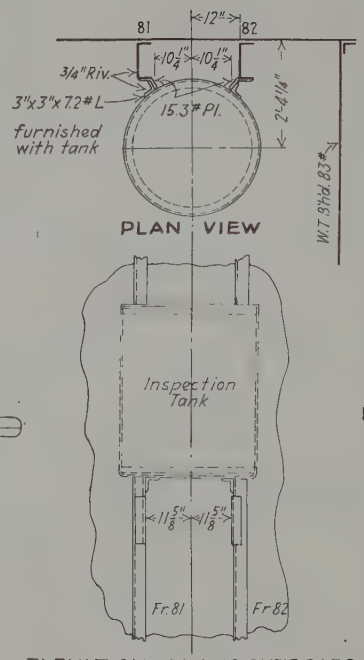
FEED PUMP MANIFOLD FOUNDATION
PORT SIDE ONLY

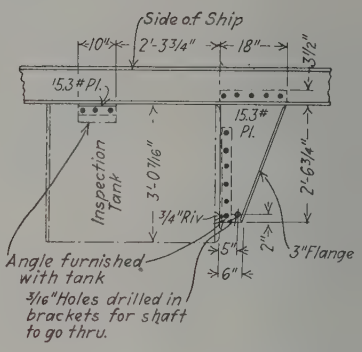




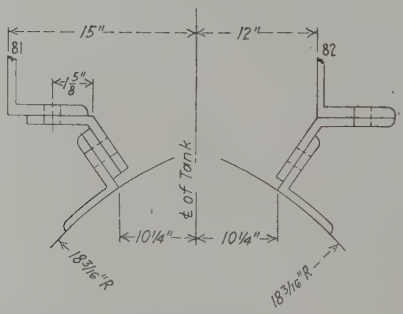
FUEL OIL SERVICE PUMP FOUNDATION
STARBOARD SIDE ONLY





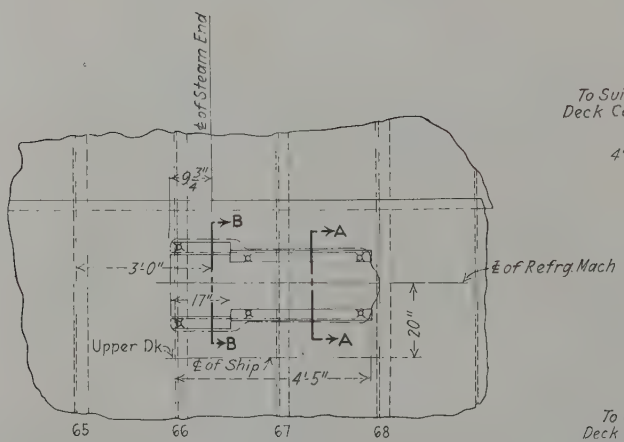


INSPECTION TANK FOUNDATION
PORT SIDE ONLY.

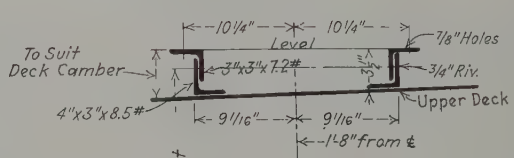


SECTION SHOWING CONN. TO TOP OF TANK

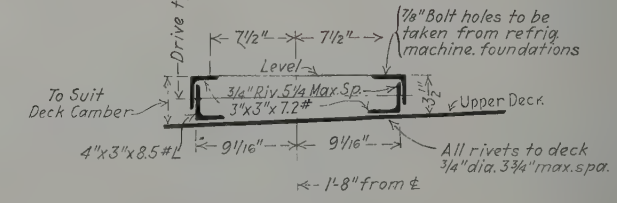
ELEVATION LOOKING OUTBOARD



PLAN VIEW



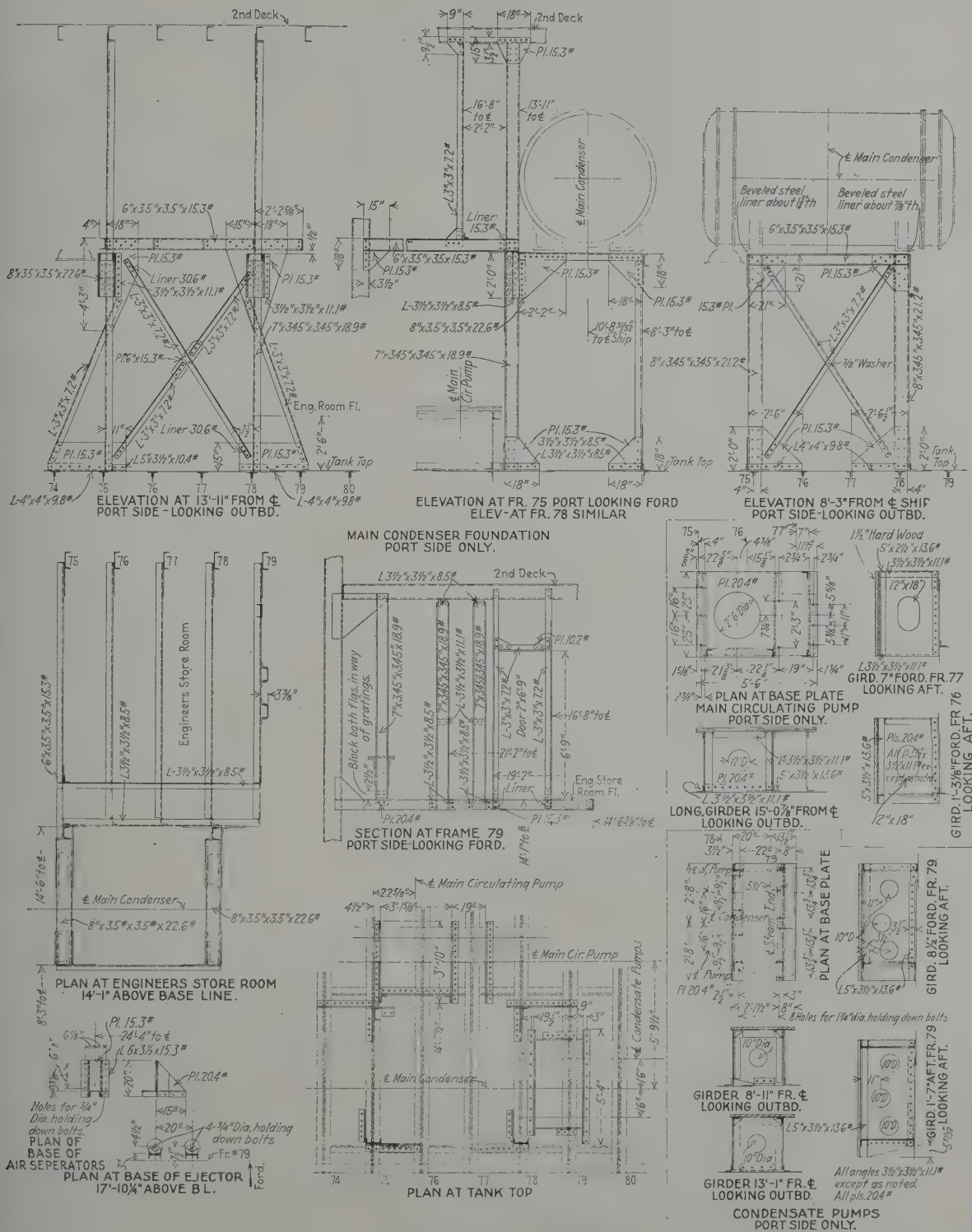
SECTION "B-B"



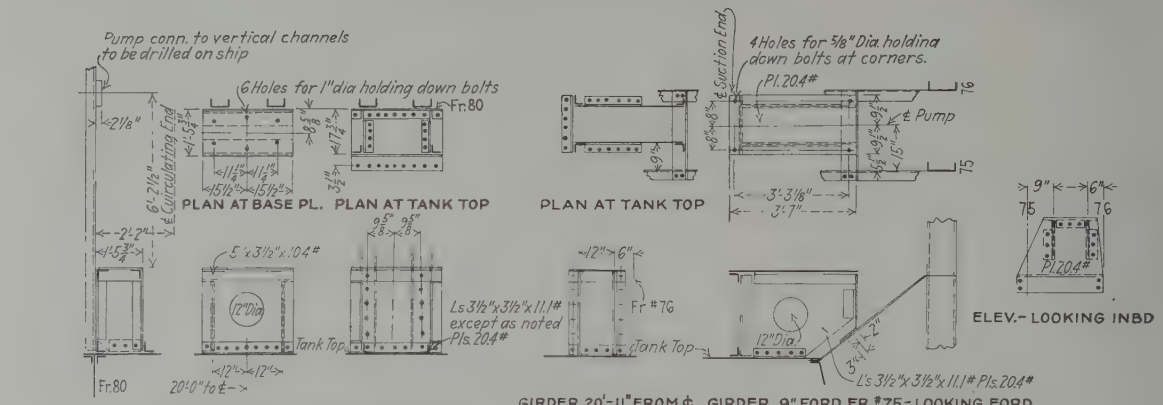
SECTION "A-A"

REFRIGERATOR MACHINE FOUNDATION
PORT SIDE ONLY

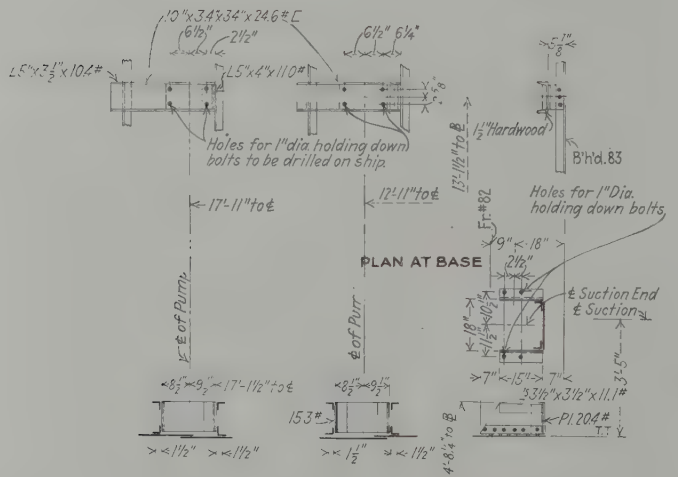
9,000-TON D. W. FREIGHTER

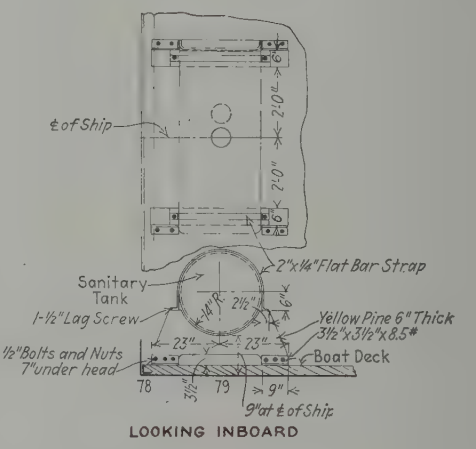

ELEVATION AT 13'-11" FROM ℄ PORT SIDE - LOOKING OUTBD.
ELEVATION AT FR. 75 PORT LOOKING FORD
ELEV - AT FR. 78 SIMILAR
ELEVATION 8'-3" FROM ℄ SHIP PORT SIDE - LOOKING OUTBD.
MAIN CONDENSER FOUNDATION PORT SIDE ONLY.
SECTION AT FRAME 79 PORT SIDE - LOOKING FORD.
PLAN AT ENGINEERS STORE ROOM 14'-1" ABOVE BASE LINE.
PLAN AT BASE OF AIR SEPERATORS
PLAN AT BASE OF EJECTOR 17'-10¼" ABOVE B.L.
PLAN AT TANK TOP
PLAN AT BASE PLATE MAIN CIRCULATING PUMP PORT SIDE ONLY.
GIRD. 7" FORD. FR. 77 LOOKING AFT.
LONG. GIRDER 15'-0⅞" FROM ℄ LOOKING OUTBD.
GIRD. 1'-3⅛" FORD. FR. 76 LOOKING AFT.
GIRD. 2" FORD. FR. 75 SIMILAR.
PLAN AT BASE PLATE
GIRD. 8½" FORD. FR. 79 LOOKING AFT.
GIRDER 8'-11" FR. ℄ LOOKING OUTBD.
GIRDER 13'-1" FR. ℄ LOOKING OUTBD.
GIRD. 1'-7" AFT. FR. 79 LOOKING AFT.
All angles 3½"x3½"x11.1# except as noted. All pls. 204#
CONDENSATE PUMPS PORT SIDE ONLY.

9,000-TON D. W. FREIGHTER

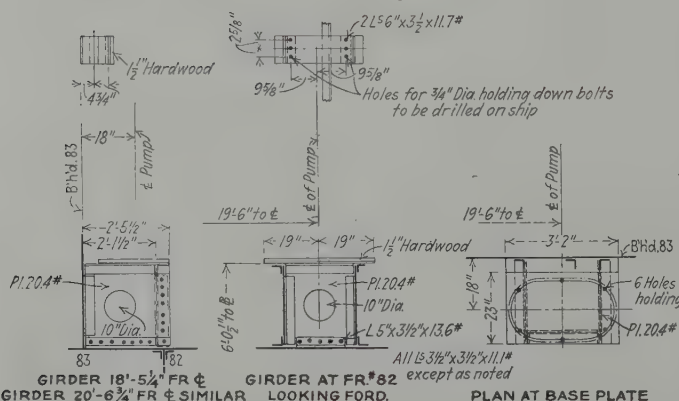

Pump conn. to vertical channels to be drilled on ship
6 Holes for 1" dia holding down bolts
Fr.80
℄ Circulating End
PLAN AT BASE PL.
PLAN AT TANK TOP
5"x3½"x.104#
12"Dia
Tank Top
Fr.80
20'-0" to ℄
GIRDER 17¾" AFT. FR.#80 LOOKING FORD.
GIRDER AT FR.#80 LOOKING FORD.
4 Holes for ⅝" Dia. holding down bolts at corners.
Pl.20.4#
℄ Suction End
℄ Pump
PLAN AT TANK TOP
Fr #76
Tank Top
Ls 3½"x3½"x11.1# except as noted Pls 20.4#
GIRDER 20'-11" FROM ℄ LOOKING INBD.
12"Dia
L's 3½"x3½"x11.1# Pls 20.4#
GIRDER 9" FORD FR.#75.- LOOKING FORD. GIRDER 6" AFT. FR.#76 SIMILAR.
FUEL OIL TRANSFER PUMP STBD ONLY.
Pl.20.4#
ELEV.- LOOKING INBD

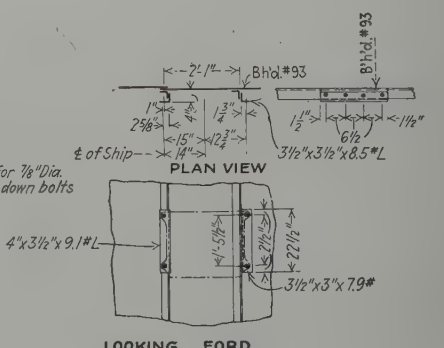
BALLAST PUMP
STARB'D ONLY

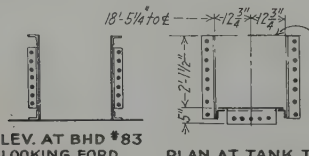




MAIN FEED PUMPS
PORT ONLY.

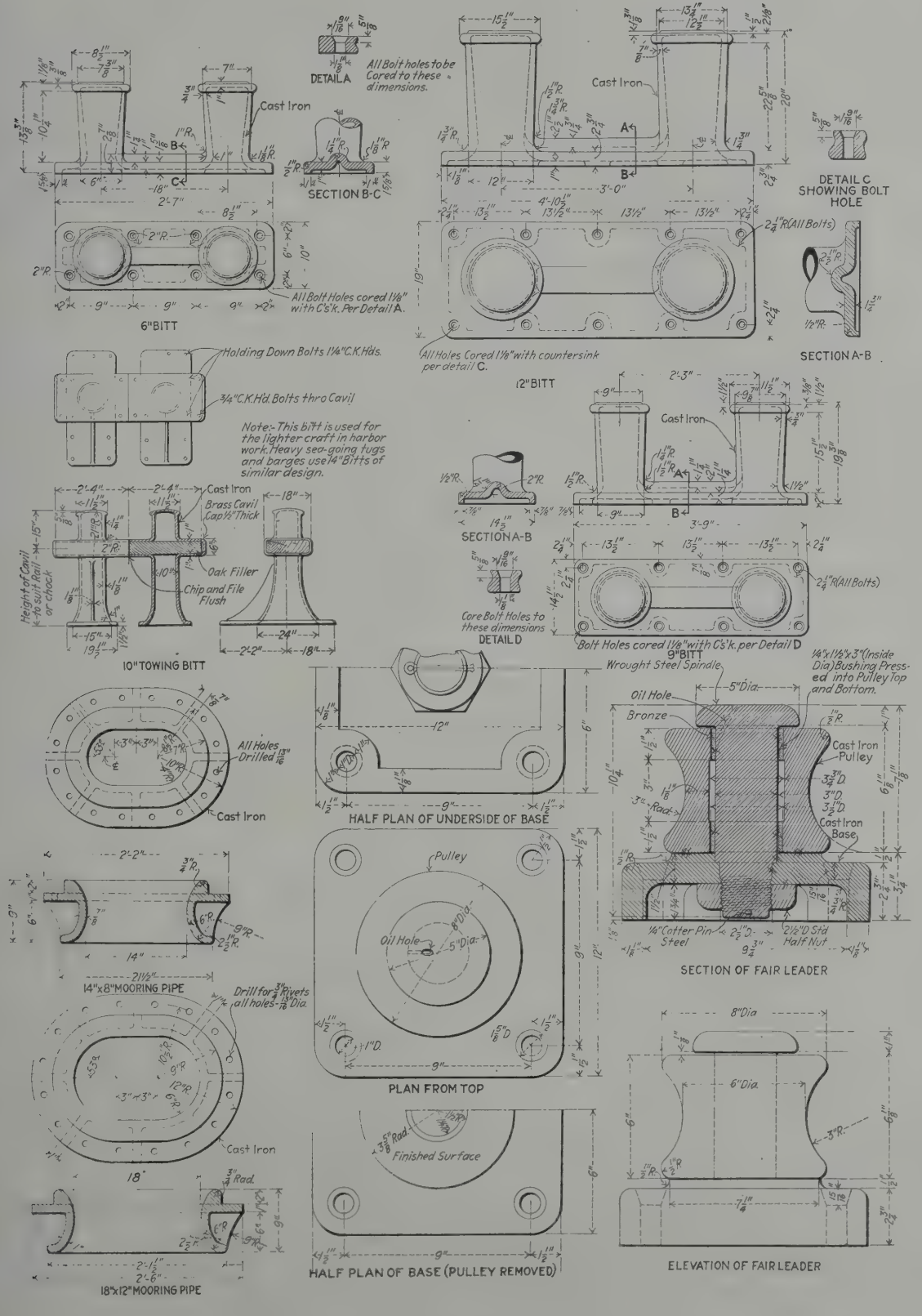

2L 6"x3½"x11.7#
½" Hardwood
Holes for ¾" Dia. holding down bolts to be drilled on ship
B'h'd.83
℄ Pump
℄ of Pumps
Pl.20.4#
10" Dia
L 5"x3½"x13.6#
All Ls 3½"x3½"x11.1# except as noted
6 Holes for ⅞" Dia. holding down bolts
GIRDER 18'-5¼" FR ℄ GIRDER 20'-6¾" FR ℄ SIMILAR
GIRDER AT FR.#82 LOOKING FORD.
PLAN AT BASE PLATE

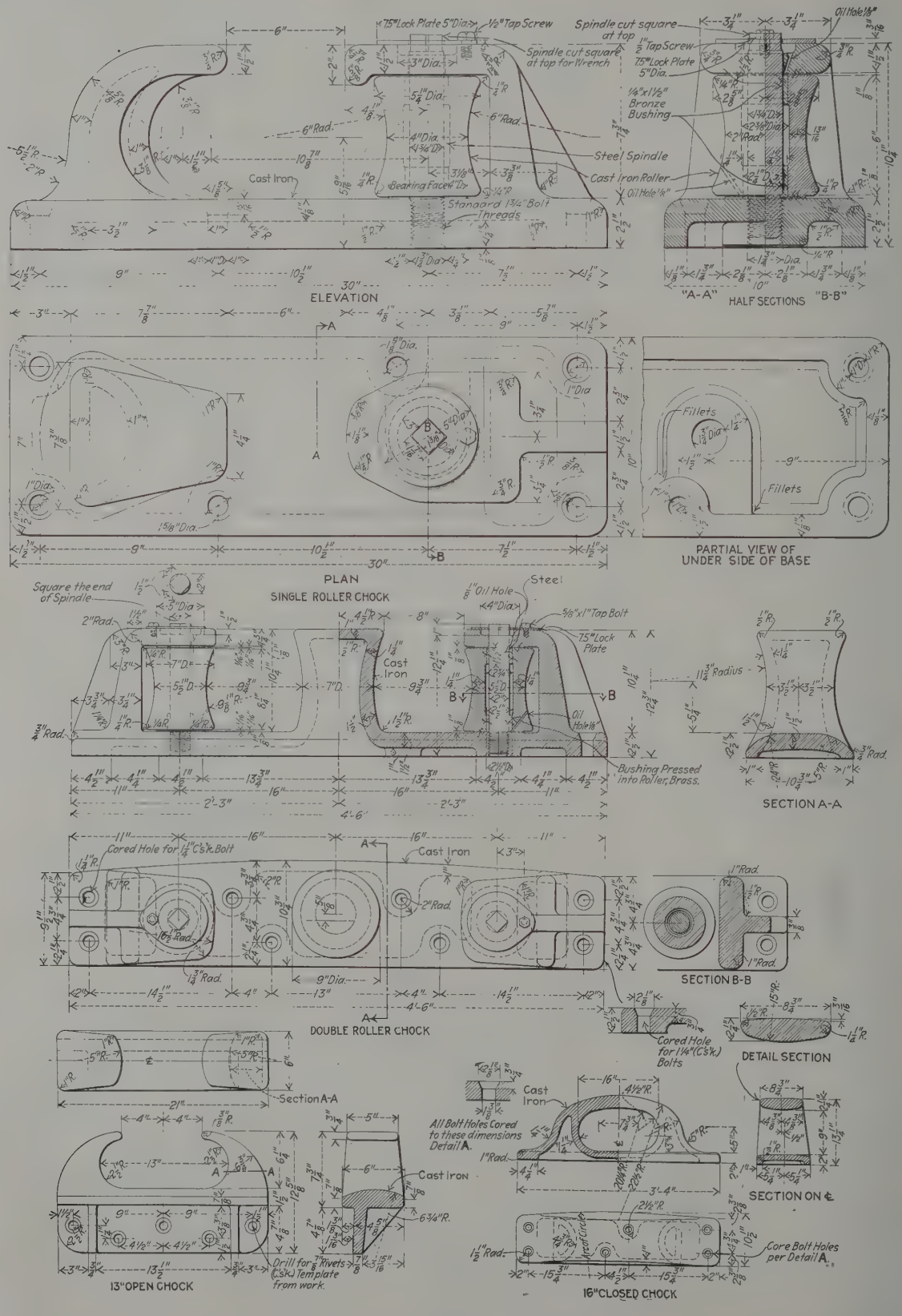


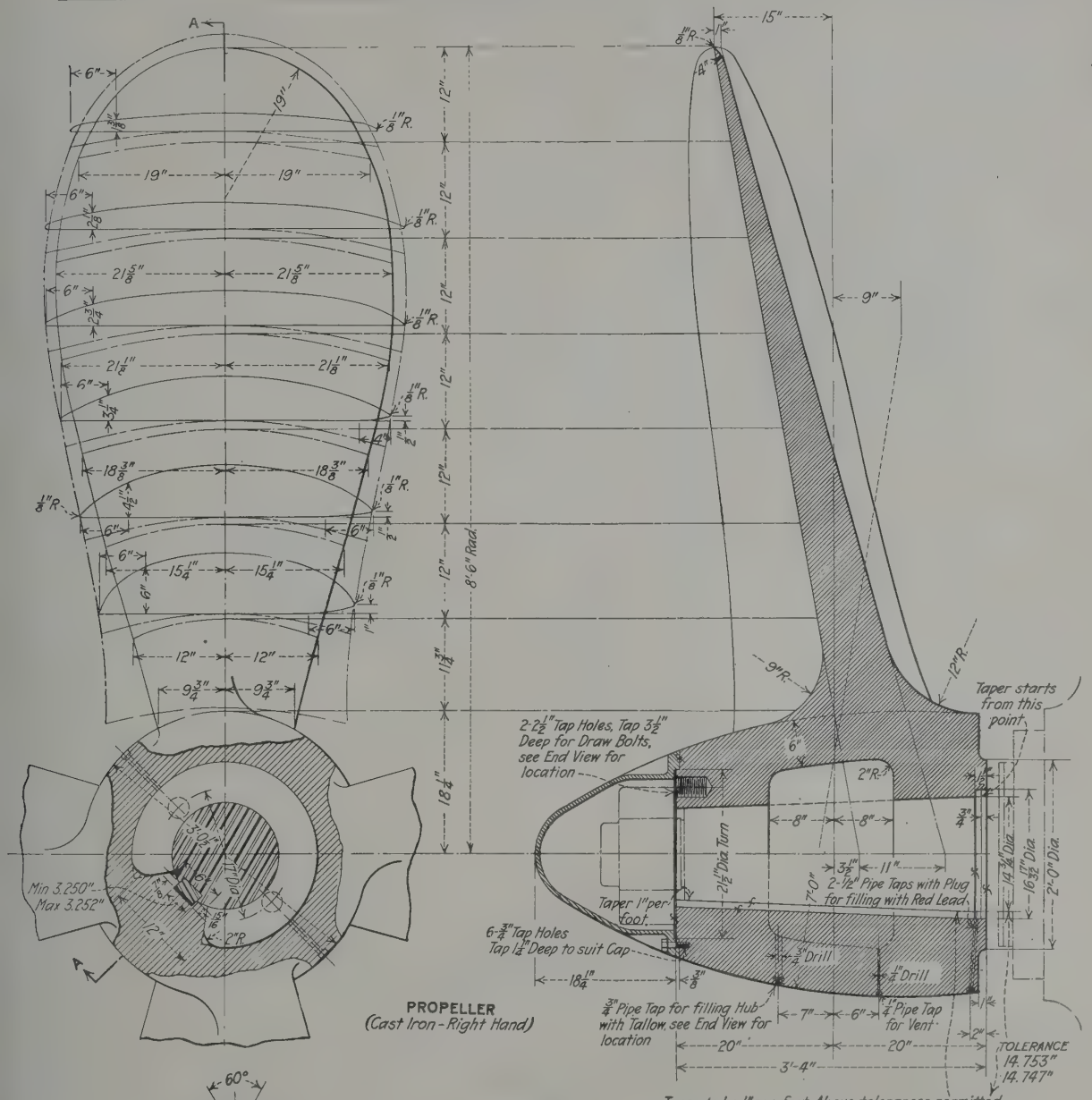


FIRE AND BILGE PUMP
STBD ONLY.

ASH HOISTING ENGINE FOUNDATION
STB'D SIDE ONLY.


DETAIL A
All Bolt holes to be Cored to these dimensions.
Cast Iron
SECTION B-C
All Bolt Holes cored 1⅛" with C'sk. Per Detail A.
6"BITT
All Holes Cored 1⅛" with countersink per detail C.
DETAIL C SHOWING BOLT HOLE
SECTION A-B
Holding Down Bolts 1¼"C.K.H'ds.
¾"C.K.H'd. Bolts thro Cavil
Note:- This bitt is used for the lighter craft in harbor work. Heavy sea-going tugs and barges use 14" Bitts of similar design.
12"BITT
SECTION A-B
Core Bolt Holes to these dimensions
DETAIL D
Bolt Holes cored 1⅛" with C'sk. per Detail D
Brass Cavil Cap ½" Thick
Oak Filler
Chip and File Flush
Height of Cavil to suit Rail or Chock
10"TOWING BITT
All Holes Drilled 13/16"
Cast Iron
HALF PLAN OF UNDERSIDE OF BASE
9"BITT
Wrought Steel Spindle
¼"x1½"x3" (Inside Dia) Bushing Pressed into Pulley Top and Bottom.
Oil Hole
Bronze
Cast Iron Pulley
Cast Iron Base
¼" Cotter Pin Steel
2½"D Std Half Nut
SECTION OF FAIR LEADER
14"x8"MOORING PIPE
Drill for ¾ Rivets all holes-⅞ Dia.
Pulley
Oil Hole
PLAN FROM TOP
Finished Surface
HALF PLAN OF BASE (PULLEY REMOVED)
ELEVATION OF FAIR LEADER
18"x12"MOORING PIPE

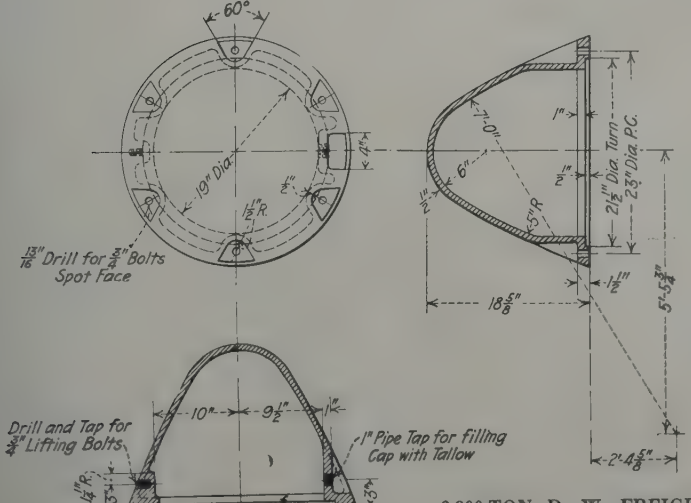

ELEVATION
"A-A"
HALF SECTIONS
"B-B"
PLAN
PARTIAL VIEW OF UNDER SIDE OF BASE
SINGLE ROLLER CHOCK
SECTION A-A
DOUBLE ROLLER CHOCK
SECTION B-B
DETAIL SECTION
Section A-A
SECTION ON ℄
13" OPEN CHOCK
16" CLOSED CHOCK
Cast Iron
Steel Spindle
Cast Iron Roller
Bushing Pressed into Roller, Brass.
Cored Hole for 1¼" (C'sk.) Bolts
All Bolt Holes Cored to these dimensions Detail A.
Core Bolt Holes per Detail A.
Drill for ⅞" Rivets (C'sk.) Template from work.



PROPELLER
(Cast Iron - Right Hand)

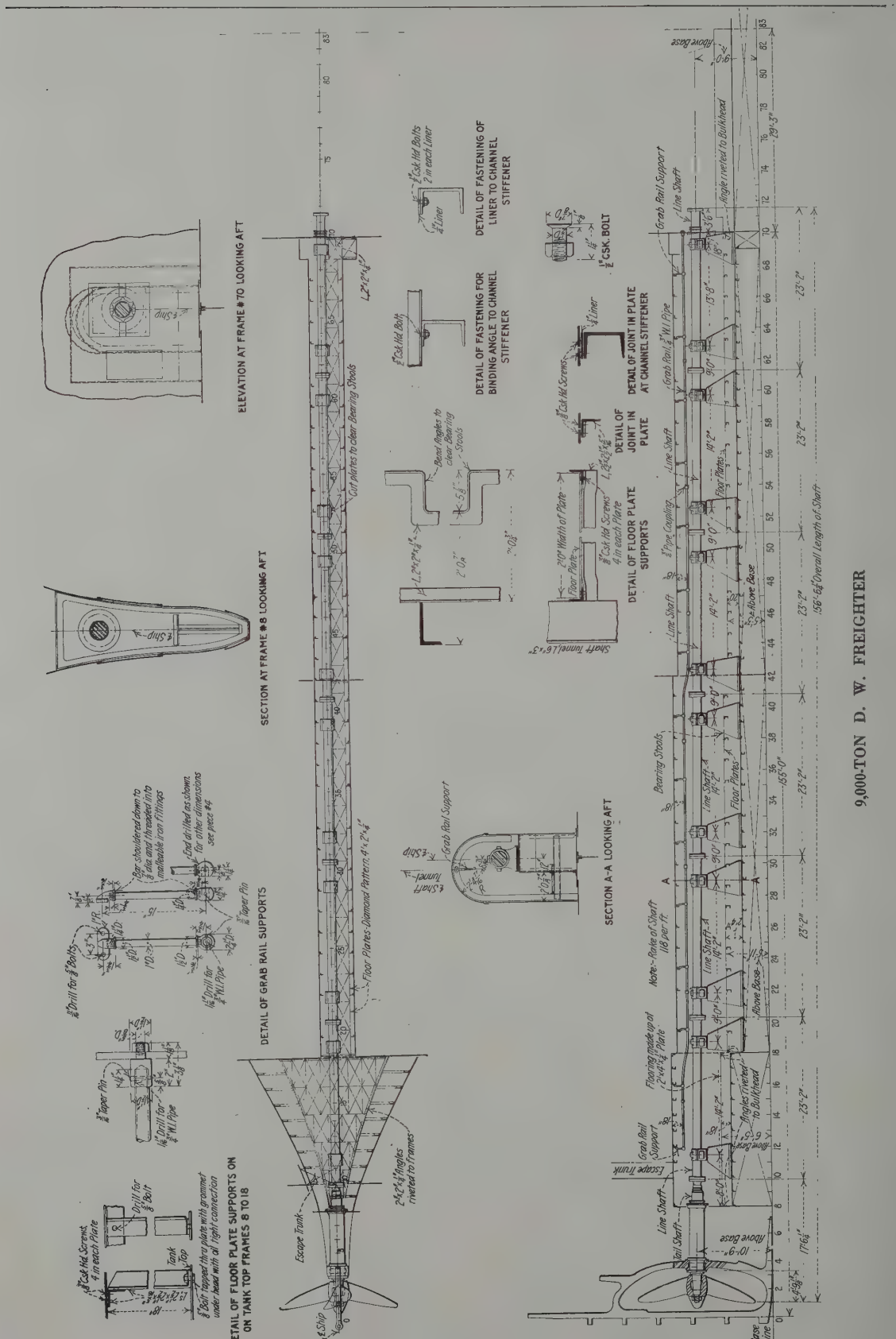
Taper to be 1" per foot. Above tolerances permitted, but if at any part tolerance is taken the same tolerance within limit of plus or minus .001" must apply to all other dimensions

Section A-A

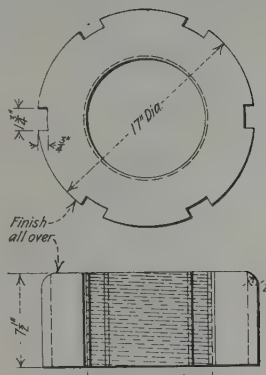


CAP
(Cast Iron)

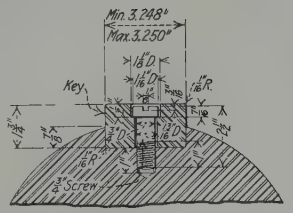
PROPELLER TRUE SCREW-RIGHT HAND	
Diameter	17'-0"
Pitch	14'-0"
Projected Area	78.86 Φ
Projected Area Ratio	.347
Developed Area	90.35 Φ
Number of Blades	4
Shaft Horsepower	3000
Revolutions per Minute	90
Speed	11 Knots


ELEVATION AT FRAME #70 LOOKING AFT
SECTION AT FRAME #8 LOOKING AFT
SECTION A-A LOOKING AFT
DETAIL OF GRAB RAIL SUPPORTS
DETAIL OF FASTENING FOR BINDING ANGLE TO CHANNEL STIFFENER
DETAIL OF FASTENING OF LINER TO CHANNEL STIFFENER
DETAIL OF JOINT IN PLATE AT CHANNEL STIFFENER
DETAIL OF FLOOR PLATE SUPPORTS
DETAIL OF FLOOR PLATE SUPPORTS ON ON TANK TOP FRAMES 8 TO 18
Escape Trunk
Line Shaft
Tail Shaft
Grab Rail Support
Floor Plates
Bearing Stools
Shaft Tunnel
Base Line
Above Base
Overall Length of Shaft

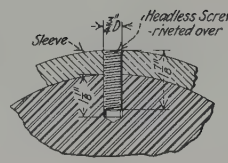
9,000-TON D. W. FREIGHTER



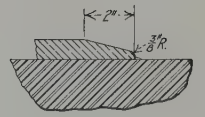
TAIL SHAFT UNIT



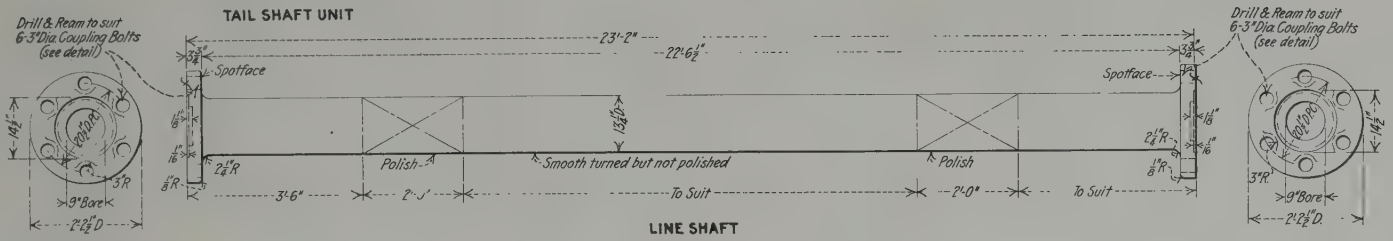
SECTION A-A



SECTION B-B

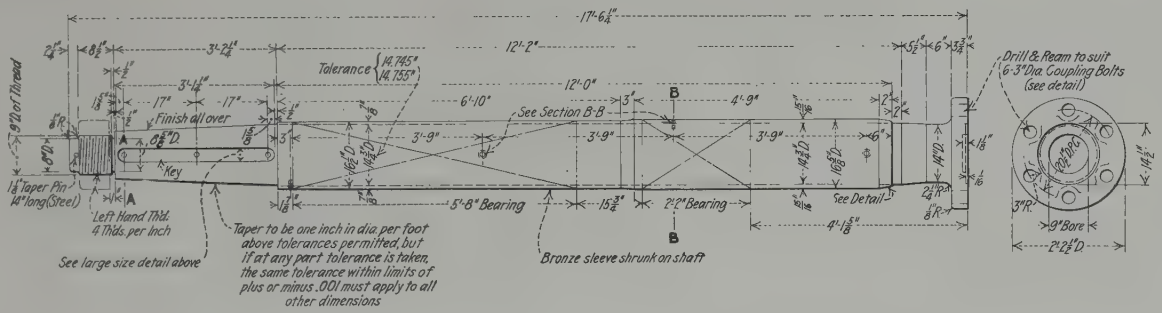


DETAIL FOR FINISHING END OF SLEEVE

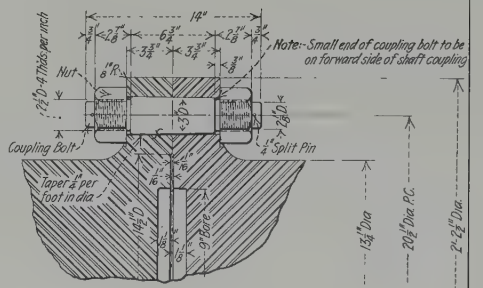


LINE SHAFT

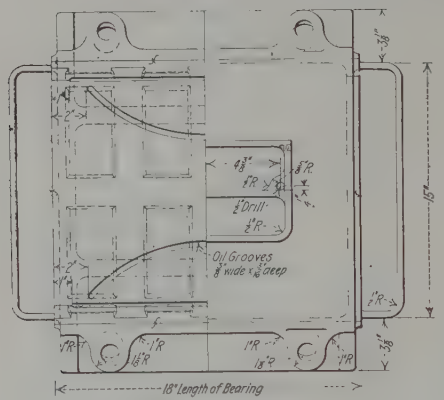
Note:- Shaft Horsepower 3000
Dia. Propeller 17'-0"
R.P.M. 90


17'-6¼"
12'-2"
12'-0"
Tolerance {14.745" 14.755"
Finish all over
Key
See Section B-B
See Detail
5'-8" Bearing
2'-2" Bearing
4'-1⅞"
Taper ⅛" per foot above tolerances permitted, but if at any part tolerance is taken, the same tolerance within limits of plus or minus .001 must apply to all other dimensions
Bronze sleeve shrunk on shaft
See large size detail above
1¾" Taper Pin 14" long (Steel)
Left Hand Thd. 4 Thds. per Inch
Drill & Ream to suit 6-3" Dia. Coupling Bolts (see detail)
9" Bore
2'-2½" D

TAIL SHAFT

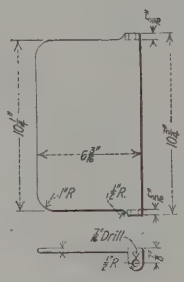


DETAIL FOR COUPLING BOLT

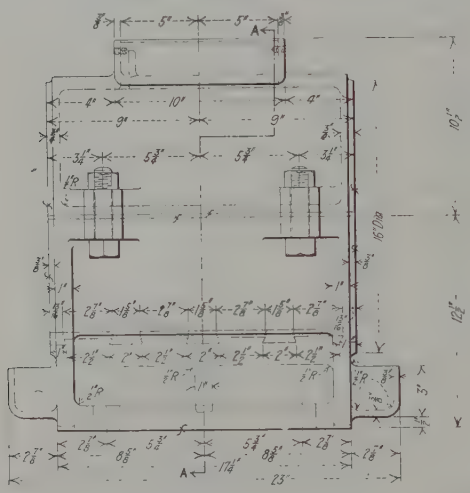


VIEW SHOWING CAP REMOVED

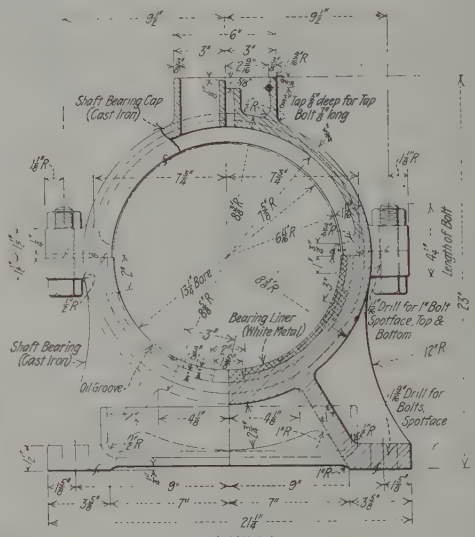
LID HINGE BOLT



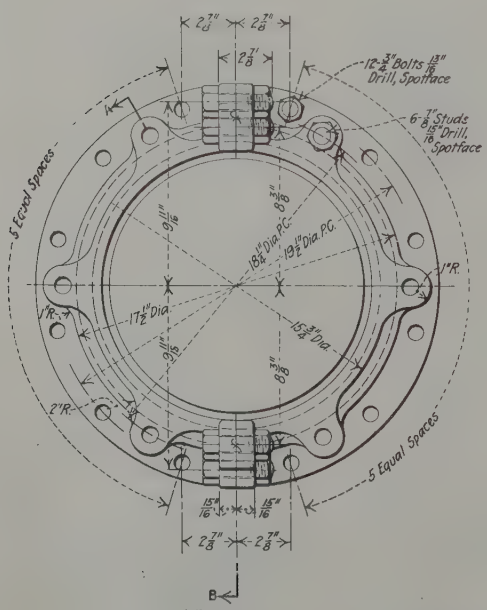
OIL POCKET LID
(Cast Iron)

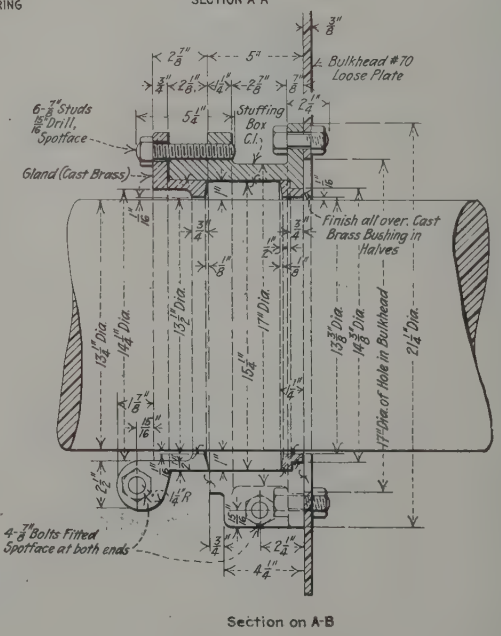


LINE SHAFT BEARING



SECTION A-A

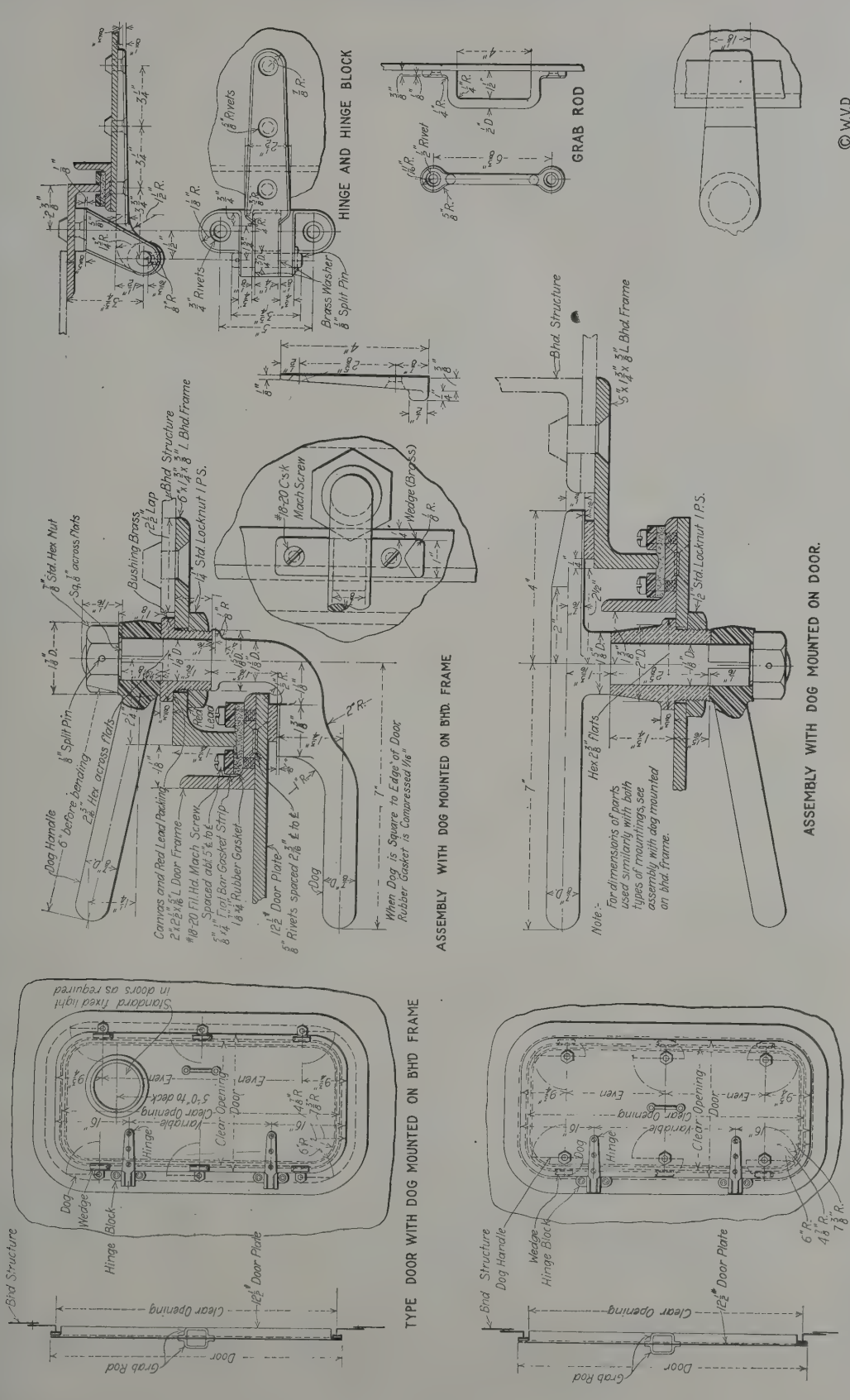


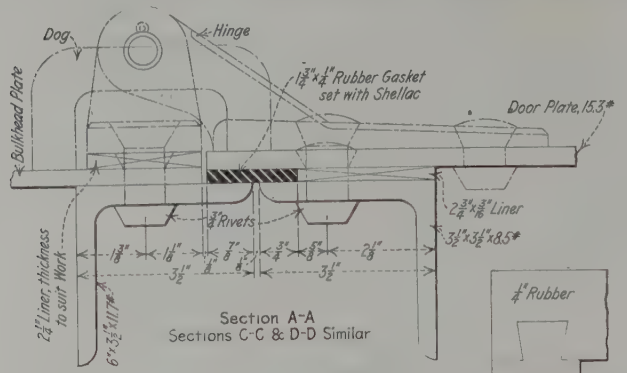

Bulkhead #70 Loose Plate
6-⅞" Studs 15/16" Drill, Spotface
Stuffing Box Cl.
Gland (Cast Brass)
Finish all over. Cast Brass Bushing in Halves
4-⅞" Bolts Fitted Spotface at both ends

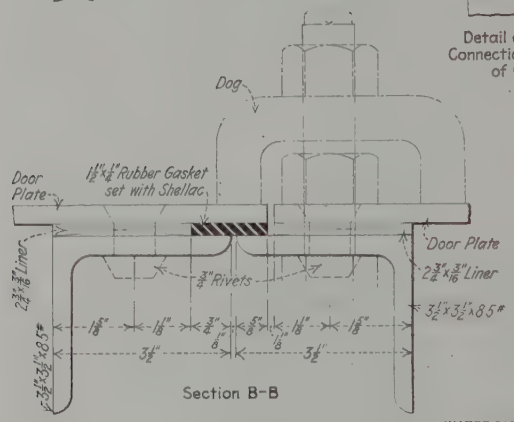
Section on A-B

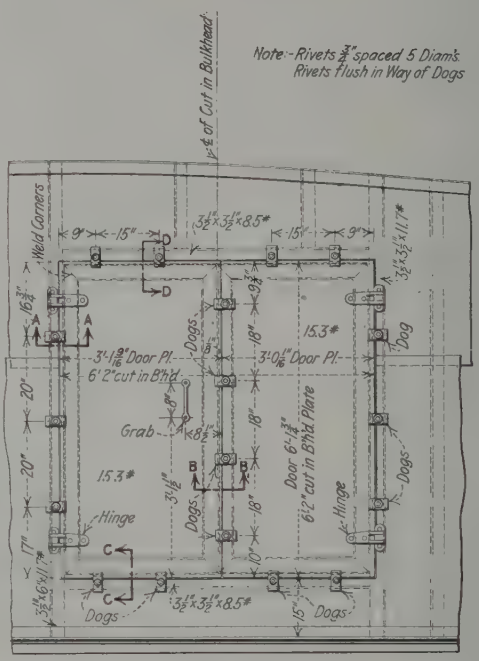
BULKHEAD STUFFING BOX

9,000-TON D. W. FREIGHTER

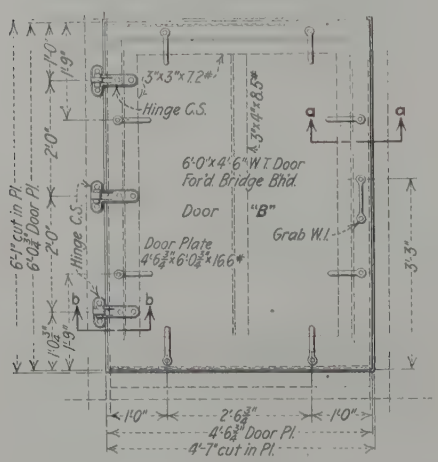

HINGE AND HINGE BLOCK
GRAB ROD
ASSEMBLY WITH DOG MOUNTED ON BHD. FRAME
ASSEMBLY WITH DOG MOUNTED ON DOOR.
TYPE DOOR WITH DOG MOUNTED ON BHD FRAME
TYPE DOOR WITH DOG MOUNTED ON DOOR
Standard fixed light in doors as required
Clear Opening
Door
Grab Rod
Bhd Structure
Dog
Wedge
Hinge Block
Hinge
Dog Handle
Door Plate
Note:- For dimensions of parts used similarly with both types of mountings, see assembly with dog mounted on bhd. frame.
© W.V.D

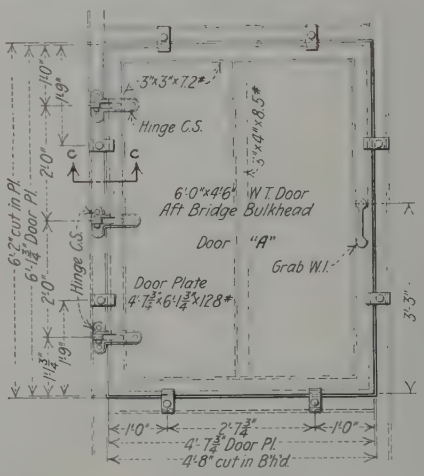


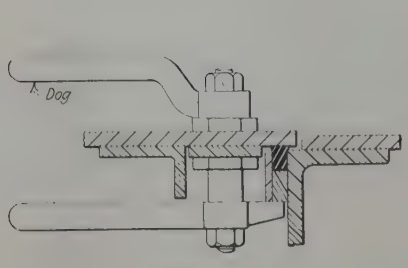


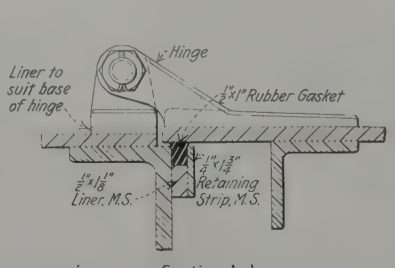


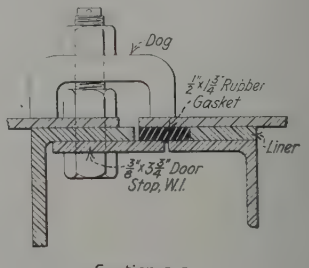
WATER TIGHT DOORS IN TWEEN DECK BULKHEADS







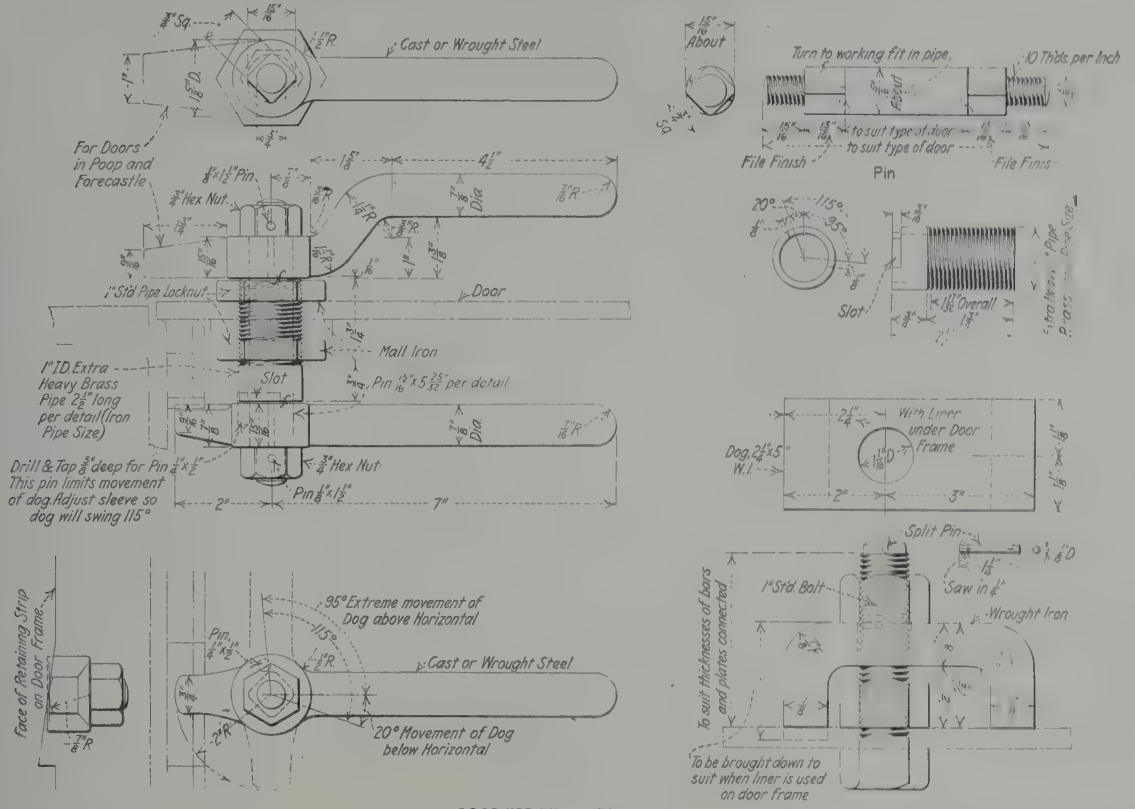




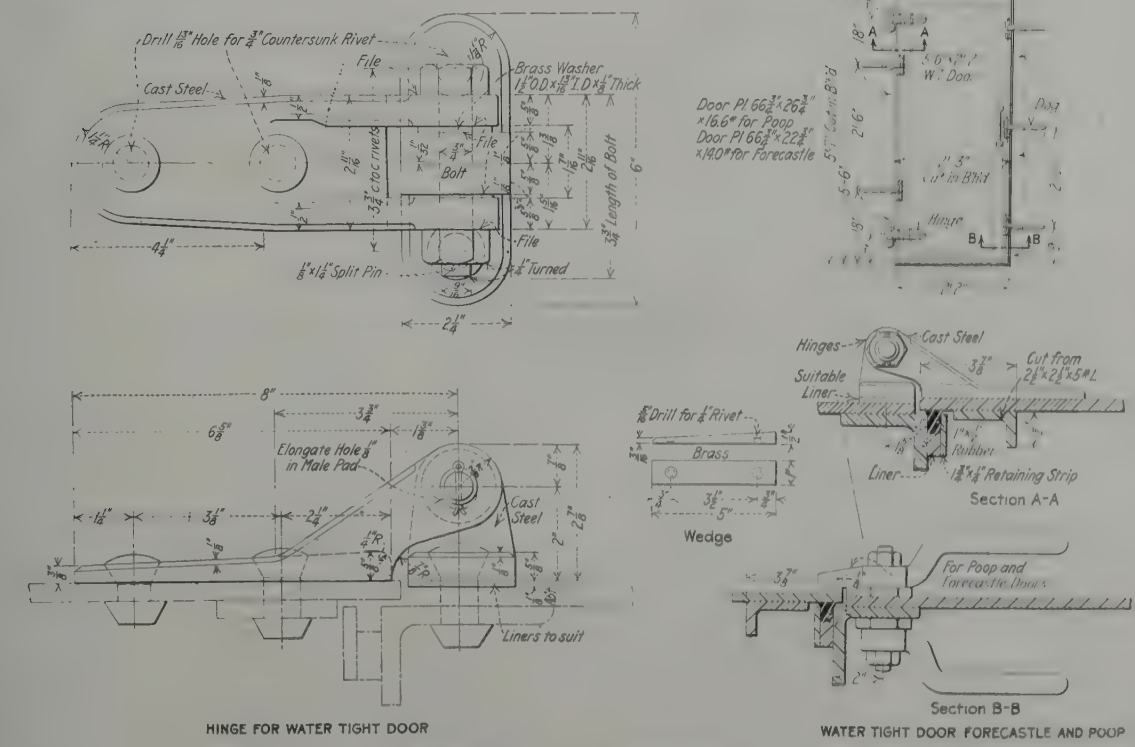
WATER TIGHT DOORS IN BRIDGE BULKHEAD

8,800-TON D. W. FREIGHTER

See Opposite Page


Cast or Wrought Steel
For Doors in Poop and Forecastle
Door
Mall Iron
Slot
Drill & Tap deep for Pin
This pin limits movement of dog. Adjust sleeve so dog will swing 115°
Turn to working fit in pipe
10 Thds. per Inch
File Finish
Pin
to suit type of door
Slot
Overall
With Liner under Door Frame
Dog, W.I.
Split Pin
Saw in
Wrought Iron
1" Std. Bolt
To suit thicknesses of bars and plates connected
To be brought down to suit when liner is used on door frame
Face of Retaining Strip on Door Frame
95° Extreme movement of Dog above Horizontal
115°
20° Movement of Dog below Horizontal

DOGS FOR WATER TIGHT DOORS



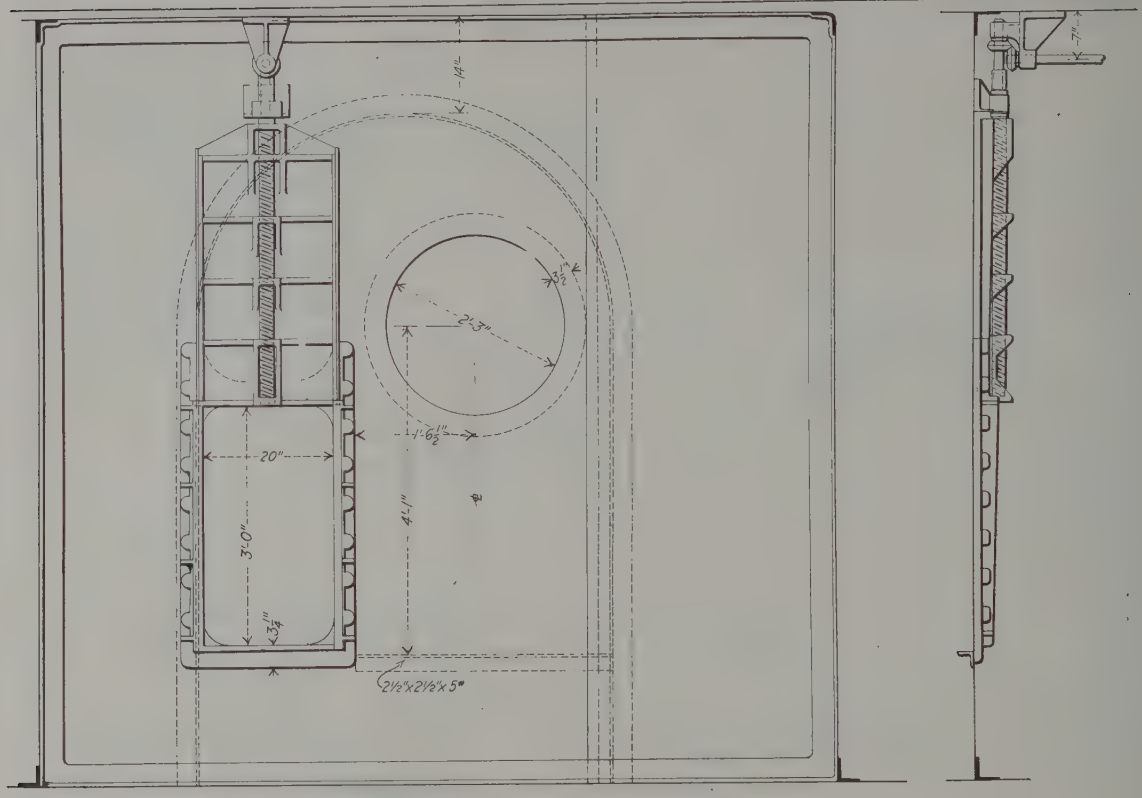
HINGE FOR WATER TIGHT DOOR

WATER TIGHT DOOR FORECASTLE AND POOP

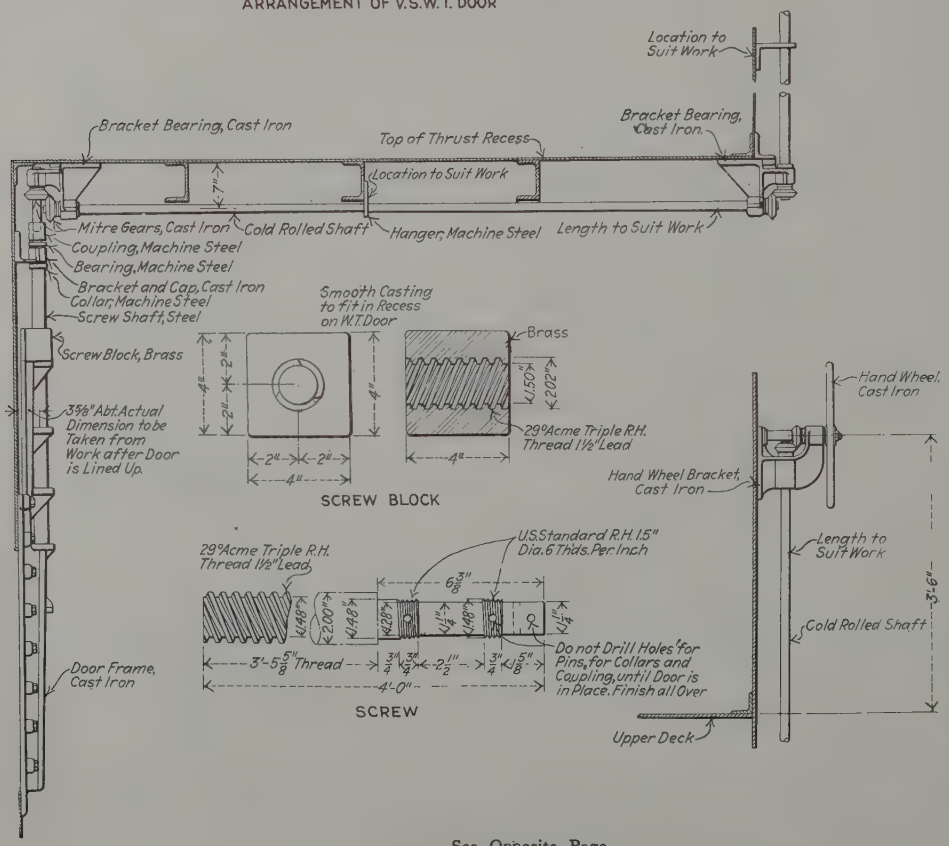
8,800-TON D. W. FREIGHTER

See Opposite Page

VERTICAL SLIDING WATER TIGHT DOOR

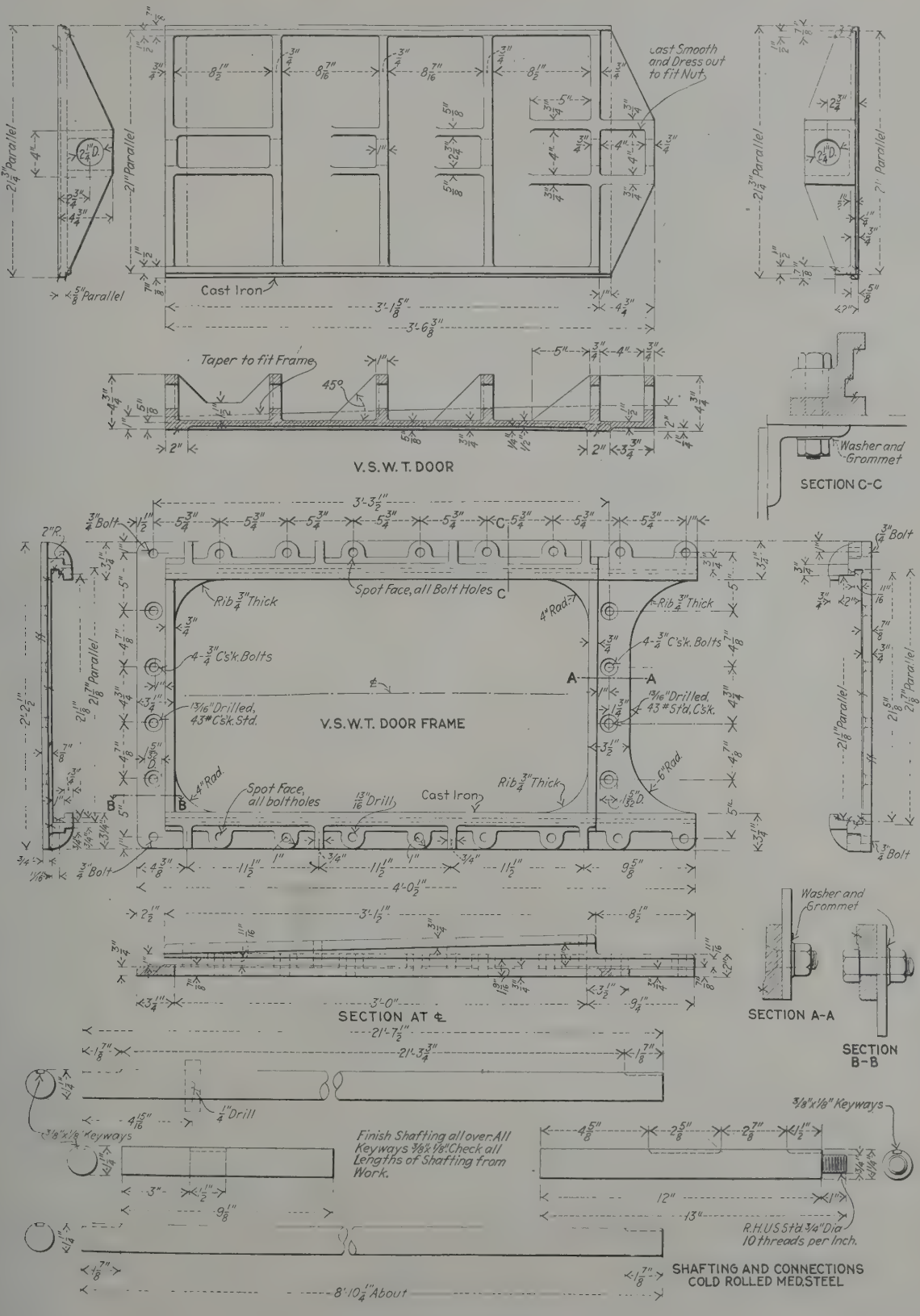


ARRANGEMENT OF V.S.W.T. DOOR



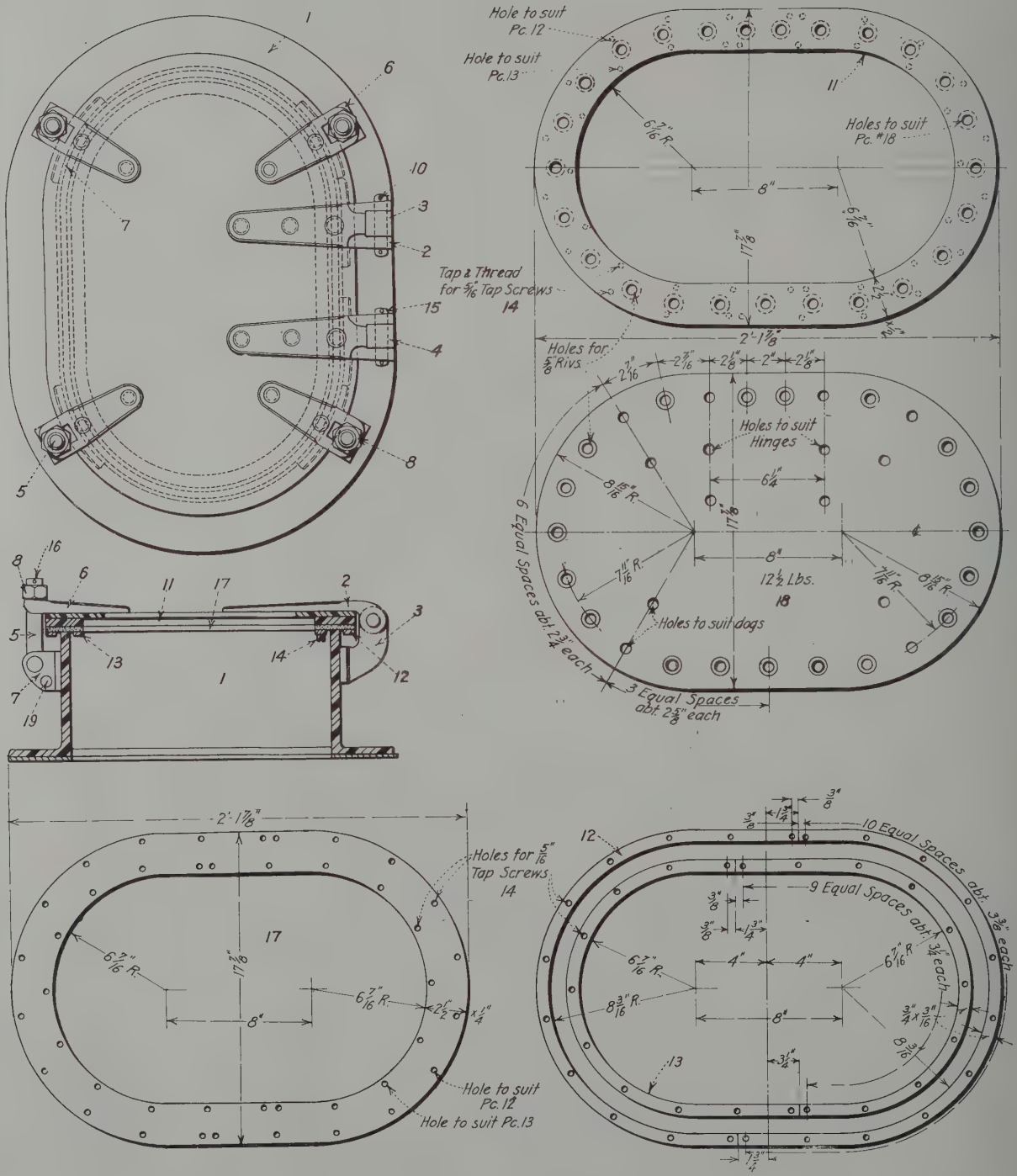
See Opposite Page

VERTICAL SLIDING WATER TIGHT DOOR


Cast Smooth and Dress out to fit Nut
Cast Iron
Taper to fit Frame
45°
V.S.W.T. DOOR
Washer and Grommet
SECTION C-C
Spot Face, all Bolt Holes
Rib ¾" Thick
4-¾" C'sk. Bolts
13/16" Drilled, 43# C'sk. Std.
V.S.W.T. DOOR FRAME
Spot Face, all boltholes
Cast Iron
SECTION AT ℄
SECTION A-A
SECTION B-B
Finish Shafting all over. All Keyways ⅜"x⅛" Check all Lengths of Shafting from Work.
⅜"x⅛" Keyways
R.H.U.S.Std. ¾" Dia 10 threads per Inch.
SHAFTING AND CONNECTIONS COLD ROLLED MED. STEEL

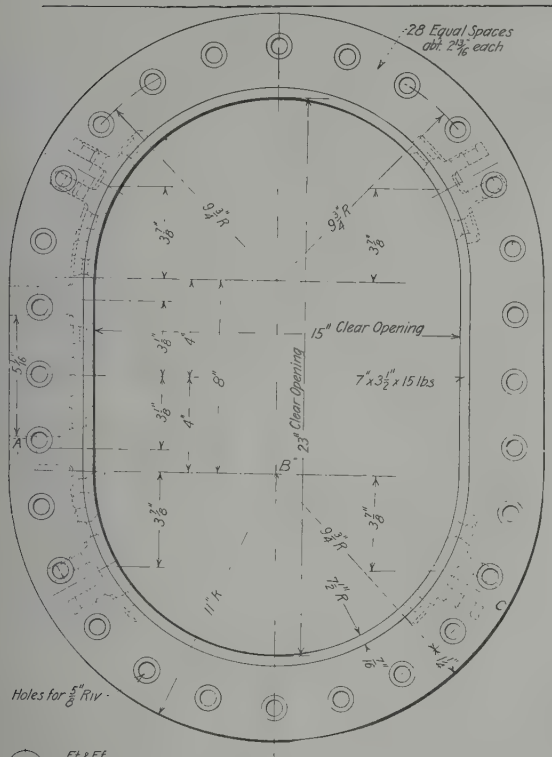
See Opposite Page

DETAILS OF RAISED WATERTIGHT MANHOLE



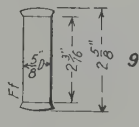
See Opposite Page.

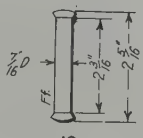
DETAILS OF RAISED WATERTIGHT MANHOLE

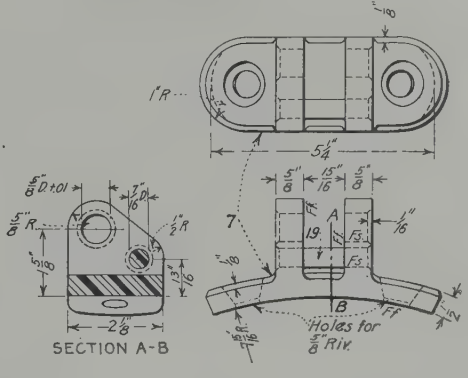


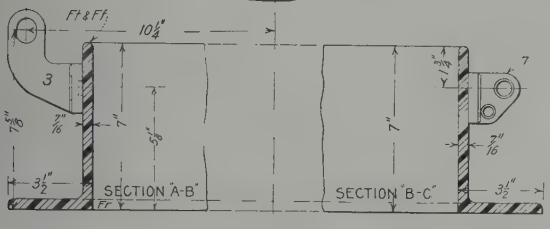
LIST OF MATERIAL FOR ONE W.T. MANHOLE COVER

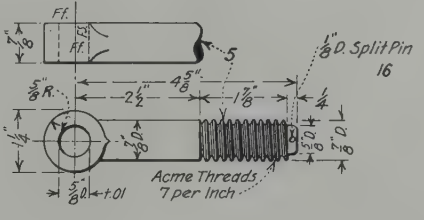
Pc. No.	No. Pcs.	Name	Mat'l	Remarks
1	1	Frame	Med. steel	High coaming.
2	2	Hinge	Med. steel	Galvanized.
3	1	Hinge pad.....	Med. steel	Galvanized.
4	1	Hinge pad.....	Med. steel	Galvanized.
5	4	Bolt, ⅞" dia...	Comp.	
6	4	Dog	Med. steel	Galvanized.
7	4	Bolt pad	Med. steel	Galvanized.
8	4	Nut, ⅞"	Comp.	Acme threads.
9	4	Pin, ⅝" dia...	Comp.	
10	2	Hinge pin, ¾" dia.	Comp.	
11	1	Cover frame...	Med. steel	2¼" x ½" flat bar.
12	2	Gasket strip....	Med. steel	Galv. ¾" x 3/16"
13	2	Gasket strip....	Med. steel	Galv. ¾" x 3/16"
14	42	Tap screw ⅛".	Comp.	¾" long.
15	4	Split pin, ¼" dia.	Comp.	
16	4	Split pin, ⅛" dia.	Comp.	
17	1	Gasket	Rubber	2¼" x ¼"
18	1	Cover plate....	Med. steel	12½ lbs.
19	4	Pin	Med. steel	Galvanized.

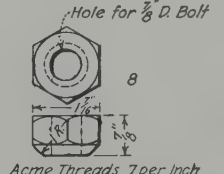


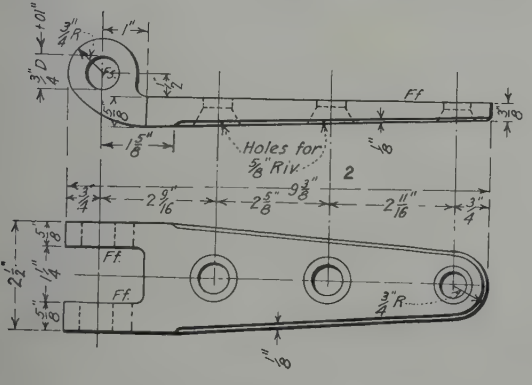


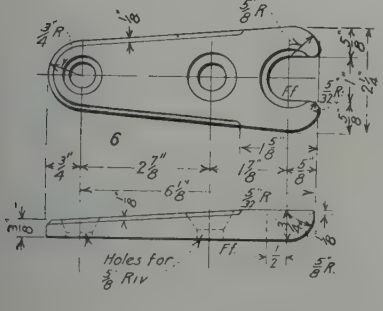


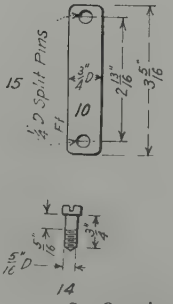


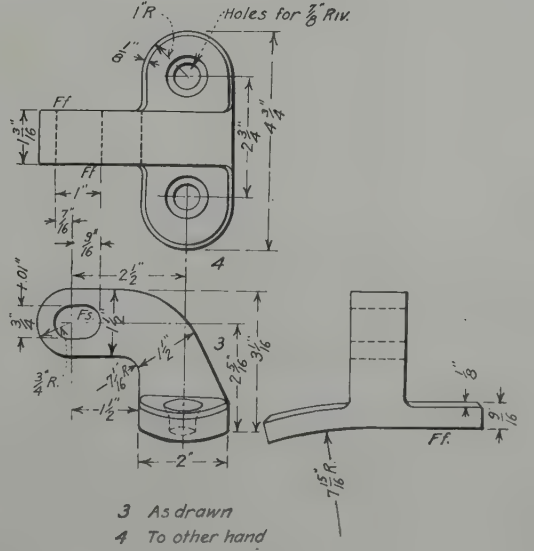






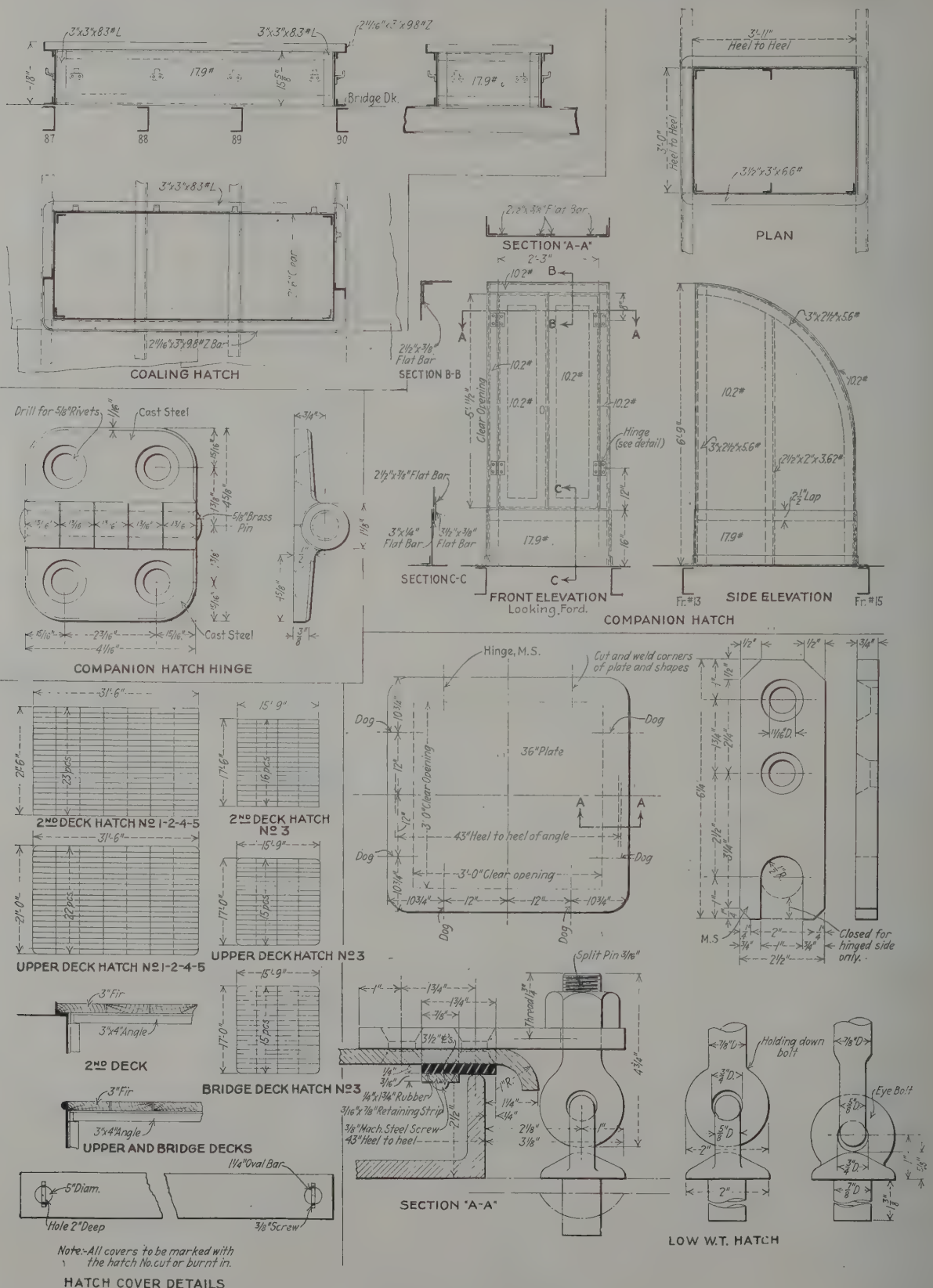






See Opposite Page.

COMPANION, COALING, AND LOW W. T. HATCH DETAILS



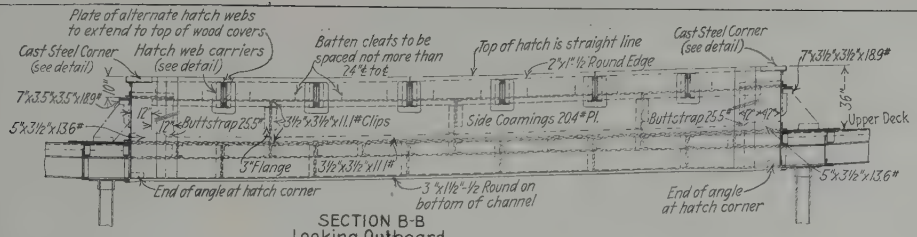
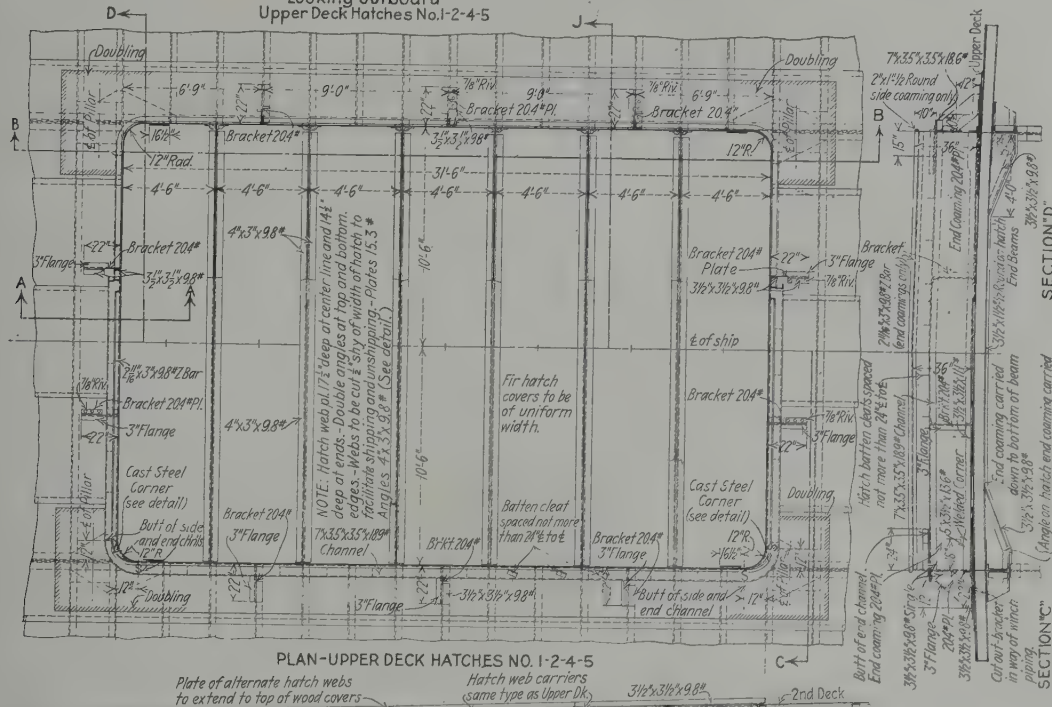


Plate of alternate hatch webs to extend to top of wood covers
Cast Steel Corner (see detail)
Hatch web carriers (see detail)
Batten cleats to be spaced not more than 24" c to c
Top of hatch is straight line
2"x1"-½ Round Edge
Cast Steel Corner (see detail)
7"x3½"x3½"x18.9#
7"x3.5"x3.5"x18.9#
5"x3½"x13.6#
12" Buttstrap 25.5#
3½"x3½"x11.1# Clips
Side Coamings 20.4# Pl.
Buttstrap 25.5#
Upper Deck
3" Flange
3½"x3½"x11.1#
End of angle at hatch corner
3"x1½"-½ Round on bottom of channel
End of angle at hatch corner

SECTION B-B
Looking Outboard
Upper Deck Hatches No. 1-2-4-5


Doubling
Bracket 20.4# Pl.
Bracket 20.4#
12" Rad.
4"x3"x9.8#
Bracket 20.4# Plate
Fir hatch covers to be of uniform width.
Cast Steel Corner (see detail)
Batten cleat spaced not more than 24" c to c
7"x3.5"x3.5"x18.9# Channel
Hatch batten cleats spaced not more than 24" c to c
Butt of side and end chain
Butt of end channel
End coaming 20.4# Pl.
Upper Deck
End Coaming 20.4# Pl.
End Beams K 4.0#
Angle on hatch end coaming carried around radius corner as far as possible.
2nd coaming carried down to bottom of beam
Coaming Angle
Carlins
Carlin bracket in way of winch piping.
Side Coaming 30.6#
Cast Steel Corner Piece (see detail)
Butt of side and end channel

SECTION "D"
Looking aft.

SECTION "C"
Looking Aft.

PLAN-UPPER DECK HATCHES NO. 1-2-4-5

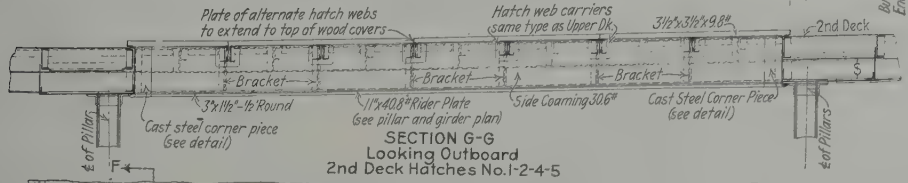
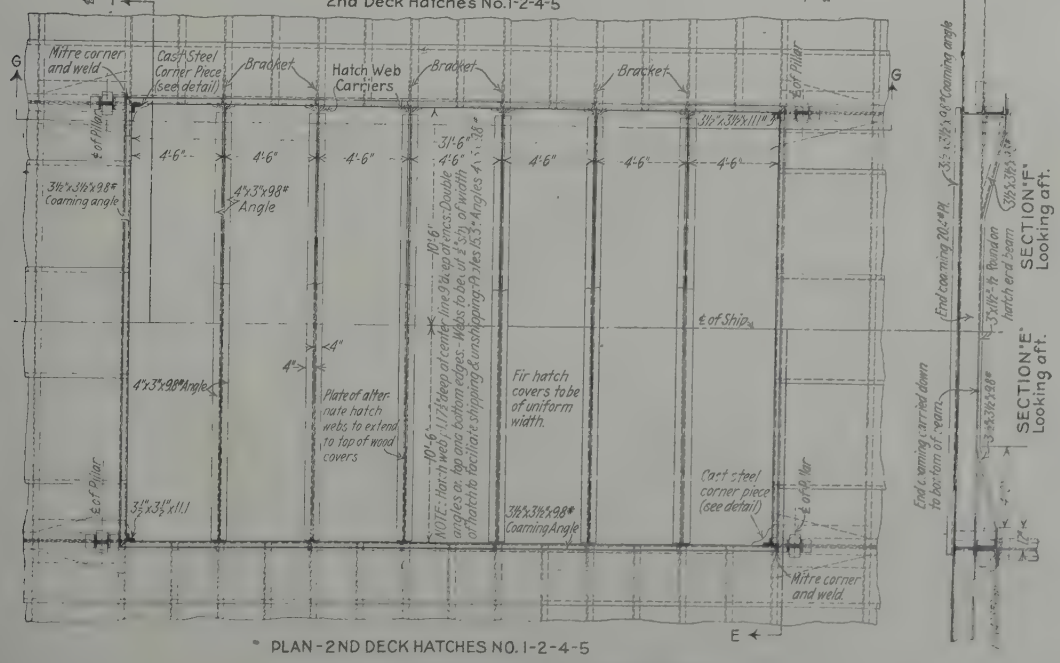


Plate of alternate hatch webs to extend to top of wood covers
Hatch web carriers (same type as Upper Dk.)
3½"x3½"x9.8#
2nd Deck
Bracket
3"x1½"-½ Round
Cast steel corner piece (See detail)
11"x40.8# Rider Plate (see pillar and girder plan)
Side Coaming 30.6#
Cast Steel Corner Piece (see detail)
℄ of Pillars

SECTION G-G
Looking Outboard
2nd Deck Hatches No. 1-2-4-5

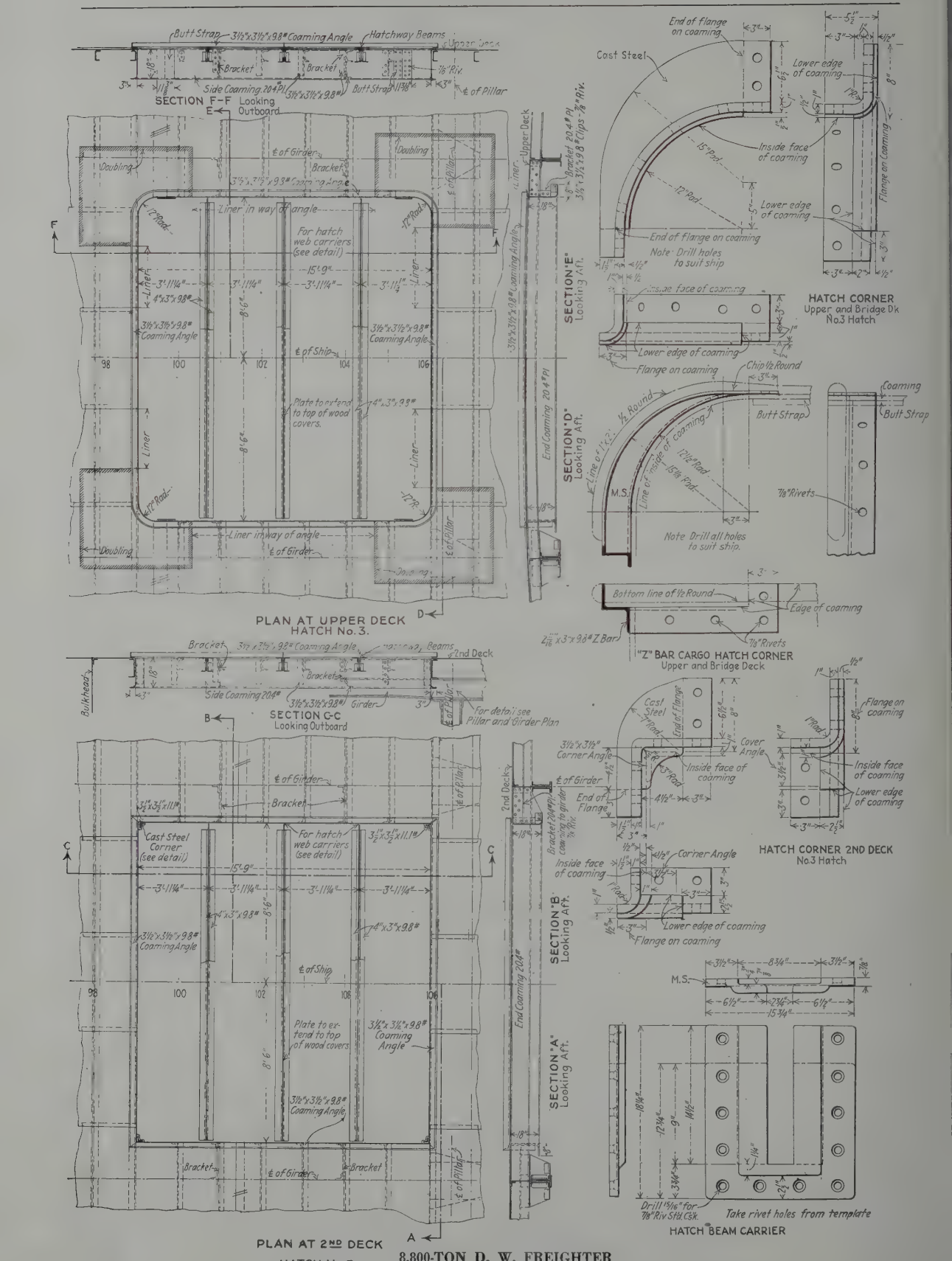

Mitre corner and weld
Cast Steel Corner Piece (see detail)
Bracket
Hatch Web Carriers
3½"x3½"x11.1#
3½"x3½"x9.8# Coaming angle
4"x3"x9.8# Angle
4"x3"x9.8# Angle
Plate of alternate hatch webs to extend to top of wood covers
Fir hatch covers to be of uniform width.
3½"x3½"x9.8# Coaming Angle
Cast steel corner piece (see detail)
Mitre corner and weld.
℄ of Ship
End coaming 20.4# Pl.
3½"x3½"x9.8# Coaming angle
3"x1½"-½ Round on hatch end beam
End coaming carried down to bottom of beam

SECTION "E"
Looking aft.

SECTION "F"
Looking aft.

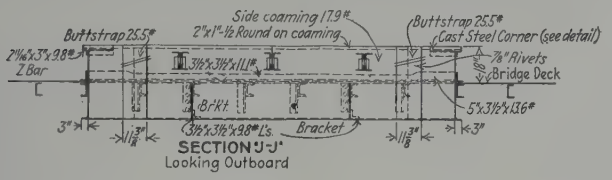
PLAN-2ND DECK HATCHES NO. 1-2-4-5

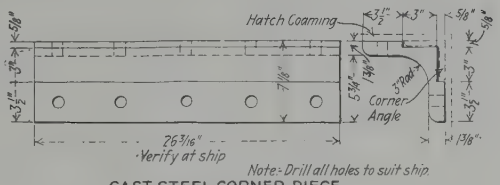
CARGO HATCH AND DETAILS


SECTION F-F Looking Outboard
PLAN AT UPPER DECK HATCH No. 3.
SECTION 'E' Looking Aft.
SECTION 'D' Looking Aft.
HATCH CORNER Upper and Bridge Dk No.3 Hatch
"Z" BAR CARGO HATCH CORNER Upper and Bridge Deck
SECTION C-C Looking Outboard
PLAN AT 2ND DECK HATCH No.3.
SECTION 'B' Looking Aft.
SECTION 'A' Looking Aft.
HATCH CORNER 2ND DECK No.3 Hatch
HATCH BEAM CARRIER
Take rivet holes from template

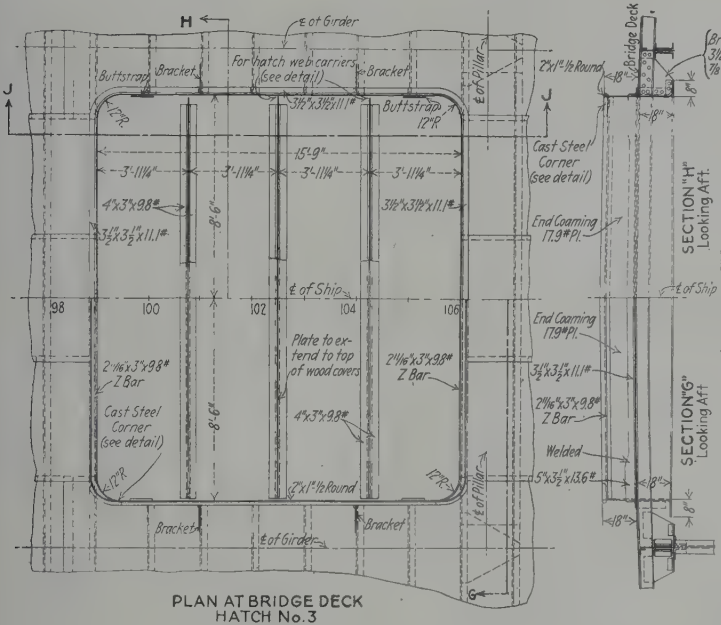
8,800-TON D. W. FREIGHTER

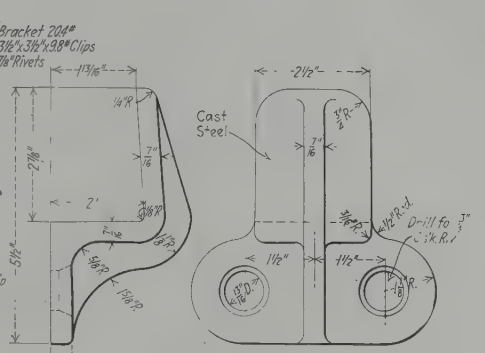
See Pages 559 and 561

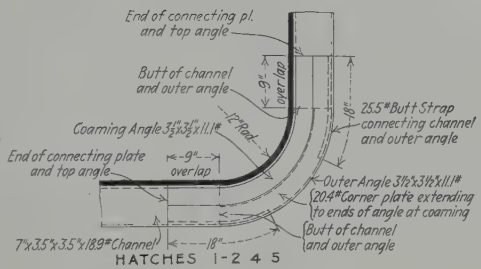


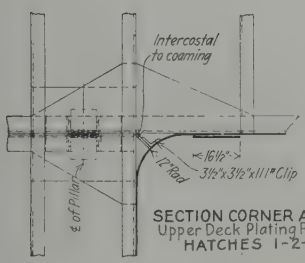


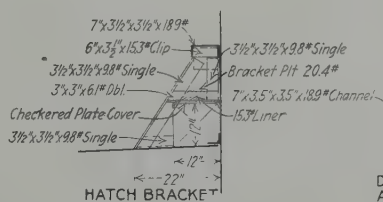
CAST STEEL CORNER PIECE
HATCHES 1-2-4-5

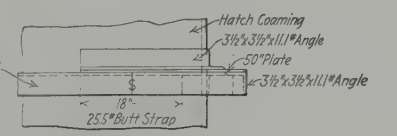




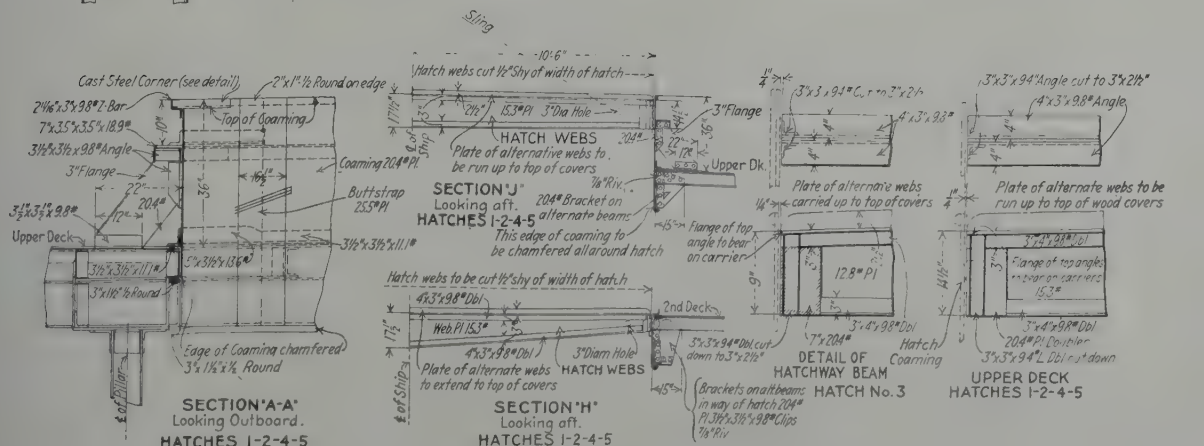

End of connecting pl. and top angle
Butt of channel and outer angle
9" overlap
12"Rad.
25.5# Butt Strap connecting channel and outer angle
Coaming Angle 3½"x3½"x11.1#
End of connecting plate and top angle
9" overlap
Outer Angle 3½"x3½"x11.1# 204# Corner plate extending to ends of angle at coaming
Butt of channel and outer angle
7"x3.5"x3.5"x18.9# Channel
18"
HATCHES 1-2 4 5





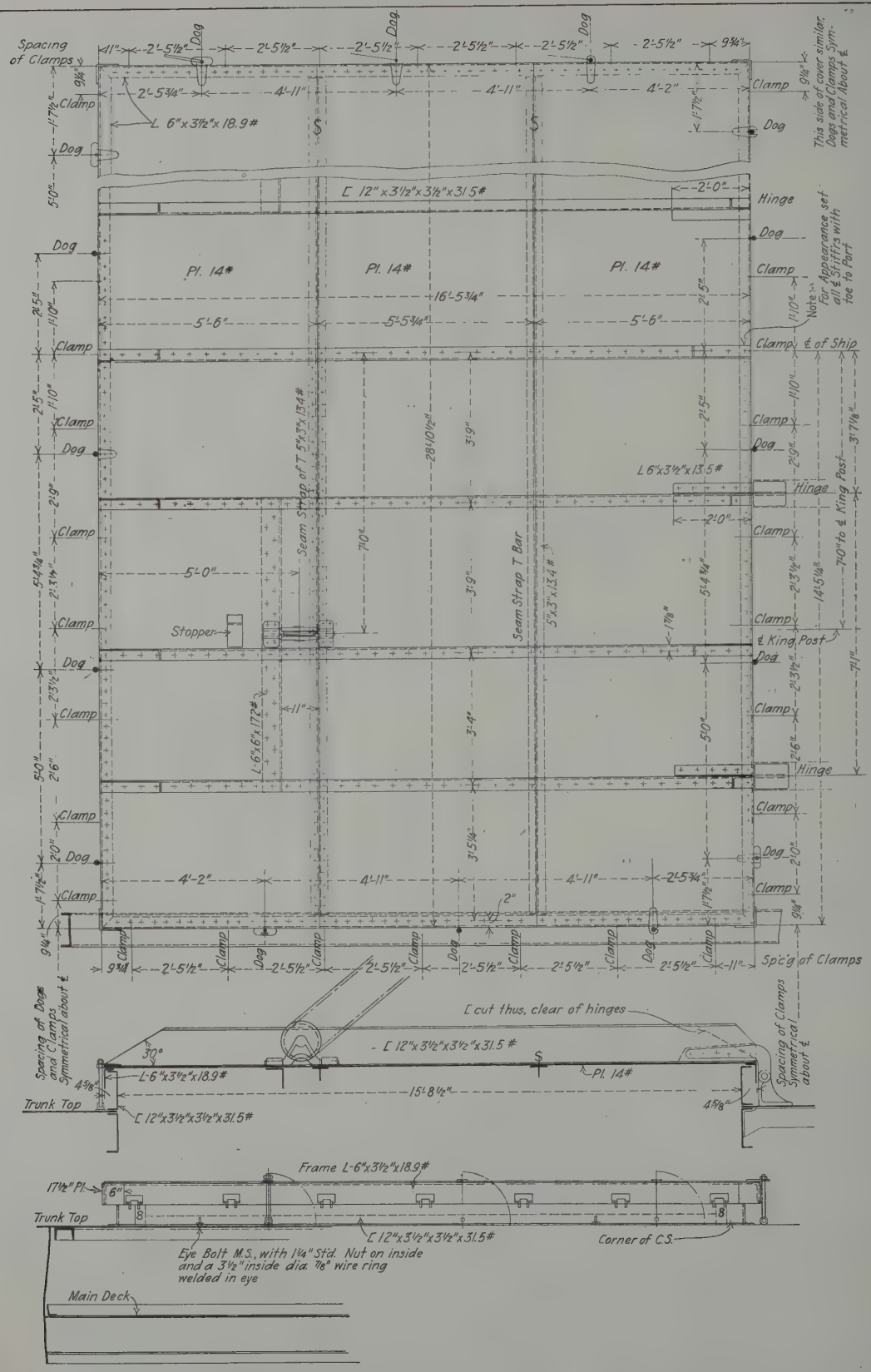


DETAIL OF CONNECTION OF SIDE AND END CHANNELS AT CORNER OF UPPER DECK HATCHES.
HATCHES 1-2-4-5


Sling
Cast Steel Corner (see detail)
2"x1"-½ Round on edge
2-11/16"x3"x9.8# Z Bar
Top of Coaming
7"x3.5"x3.5"x18.9#
3½"x3½"x9.8# Angle
3"Flange
Coaming 20.4# Pl.
Buttstrap 25.5# Pl
3½"x3½"x9.8#
Upper Deck
3½"x3½"x11.1#
5"x3½"x13.6#
3"x1½"x½ Round
Edge of Coaming chamfered 3"x1½"x¾ Round
℄ of Pillar
SECTION "A-A" Looking Outboard.
HATCHES 1-2-4-5
Hatch webs cut ½" Shy of width of hatch
HATCH WEBS
Plate of alternative webs to be run up to top of covers
15.3# Pl
3" Dia Hole
℄ of Ship
SECTION "J" Looking aft.
HATCHES 1-2-4-5
204# Bracket on alternate beams
This edge of coaming to be chamfered all around hatch
Upper Dk.
7/8" Riv.
Flange of top angle to bear on carrier
Hatch webs to be cut ½" shy of width of hatch
4"x3"x9.8# Dbl
2nd Deck
Web Pl 15.3#
3" Diam Hole
HATCH WEBS
Plate of alternate webs to extend to top of covers
SECTION "H" Looking aft.
HATCHES 1-2-4-5
Brackets on alt beams in way of hatch 204# Pl. 3½"x3½"x9.8# Clips 7/8" Riv.
3"x3"x9.4" Angle cut to 3"x2½"
4"x3"x9.8" Angle
Plate of alternate webs carried up to top of covers
12.8# Pl
3"x4"x9.8# Dbl
7"x20.4#
Hatch Coaming
DETAIL OF HATCHWAY BEAM HATCH No. 3
Plate of alternate webs to be run up to top of wood covers
Flange of top angles to bear on carriers 15.3#
3"x4"x9.8# Dbl
20.4# Pl Doubler
3"x3"x9.4" L Dbl cut down
UPPER DECK HATCHES 1-2-4-5

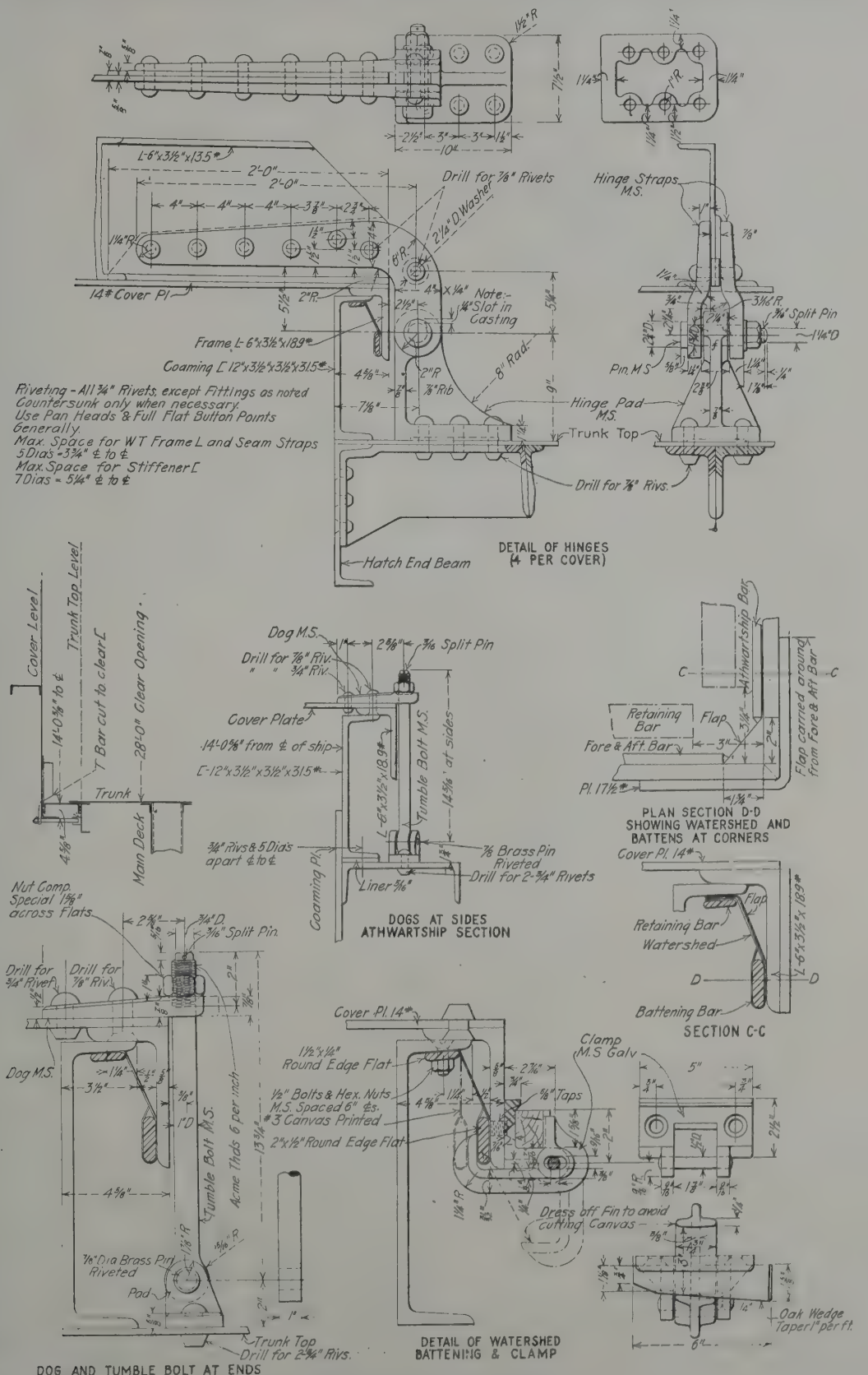
8,800-TON D. W. FREIGHTER

See Pages 559 and 560



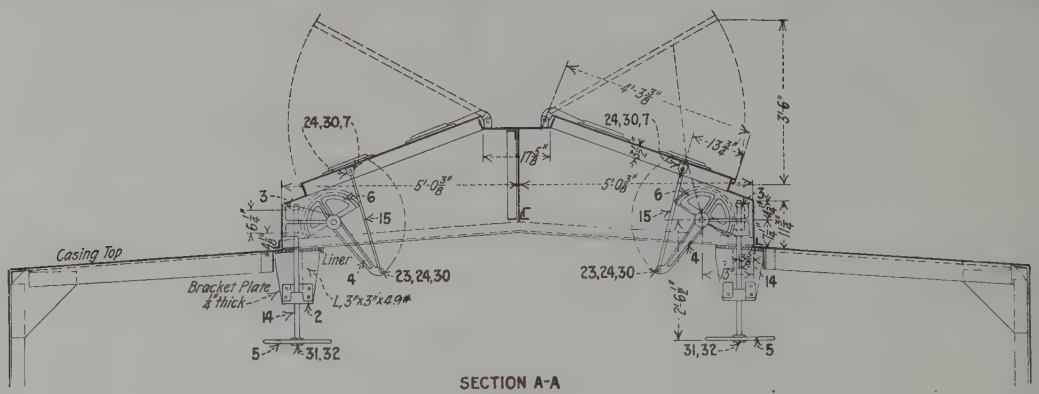
6,422-TON D. W. COLLIER
New York Shipbuilding Co., Camden, N. J.

See Opposite Page

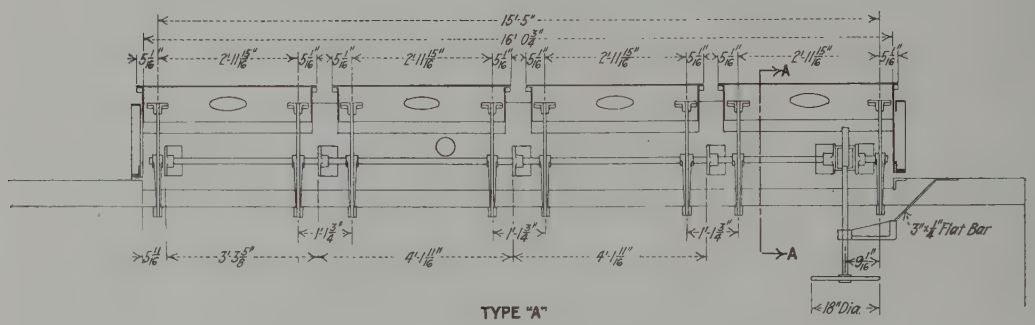


6,422-TON D. W. COLLIER
New York Shipbuilding Co., Camden, N. J.

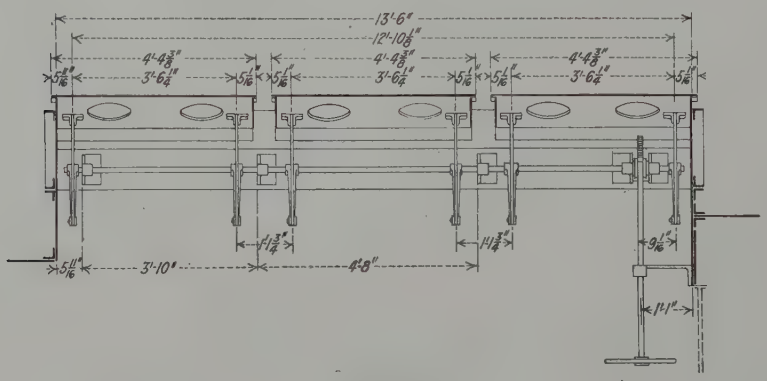
See Opposite Page



SECTION A-A



TYPE "A"

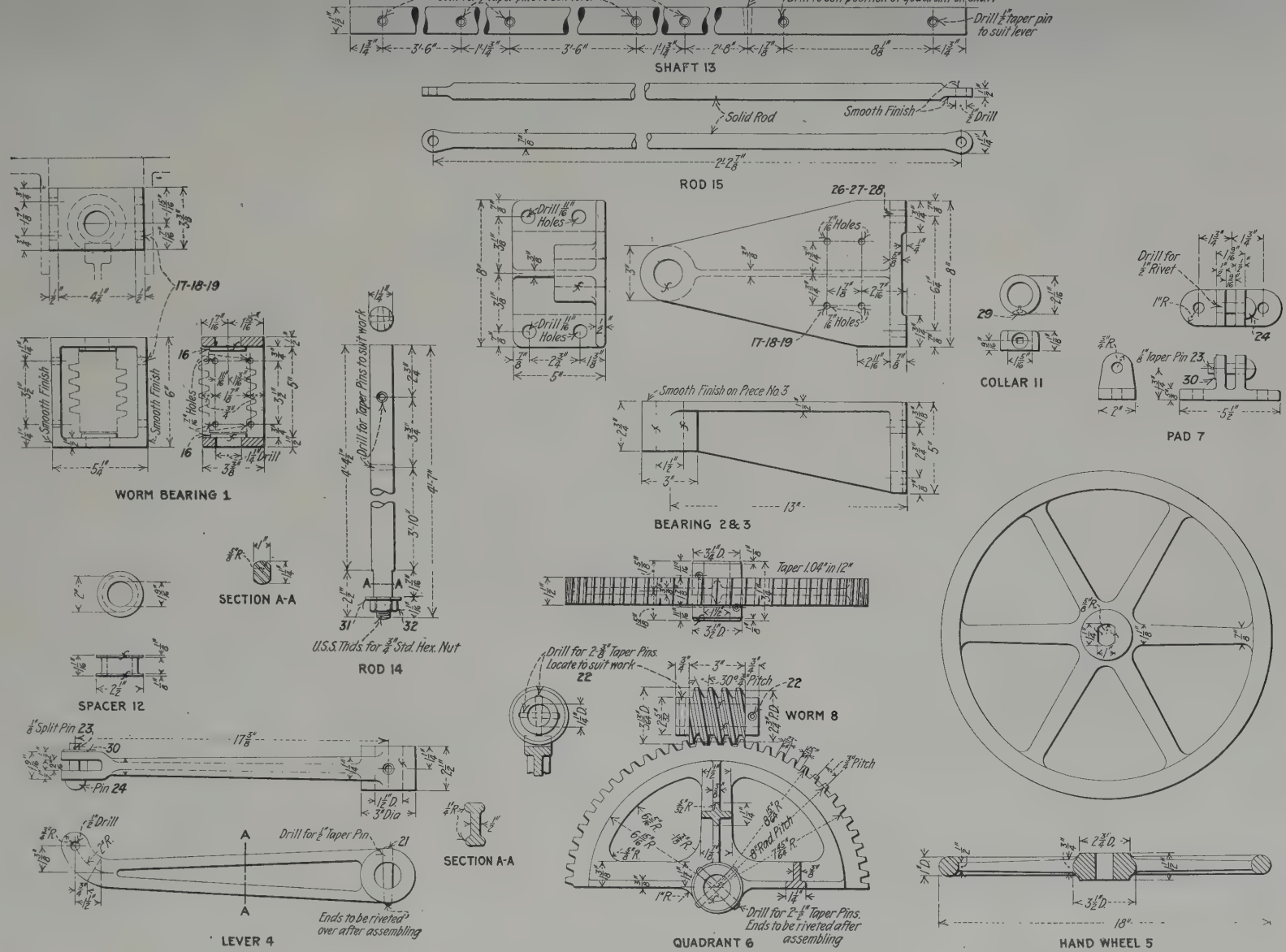


TYPE "B"

LIST OF MATERIAL

Pc. No.	Name	Material	Remarks
1	Worm Bearing	C. I.	
2	Bearing	C. I.	
3	Bearing	C. I.	To be drilled for Pc. No. 2
4	Lever	Mal. C. I.	
5	Handwheel	C. I.	
6	Quadrant	C. I.	
7	Pad	Mal. C. I.	
8	Worm	Steel	
11	Collar	Steel	For 1¼" Rod.
12	Washer	C. I.	For 1½" Shaft between bearing.
13	Shaft 1½" Dia.....	C. R. Steel	
14	Rod 1¼" Dia.....	C. R. Steel	
15	Rod ⅞" Dia.	C. R. Steel	
16	Washer	Brass	2" O. D. for 1¼" Rod.
17	Washer	Steel	For ⅜" Bolt.
18	⅜" Machine Bolt...	Steel	1¾" Long.
19	⅜" Std. Hex. Nut.	Steel	
21	½" Taper Pin.....	Steel	3½" Long.
22	⅜" Taper Pin.....	Steel	2½" Long.
23	⅛" Split Pin.....	Steel	1" Long.
24	½" Pin	Steel	2" Long.
26	⅝" Machine Bolt...	Steel	2" Long.
27	⅝" Std. Hex. Nut..	Steel	
28	Washer	Steel	For ⅝" Bolt.
29	⅜" Set Screw	Steel	½" Long Under Head.
30	Washer	Steel	For ½" Pin.
31	Washer	Steel	For ¾" Rod.
32	¾" Std. Hex. Nut..	Steel	For ¾" Rod.

See Opposite Page



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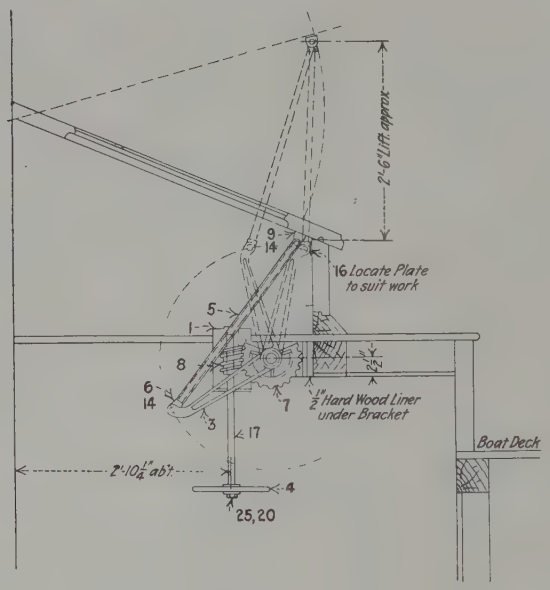
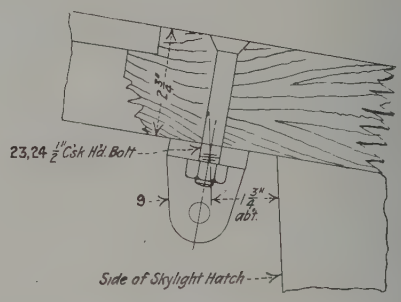
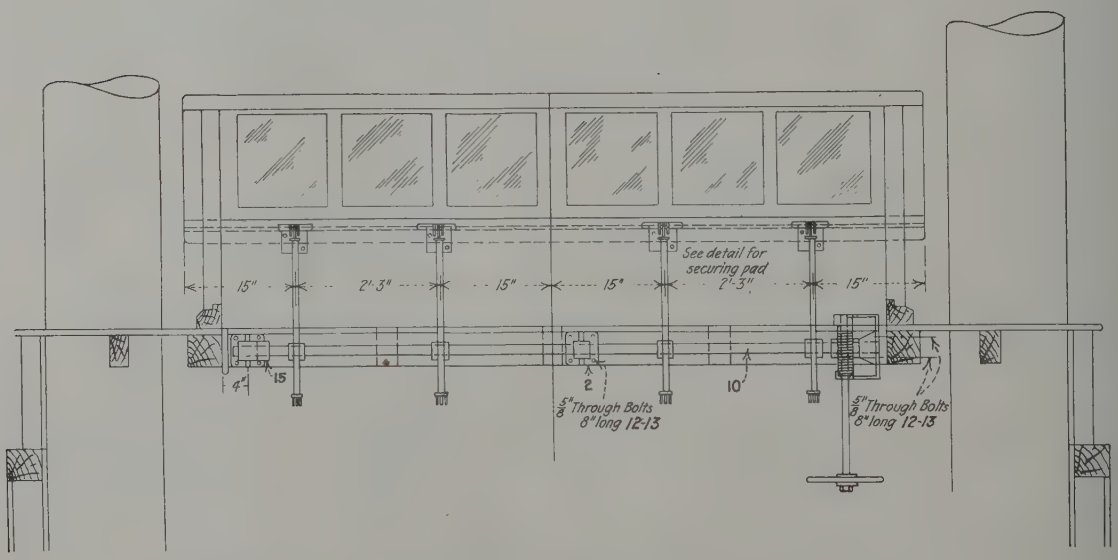




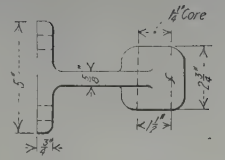
DETAIL SHOWING METHOD OF SECURING PAD

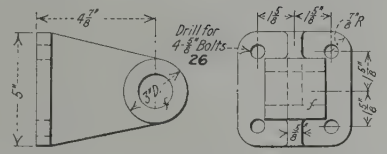


MATERIAL FOR ONE LIFTING GEAR FOR ONE COMPLETE SKYLIGHT

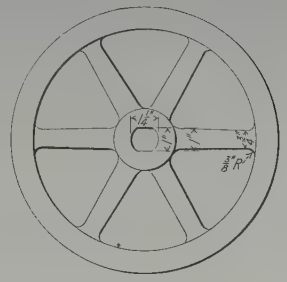
Pc. No.	No. Pcs.	Name	Material	Remarks
1	2	Worm wheel bearing	C. I.	
2	4	Bearing	C. I.	
3	8	Lever	Mal. C. I.	
4	2	Hand wheel	C. I.	
5		7/8" rod	Steel	2'-11" long
6		7/8" rod	Steel	
7	2	Worm wheel	C. I.	
8	2	Worm	Steel	
9	8	Pad	C. I.	
10	2	1 1/2" Shaft	C. R. Steel	8'-2" long
11	8	1/2" Taper pin	Steel	3 1/4" long
12	26	5/8" Carriage bolts	Steel	7 1/2" long
13	26	5/8" Std. Hex. Nuts	Mild Steel	
14	16	1/2" Pin	Steel	2 1/8" long
15	2	Collar	Steel	
16	8	Plate	Steel	1/8" thick
17	2	Rod 1 1/4" dia	C. R. Steel	
18	16	1/4" wood screws	Steel	(csk) 1" long
19	10	3/8" Taper Pin	Steel	2 1/2" long
20	2	Washer	W. I.	2" O. D.
21	16	Washer	W. I.	1 3/8" O. D.
22	16	1/8" Split Pin	Steel	3/4" long
23	16	1/2" Csk. Hd. Bolts	Steel	4" long
24	16	1/2" Std. Hex. Nut	Mild Steel	
25	2	3/4" Std. Hex. Nut	Mild Steel	
26	4	1/4" Fiber washer	Fiber	Top and bottom of worm

See Opposite Page

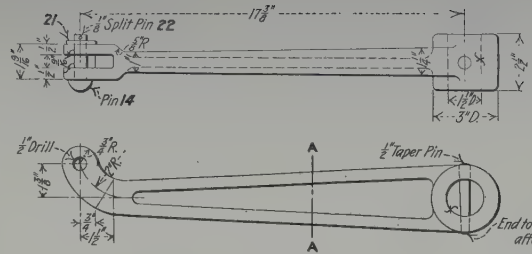




BEARING 2

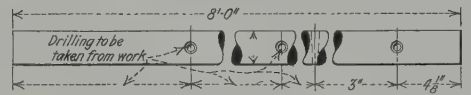


HAND WHEEL 4

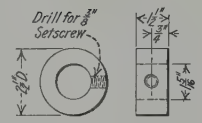


LEVER 3

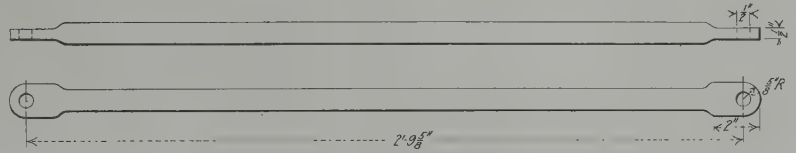
SECTION A-A



SHAFT 10



COLLAR 15



SOLID ⅞" ROUND IRON ROD FLATTENED AT BOTH ENDS

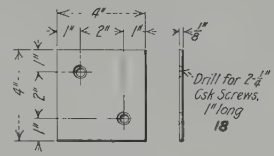
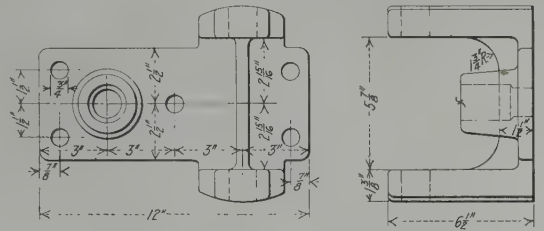
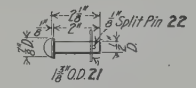
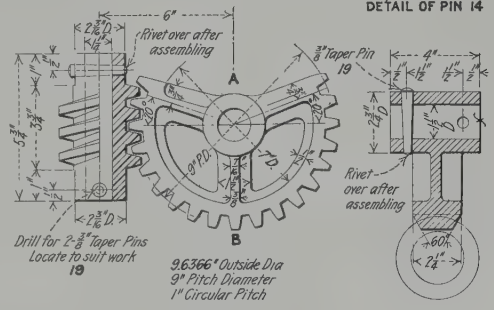


PLATE 16



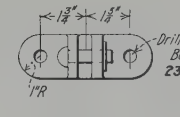


DETAIL OF PIN 14

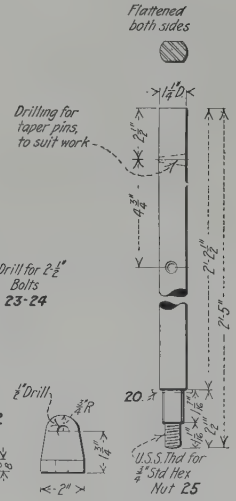


WORM WHEEL 7 & WORM (SINGLE THREAD) 8

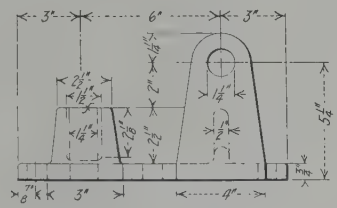
SECTION A-B



PAD 9



ROD 17



WORM WHEEL BEARING 1

See Opposite Page

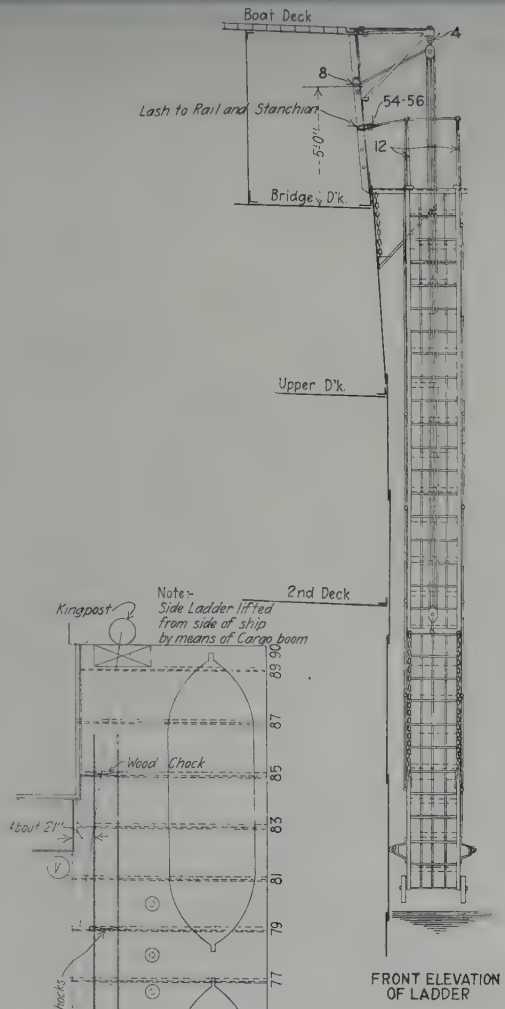
For Arrangement and Details of Accomodation Ladder
See Pages 569 and 570

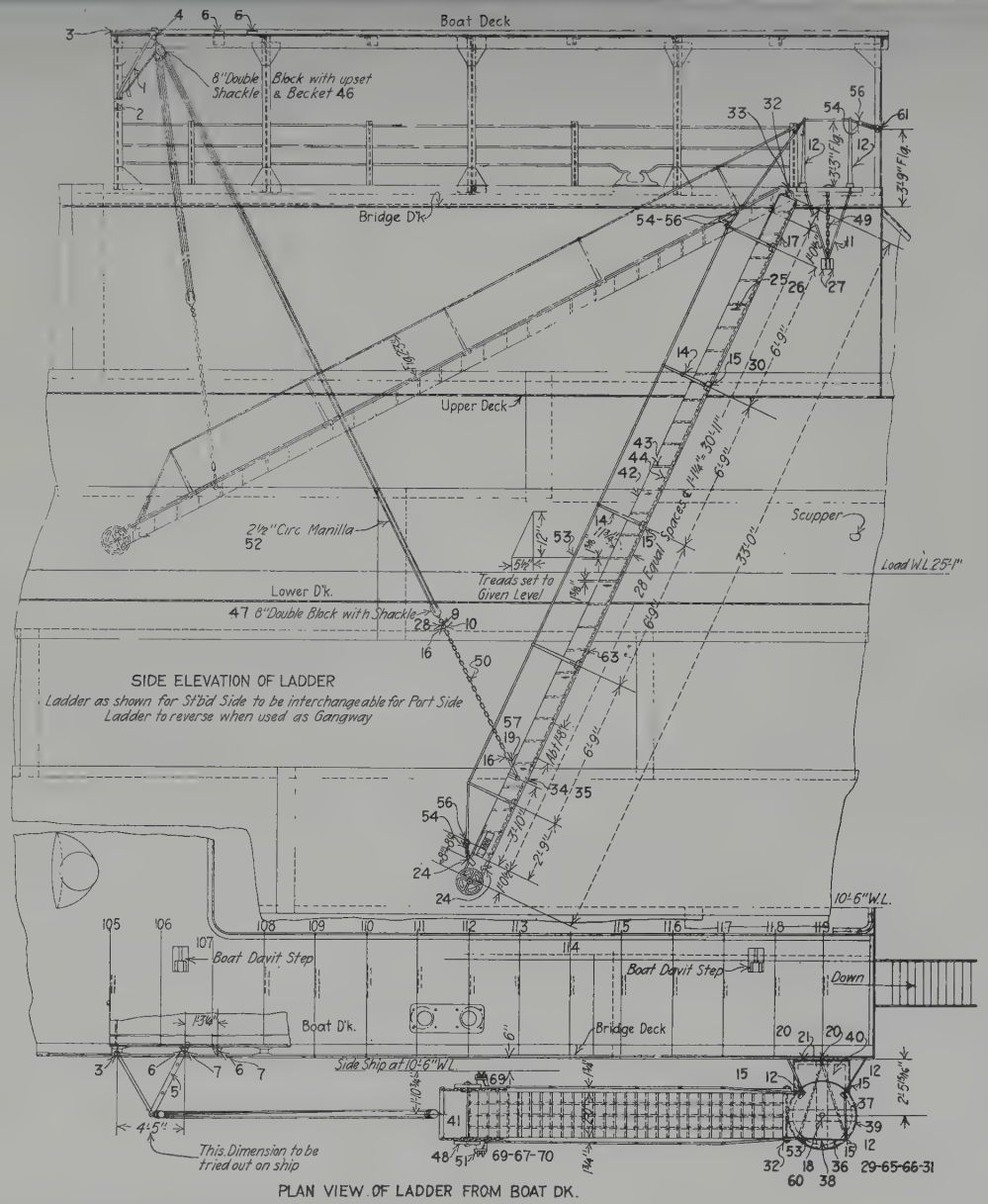
LIST OF MATERIAL FOR ONE LADDER

Pc. No.	No. of Pcs.	Name	Mat'l	Remarks
1	1	Davit	Med. steel	
2	2	Bottom pad	S. angle	
3	2	Top pad	S. angle	
4	1	1¼" eye bolt	Med. steel	Galv.
5	1	Davit stay	Med. steel	Galv.
6	4	Davit stay pad	S. angle	Galv.
7	4	¾" bolt and nut	Med. steel	2" under head galv.
8	2	12" cleat	Med steel	Galv.
9	1	⅞" shackle with 1" eye bolt	Med steel	For yoke center line pc. No. 28 galv.
10	2	⅝" shackle with ¾" eye bolt	Med. steel	For yoke ends pc. No. 28 galv
11	1	Platform brace	Med. steel	Galv.
12	4	Platform stanchions	Med. steel	Galv.
13	1	1¼" nut	Med. steel	For pc. No. 4.
14	10	Ladder stanchions	Med. steel	Galv.
15	14	Pads	Med. steel	Galv. for pc Nos. 12 & 14.
16	4	½" links	Med steel	Weld in pc. No. 50.
17	4	Hinge bands	Med. steel	Galv.
18	1	1¼" bolt	Med. steel	Galv.
19	2	Lifting shackle	Med. steel	Galv.
20	3	Hinge male	Med. steel	Galv.
21	4	Hinge female	Med. steel	Galv.
22	2	Links	Med. steel	Weld into pc. No. 49.
23	1	1½" nut	Brass	For pc. No. 1.
24	4	Eye plate	Iron	6" long, galv.
25	8	Ladder tie rod	Med. steel	Galv.
26	16	Washer	Med. steel	Galv. for pc. No. 25.
27	2	Clip	S. angle	Galv. 5"x3"-1-left. x9.8 # 1-right and
28	1	**Yoke**	**T-bar.**	**4"x4" x 10.5# T-bar.**
29	4	Clips	S. angle	3½" x 2½" x 7.2 # galv.
30	20	Washers	Med. steel	Galv. for pc. No. 14.
31	2	¾" pins	Med. steel	For pc. No. 65-66 galv.
32	1	Ladder hinge bolt	Med. steel	Galv.
33	2	Platform lugs	Med. steel	Galv.
34	2	Shackle bands	Med. steel	Galv.
35	2	Washer	Med. steel	Galv.
36	1	Rev'l'v. plate	Steel plate	
37	1	Cross plate	Med. steel	
38	1	Cross plate	Med. steel	
39	1	B'd'r'y angle	S. angle	
40	1	Stay plate	Steel plate	
41	1	Ladder axle	Med. steel	
42	2	Stringers	Ash or white oak	
43	29	Threads	Ash or white oak	
44	As Req'd.	6" planking	Ash or white oak	As required.
45	16	Hinge band tie rods	Med. steel	Galv. for pc. No. 17.
46	1	8" double block	Wood	With upset shackle and becket.
47	1	8" double block	Wood	With shackle.

LIST OF MATERIAL FOR ONE LADDER—Continued

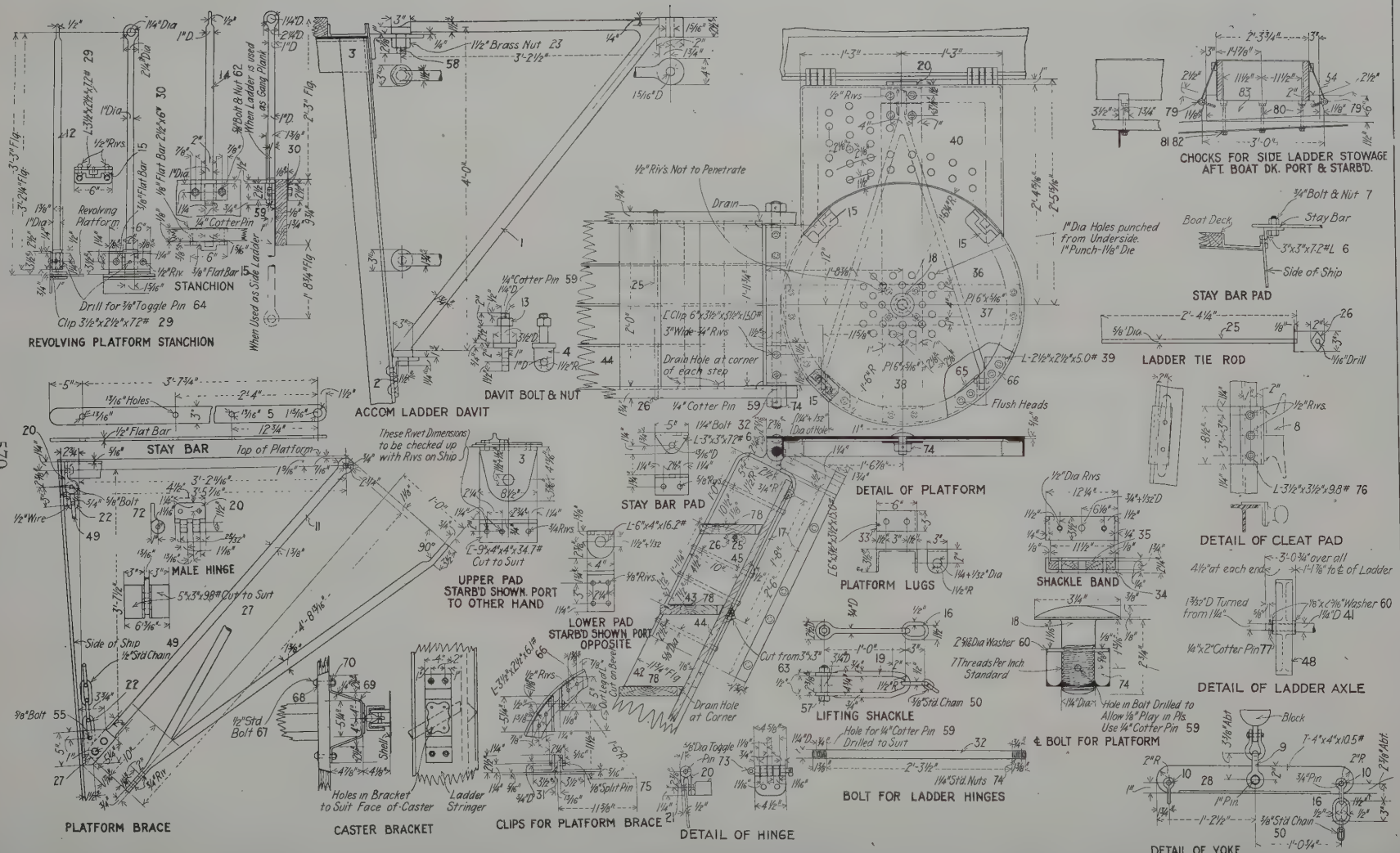
Pc. No.	No. of Pcs.	Name	Mat'l	Remarks
48	2	Wheel	C. I.	14" dia.
49	1	½" St'd chain	Med. steel	3'-0" long.
50	1	⅜" St'd chain	Med. steel	17'-0" to cut. galv.
51	2	Caster rollers	Brass	
52	125 ft.	2½" cir. rope	Manila	For falls.
53	100 ft.	2½" cir. rope	Manila	For head line.
54	As Req'd.	Lashing	Hemp	
55	1	⅝" bolt and nut	Med. steel	For pc. No. 27 2¼" under hd. glv.
56	8	Thimbles (ring) ⅞"	Med. steel	For manila rope.
57	2	¾" St'd. hex, bolt & nut	Med. steel	Galv. for pc. No. 19.
58	1	¼" split pin	Med. steel	For pc. No. 1 galv.
59	18	¼" cotter .pin	Med. steel	Galv.
60	5	⅛"x2 5-16" washer	Med. steel	For 1¼" bolts pc. No. 18 & 41 galv.
61	2	Ring pad	Med. steel	
62	20	⅝" bolt and nut	Med. steel	Galv. 3" under hd. for pc. No. 14.
63	20	Threads	Ash or white oak	
64	4	⅜" toggle pin	W. steel	L-2" galv.
65	2	Clips	Med. steel	Make right and left.
66	2	Clips	Med. steel	Make right and left.
67	8	½" St'd. round headed bolts	Med. steel	Galv. for pc. No. 69.
68	8	St'd. washer for ½" bolt	Med. steel	Galv. for pc. No. 67.
69	2	Caster brackets	Med. steel	Galv. for pc. No. 51.
70	8	St'd. ½" hex. hd. nut	Med. steel	Galv. for pc. No. 67.
72	1	⅝" dia. bolt	Med. steel	Galv. 3¾" under head pc. No. 20.
73	2	⅝" dia. toggle pin	Combin.	L-4⅝" galv.
74	3	1¼" St'd. nut hex	Med. steel	For pc. No. 18 and 32 galv.
75	4	⅛" split pins	Med. steel	For pc. No. 31 galv.
76	2	Cleat pad	S. angle	3½"x3½"x 9.8 # L.
77	2	¼"x2" cotter pin	Med. steel	For pc. No. 41 galv.
78	29	Safety tread	C. Iron	For pc. No. 43. 18" x 4" galv.
79	6	Eye bolt, ⅞" eye, ⅝" iron	W. Iron	(4" under eye) galv.
80	9	Dk. bolt and nuts, ⅝"	W. steel	Galv.
81	9	Washer, ⅝"	W. steel	For Pc. No. 80 galv.
82	9	Grommet, ⅝"	Canvas	For pc. No. 80.
83	3	Chock	Pine	



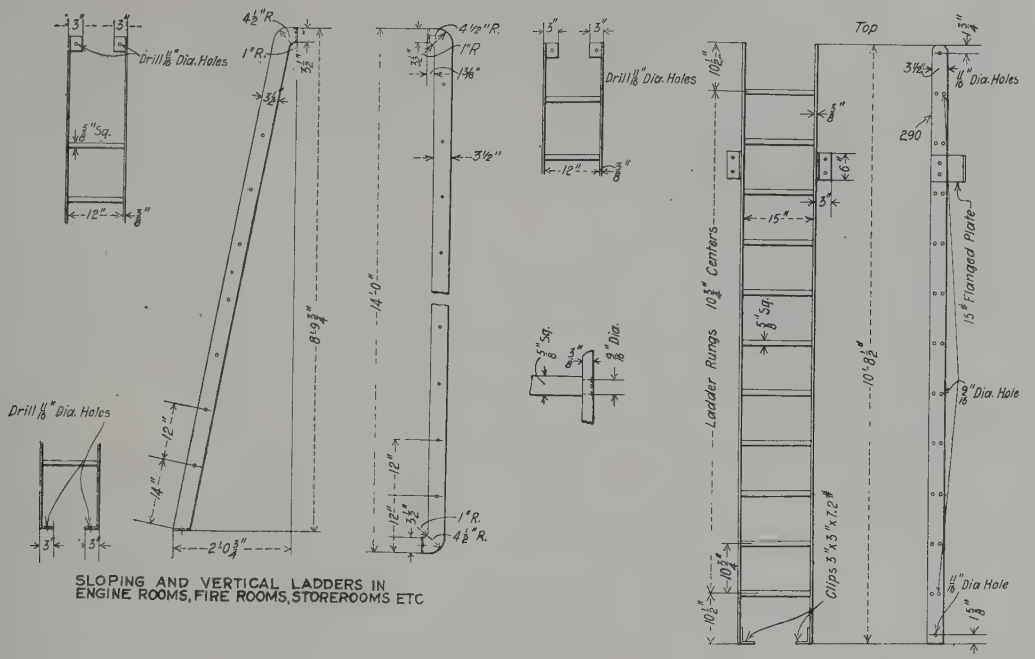

Boat Deck
8" Double Shackle Block with upset & Becket 46
Bridge D'k.
54-56
2½" Circ Manilla
52
Lower D'k.
47 8" Double Block with Shackle
Upper Deck
Treads set to Given Level
28 Equal Spaces @ 1'1¼" = 30'-11"
33'-0"
Scupper
Load W.L. 25'-1"
SIDE ELEVATION OF LADDER
Ladder as shown for St'bd Side to be interchangeable for Port Side Ladder to reverse when used as Gangway
10'-6" W.L.
Boat Davit Step
Boat Davit Step
Down
Boat D'k.
Bridge Deck
Side Ship at 10'-6" W.L.
This Dimension to be tried out on ship
PLAN VIEW OF LADDER FROM BOAT DK.

9,000-TON D. W. FREIGHTER

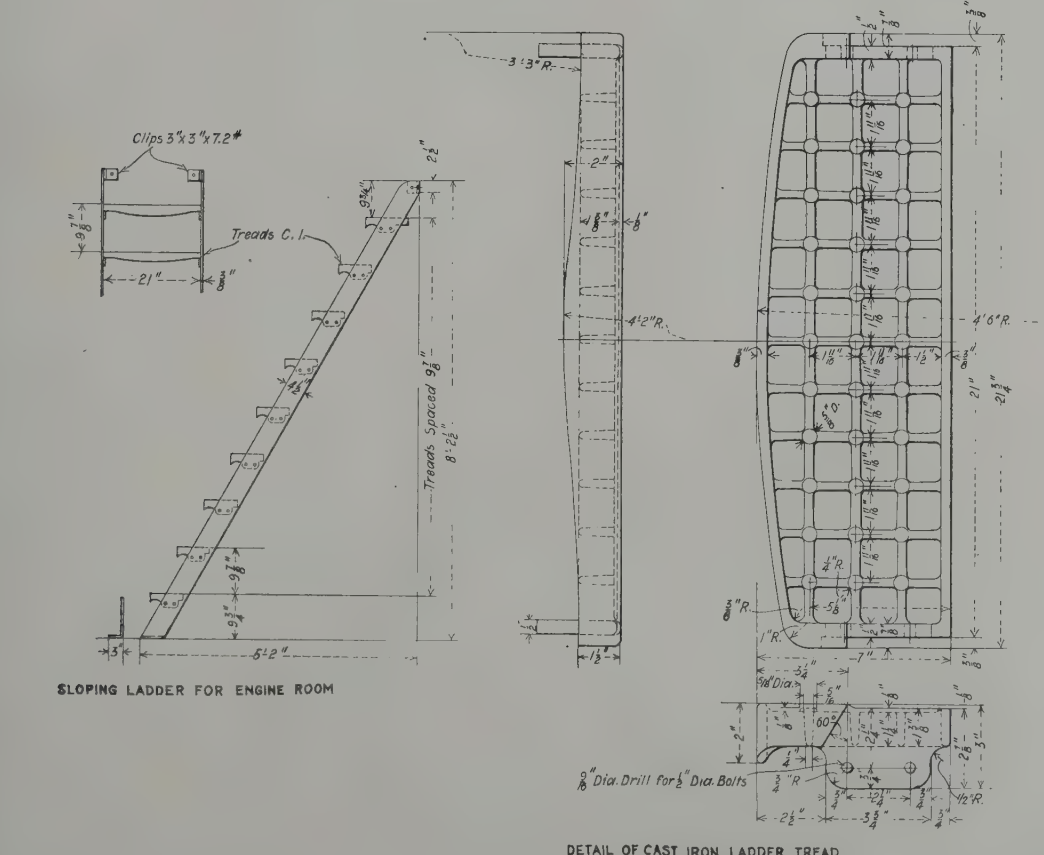
See Pages 568 and 570



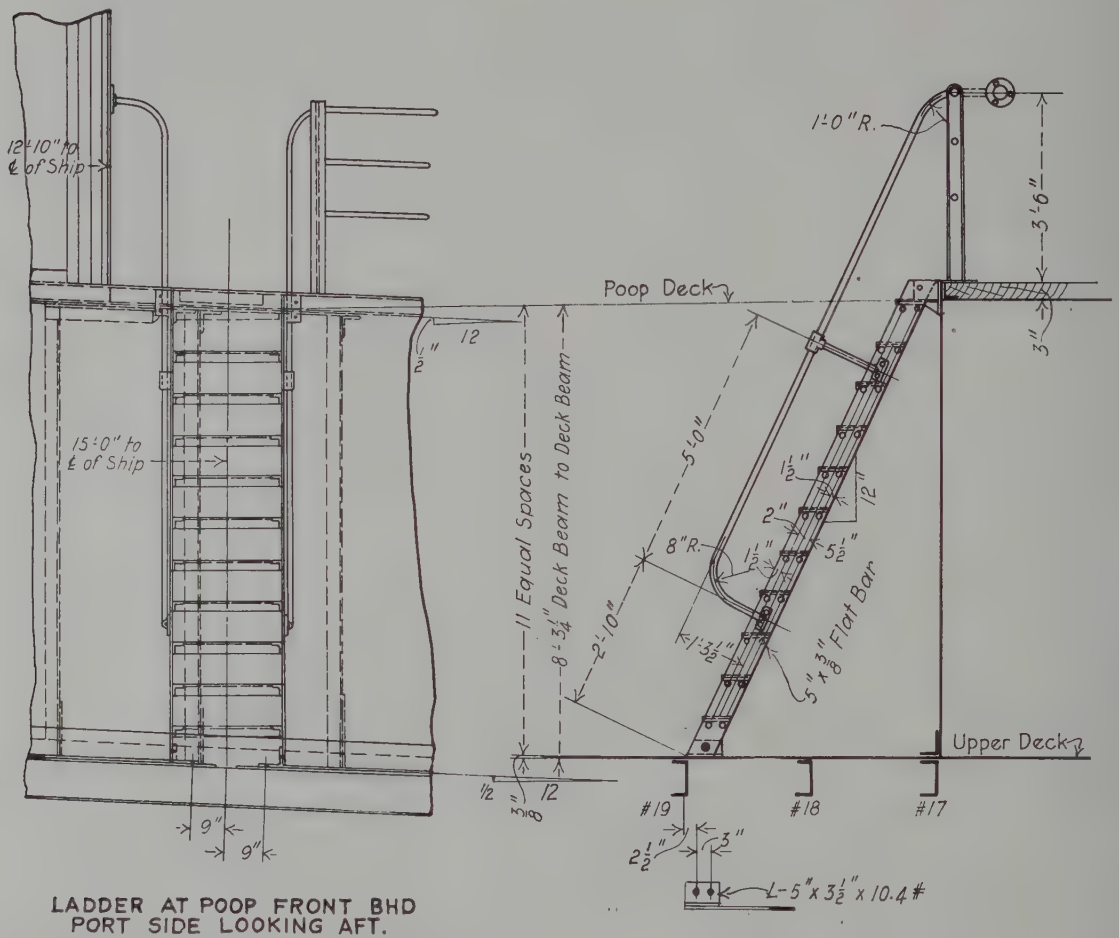
See Pages 568 and 569



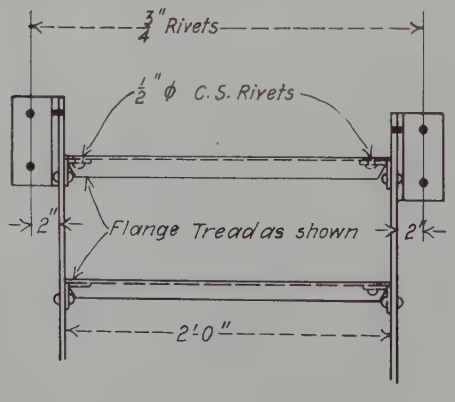
SLOPING AND VERTICAL LADDERS IN ENGINE ROOMS, FIRE ROOMS, STOREROOMS ETC

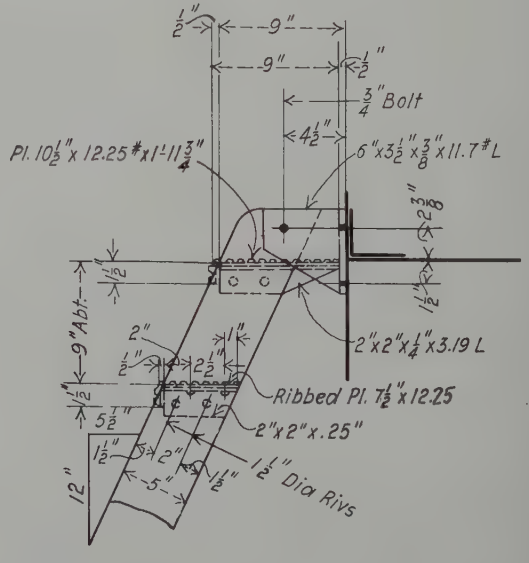


SLOPING LADDER FOR ENGINE ROOM

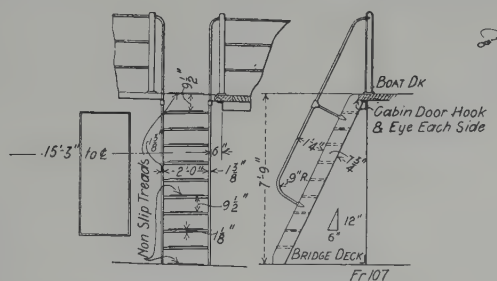


LADDER AT POOP FRONT BHD
PORT SIDE LOOKING AFT.

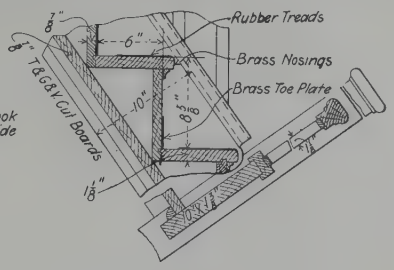




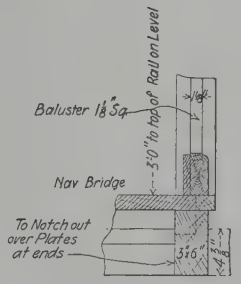
TYPICAL DETAIL OF TOP OF LADDER.



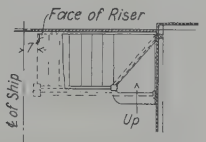
LADDER FROM BOAT DECK TO BRIDGE DECK
STARB'D SIDE SHOWN. PORT SIDE OPPOSITE



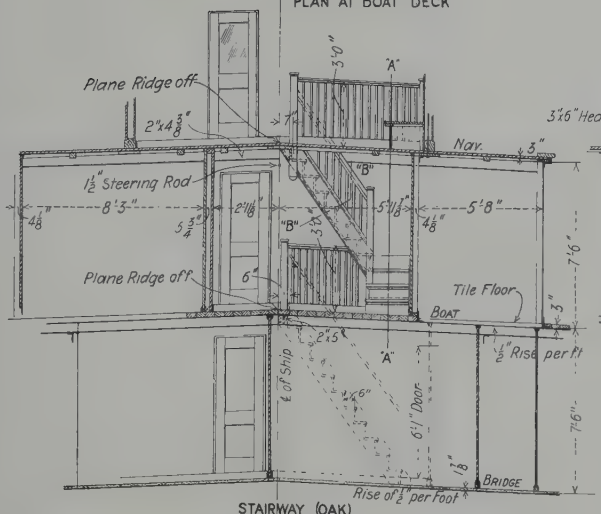
SECTION B-B



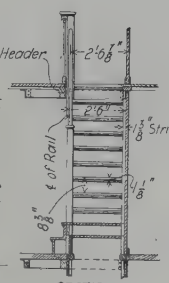
HEADER TO CARRY ENDS
OF WOOD SLEEPERS
AT STAIR WELL



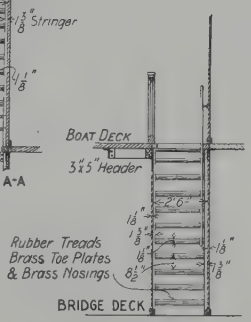
PLAN AT BOAT DECK

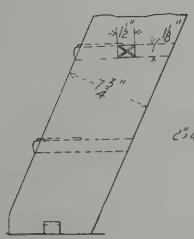


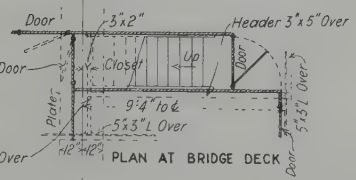
STAIRWAY (OAK)



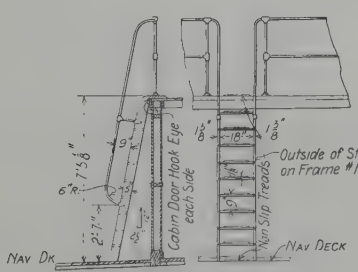
SECTION A-A



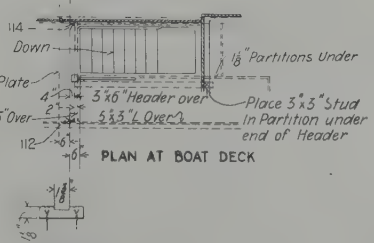




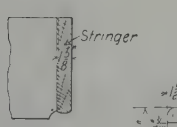
PLAN AT BRIDGE DECK

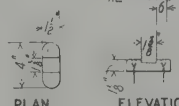


LADDER FROM NAVIGATING DECK TO
TOP OF CHART & WHEEL HOUSE
PORT SIDE ONLY

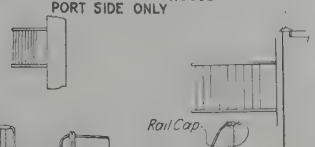


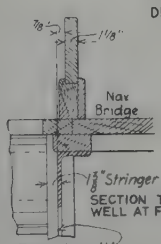
PLAN AT BOAT DECK





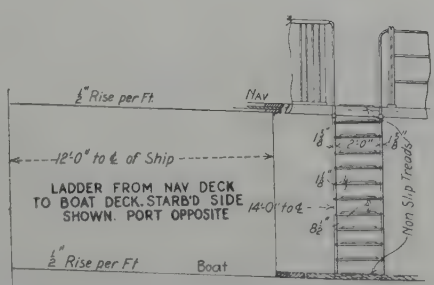
DETAIL OF WOOD BLOCK
AT FLOOR



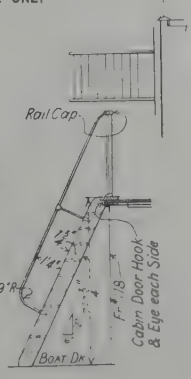


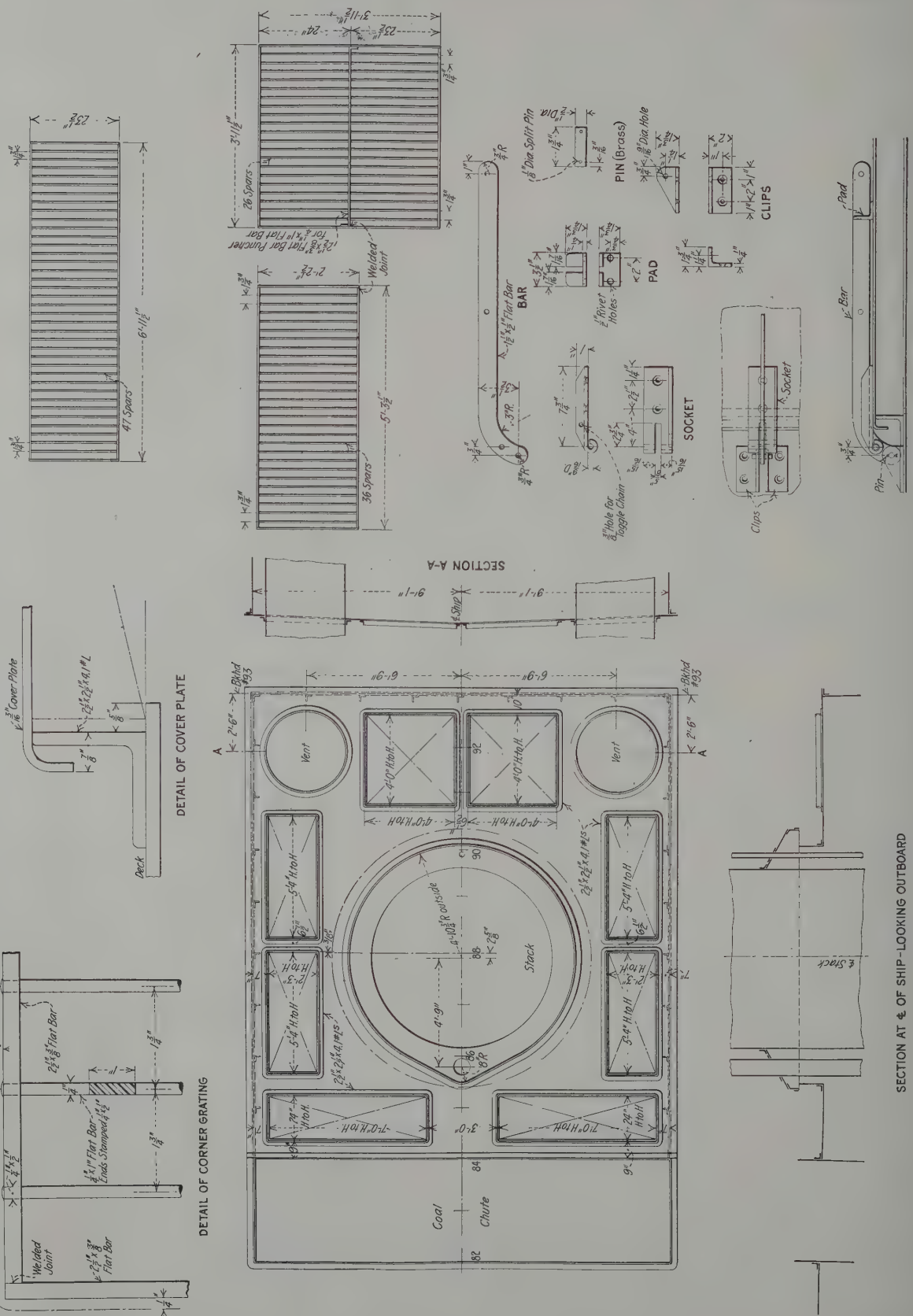
HAND RAIL BRACKET, BRASS
OR COMPOSITION

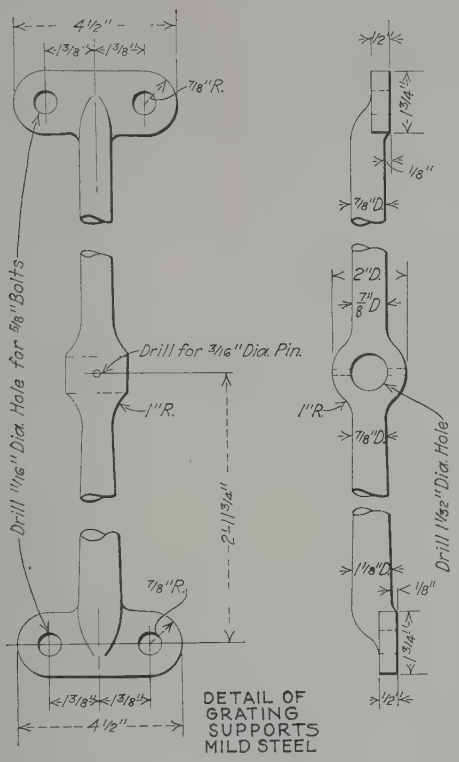
SECTION THRO
WELL AT FR NO 114



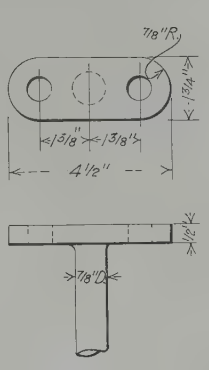
LADDER FROM NAV DECK
TO BOAT DECK. STARB'D SIDE
SHOWN. PORT OPPOSITE



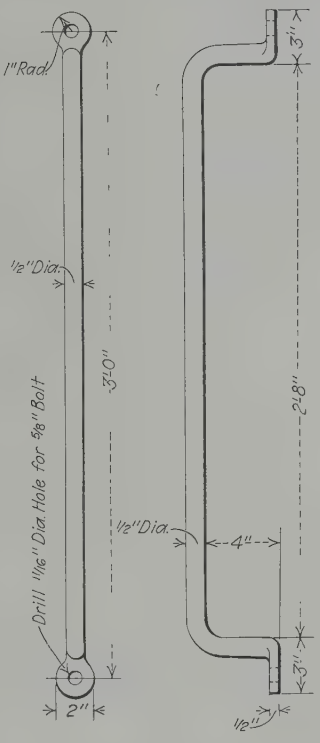

SECTION A-A
DETAIL OF COVER PLATE
DETAIL OF CORNER GRATING
SECTION AT ℄ OF SHIP-LOOKING OUTBOARD
9,000-TON D. W. FREIGHTER
Vent
Stack
Coal
Chute
SOCKET
PIN (Brass)
CLIPS
PAD
BAR
Pad
Socket
Clips
Pin
Deck
Ends riveted over
Welded Joint
26 Spars
47 Spars
36 Spars



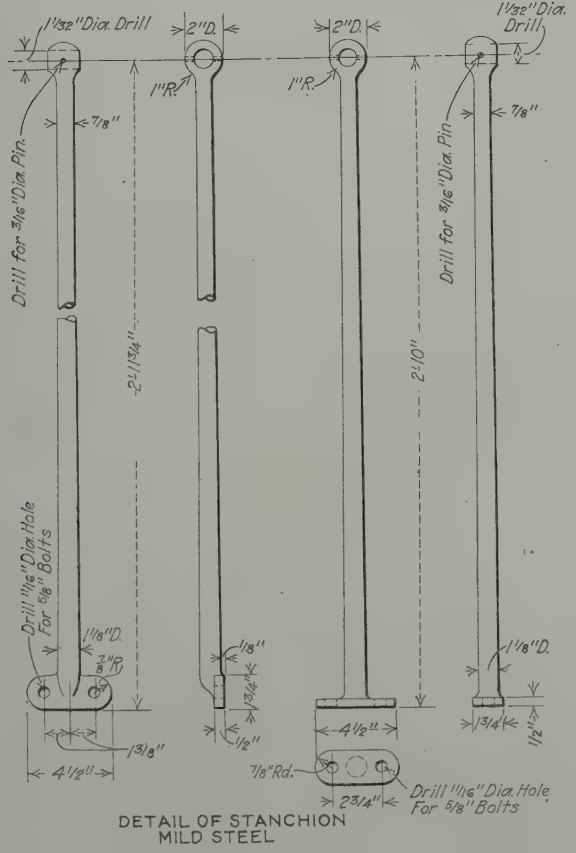
DETAIL OF GRATING SUPPORTS MILD STEEL



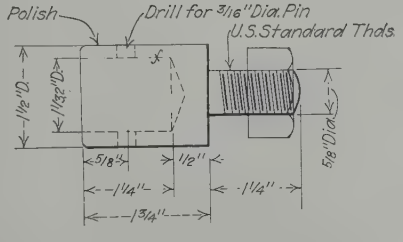
DETAIL OF FLAT FOR STANCHION



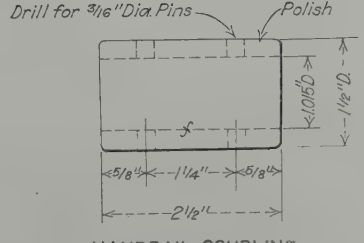
GRAB RAIL MILD STEEL



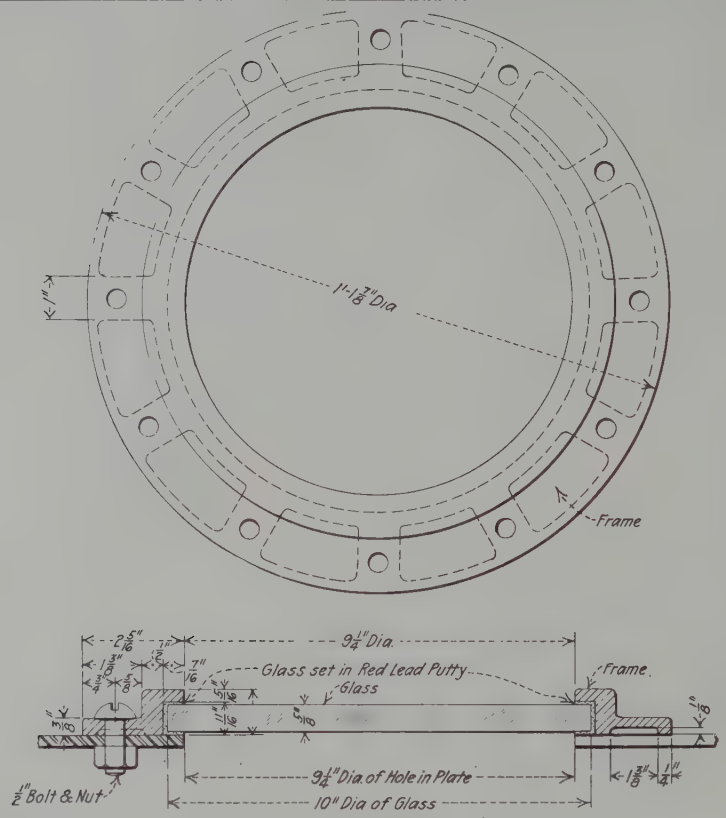
DETAIL OF STANCHION MILD STEEL



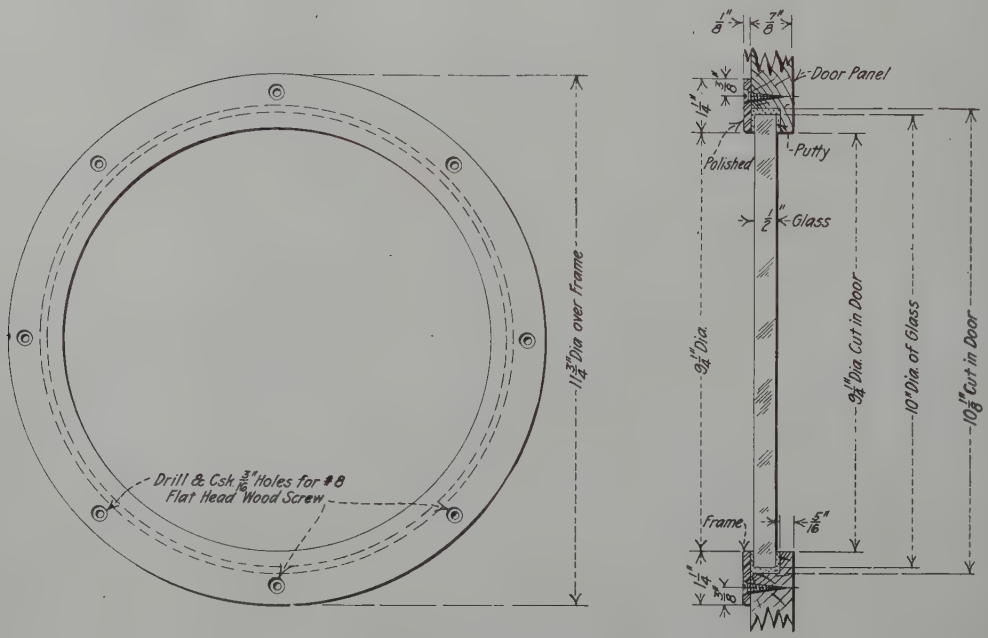
B'K'H'D. HANDRAIL CONNECTION MILD STEEL



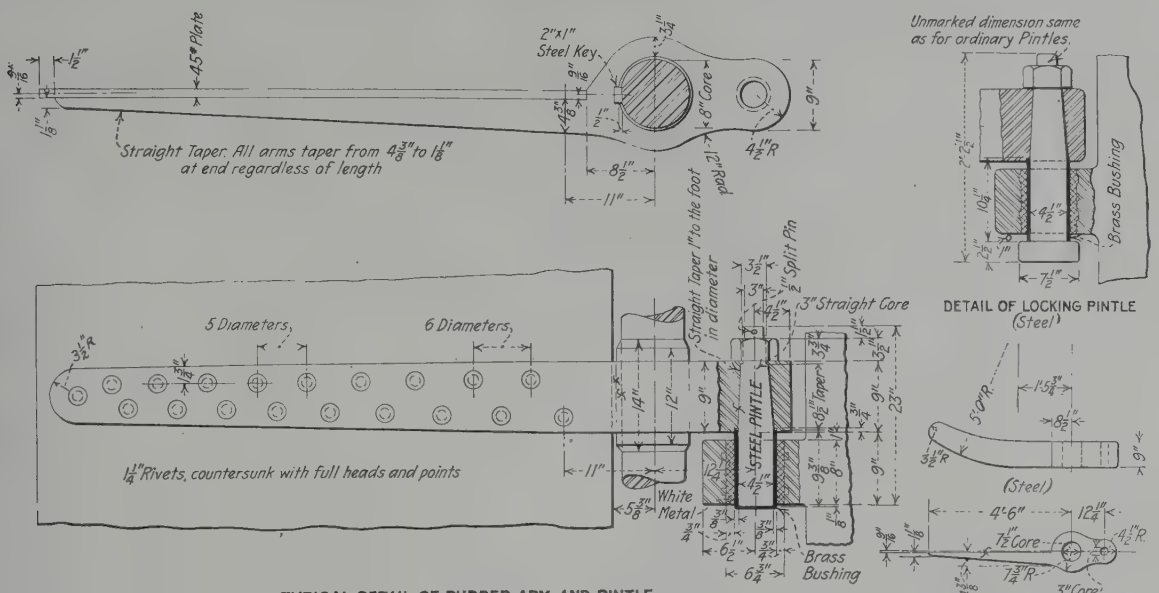
HANDRAIL COUPLING MILD STEEL



9¼" FIXED LIGHT IN STEEL COVERS



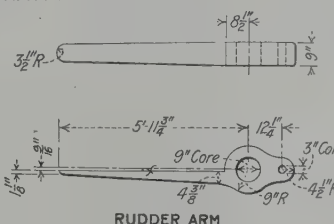
9¼" FIXED LIGHT IN JOINER DOORS



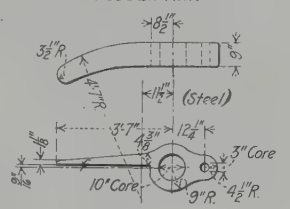
TYPICAL DETAIL OF RUDDER ARM AND PINTLE
(Steel)

DETAIL OF LOCKING PINTLE
(Steel)

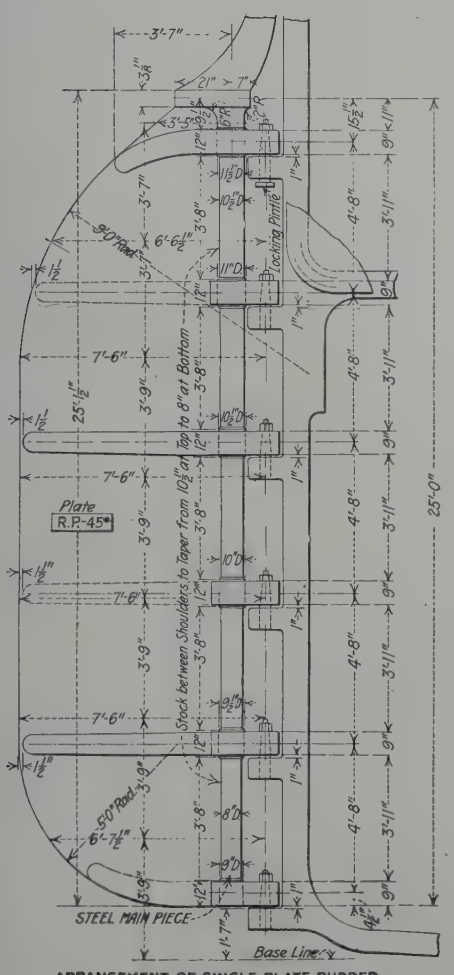
RUDDER ARM



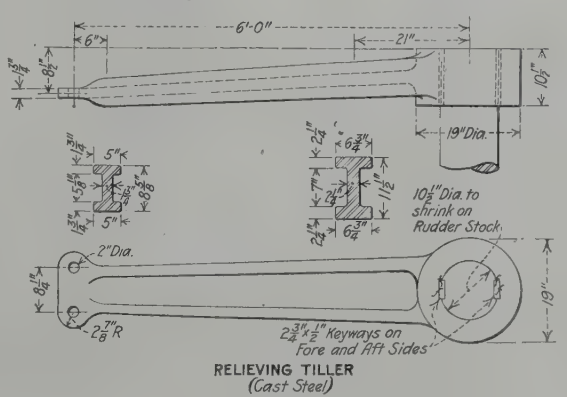
RUDDER ARM
(Cast Steel)



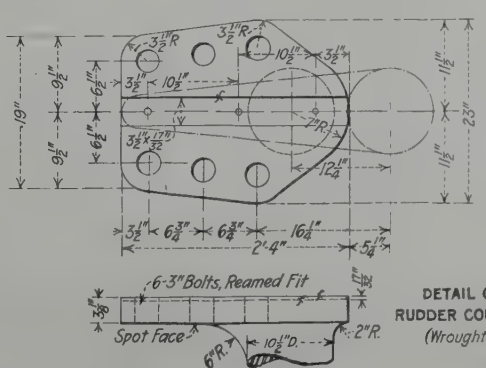
RUDDER ARM



ARRANGEMENT OF SINGLE PLATE RUDDER
(Wrought Steel)

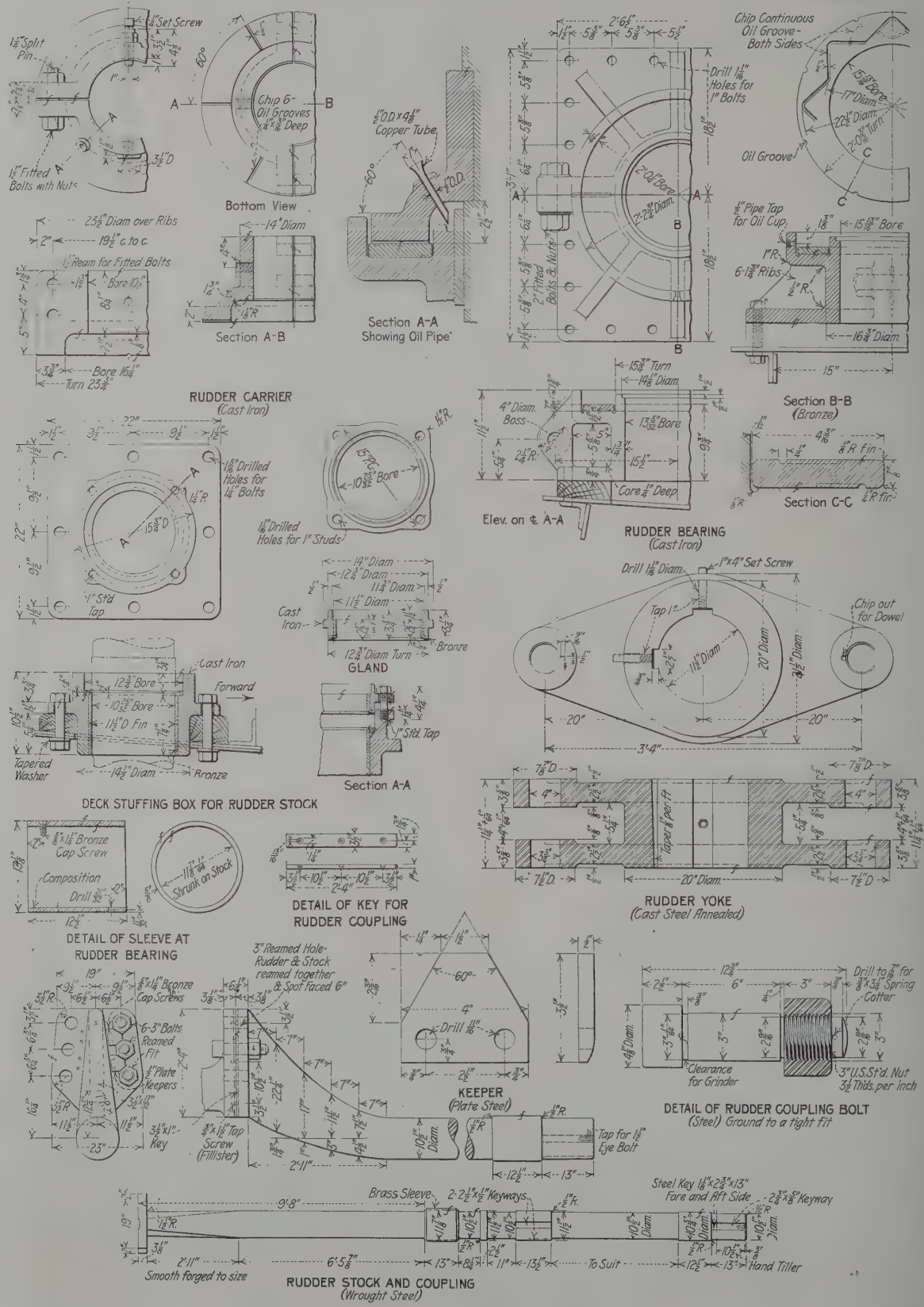


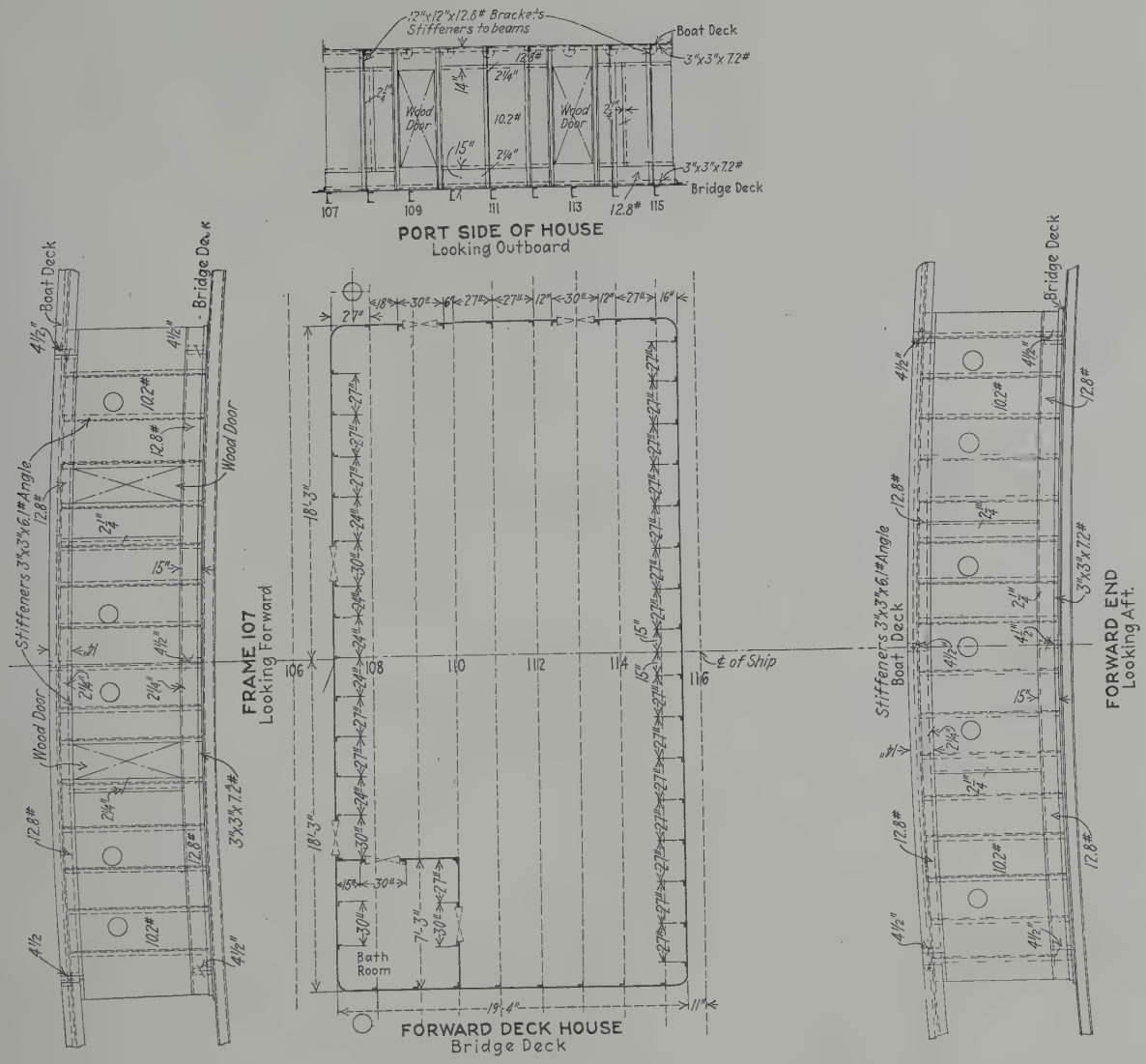
RELIEVING TILLER
(Cast Steel)

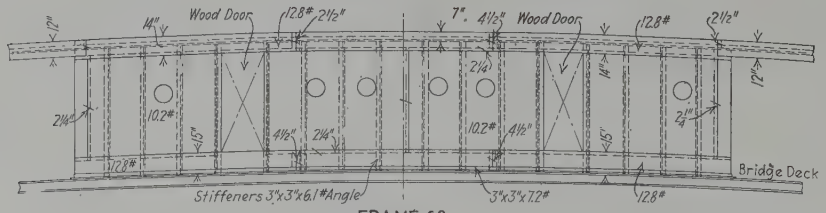


DETAIL OF RUDDER COUPLING
(Wrought Steel)

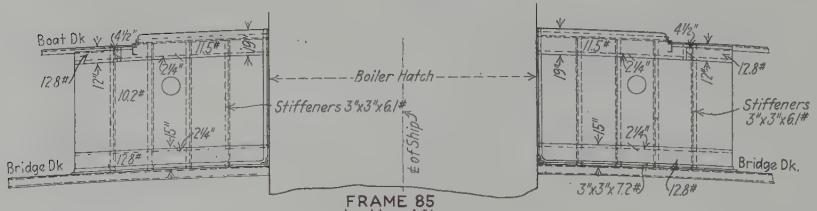
See Page 578


Bottom View
Section A-B
Section A-A
Showing Oil Pipe
RUDDER CARRIER
(Cast Iron)
DECK STUFFING BOX FOR RUDDER STOCK
GLAND
DETAIL OF SLEEVE AT
RUDDER BEARING
DETAIL OF KEY FOR
RUDDER COUPLING
RUDDER BEARING
(Cast Iron)
Section B-B
(Bronze)
Section C-C
Elev. on ℄ A-A
RUDDER YOKE
(Cast Steel Annealed)
KEEPER
(Plate Steel)
DETAIL OF RUDDER COUPLING BOLT
(Steel) Ground to a tight fit
RUDDER STOCK AND COUPLING
(Wrought Steel)
Brass Sleeve
Steel Key
Fore and Aft Side
Smooth forged to size
To Suit
Hand Tiller

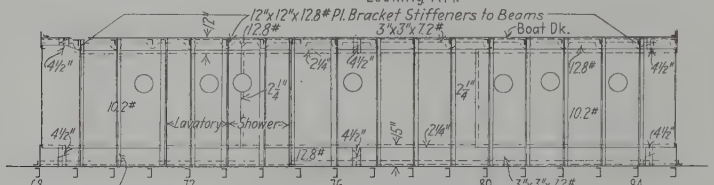

12"x12"x12.8# Brackets Stiffeners to beams
Boat Deck
3"x3"x 7.2#
Wood Door
10.2#
12.8#
Bridge Deck
PORT SIDE OF HOUSE
Looking Outboard
Stiffeners 3"x3"x6.1# Angle
Boat Deck
Bridge Deck
FRAME 107
Looking Forward
FORWARD END
Looking Aft.
Bath Room
FORWARD DECK HOUSE
Bridge Deck
℄ of Ship
STARBOARD SIDE OF HOUSE
Looking Inboard
Note: Butt Straps Top and Bottom Coaming 15.3#
FORE & AFT BATH RM. BHD.
Looking Inboard
TRANS-BATH RM. BHD.
Looking Aft.



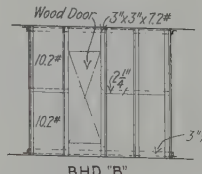
FRAME 68
Looking Forward



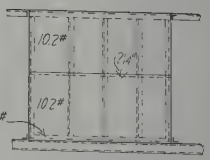
FRAME 85
Looking Aft.



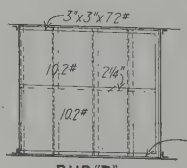
PORT SIDE OF HOUSE
Looking Outward



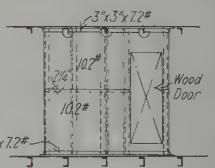
BHD. "B"
Looking Aft.



BHD. "C"
Looking Aft.

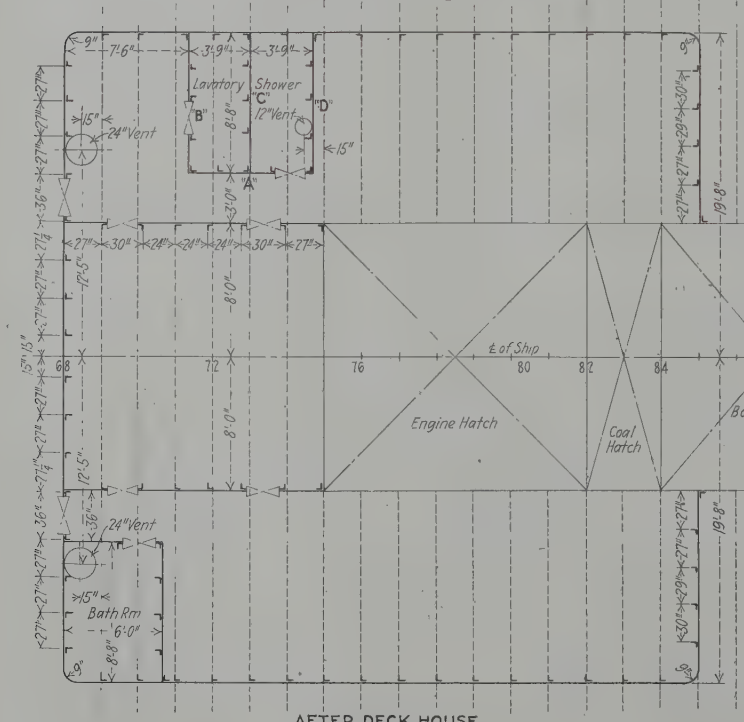


BHD. "D"
Looking Aft.



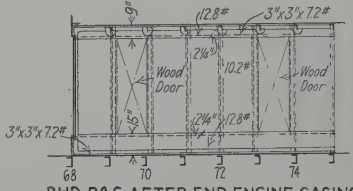
BHD. "A"
Looking Outboard

LAVATORY AND SHOWER BHDS. AFTER HOUSE

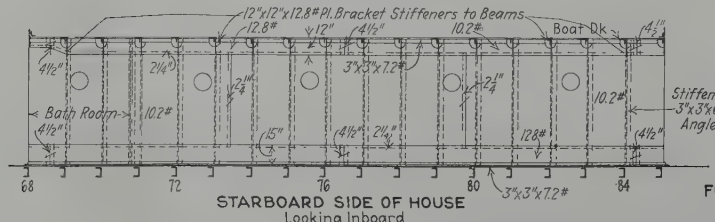


AFTER DECK HOUSE
Bridge Deck

Note:- Butt Straps top and bottom coaming 15.3#

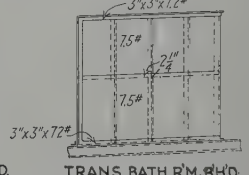


BHD. P.&S. AFTER END ENGINE CASING
Looking Inboard



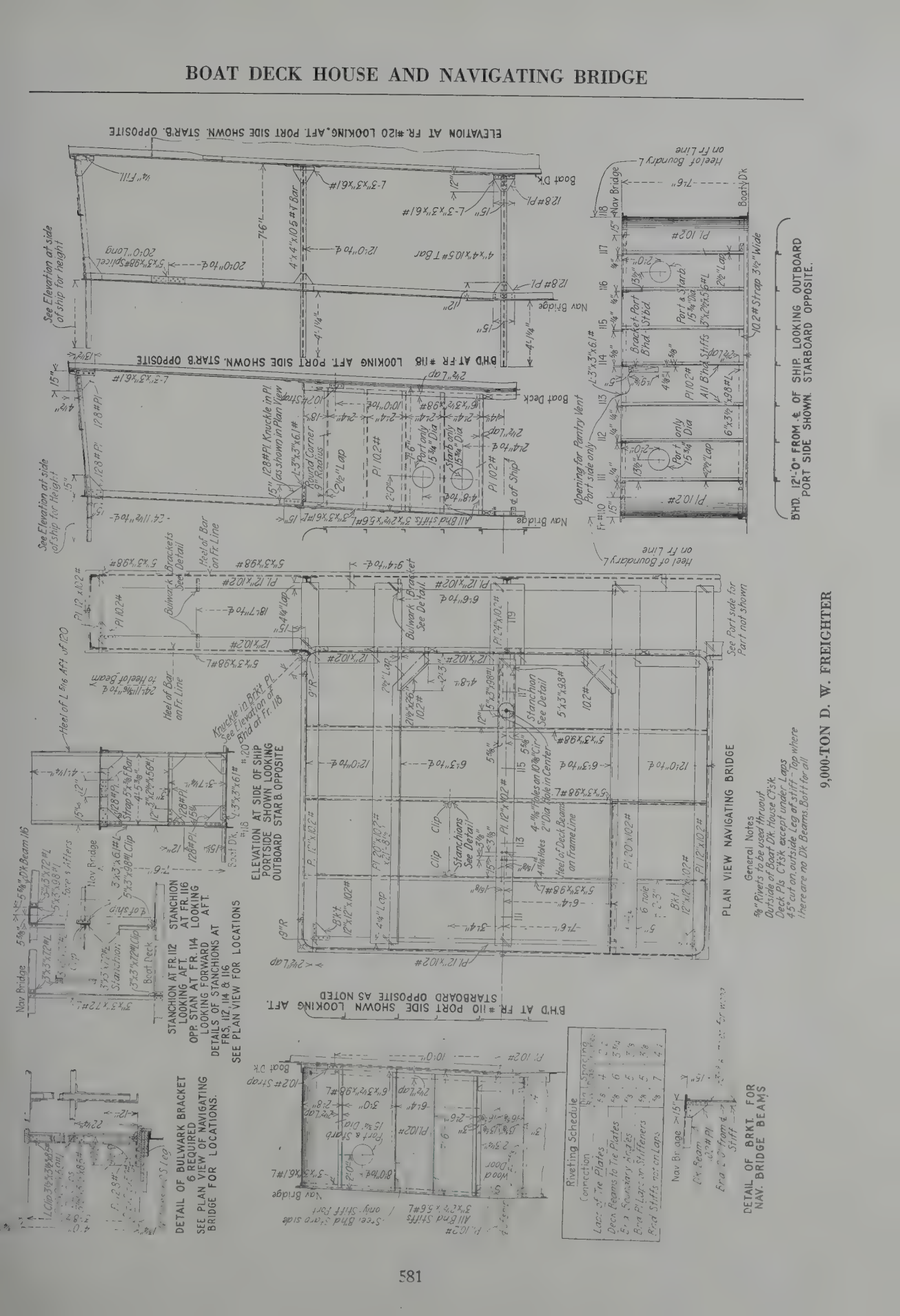
STARBOARD SIDE OF HOUSE
Looking Inboard

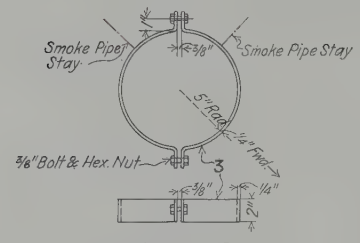
FORE & AFT. BATH RM. BHD.
Looking Inboard



TRANS BATH RM. BHD.
Looking Aft.

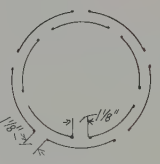
8,800-TON D. W. FREIGHTER


ELEVATION AT FR. #120 LOOKING AFT. PORT SIDE SHOWN. STAR'B. OPPOSITE
B'HD AT FR #118 LOOKING AFT. PORT SIDE SHOWN. STAR'B OPPOSITE
B'HD. AT FR #110 PORT SIDE SHOWN LOOKING AFT. STARBOARD OPPOSITE AS NOTED
B'HD. 12'-0" FROM ℄ OF SHIP. LOOKING OUTBOARD PORT SIDE SHOWN. STARBOARD OPPOSITE.
ELEVATION AT SIDE OF SHIP PORTSIDE SHOWN. LOOKING OUTBOARD STAR'B. OPPOSITE
PLAN VIEW NAVIGATING BRIDGE
9,000-TON D. W. FREIGHTER
General Notes
Rivets to be used throughout
Outside of Boat Dk. House C'S'K.
Deck Pls C'S'K except under Laps
45° cut on outside Leg of stiff - Top where there are no Dk Beams. Both for all
STANCHION AT FR. 112 LOOKING AFT OPP. STAN AT FR. 114 LOOKING AFT.
LOOKING FORWARD
DETAILS OF STANCHIONS AT FRS. 112, 114 & 116
SEE PLAN VIEW FOR LOCATIONS
DETAIL OF BULWARK BRACKET 6 REQUIRED
SEE PLAN VIEW OF NAVIGATING BRIDGE FOR LOCATIONS.
DETAIL OF BRKT. FOR NAV. BRIDGE BEAMS
Riveting Schedule



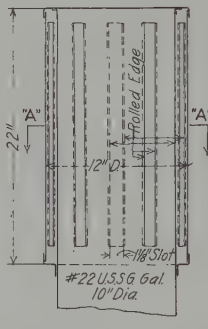
STAY BAND
FOR GALLEY SMOKE PIPE

PLAN VIEW OF TOP
OF SMOKE PIPE

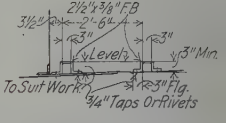


SECTION A-A

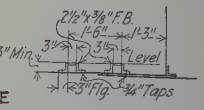
General Note
All Dimensions Except Those given
To Be Taken From Work



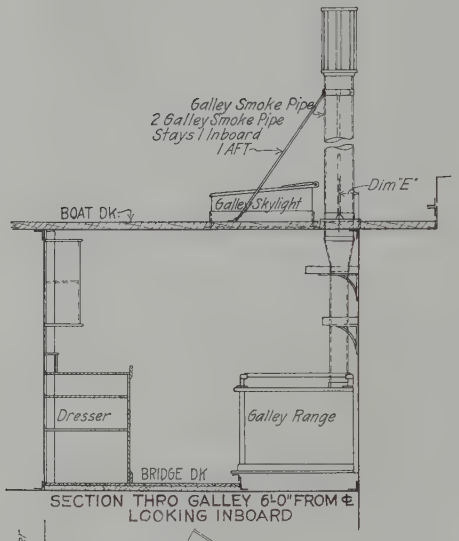
SECTION THRO SMOKE PIPE



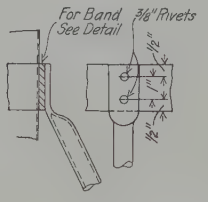
FOUNDATION FOR
VEGETABLE STEAMER
LOOKING FOR'D.

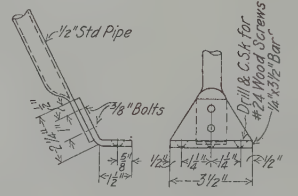


FOUNDATION FOR
WATER BOILER
LOOKING FOR'D

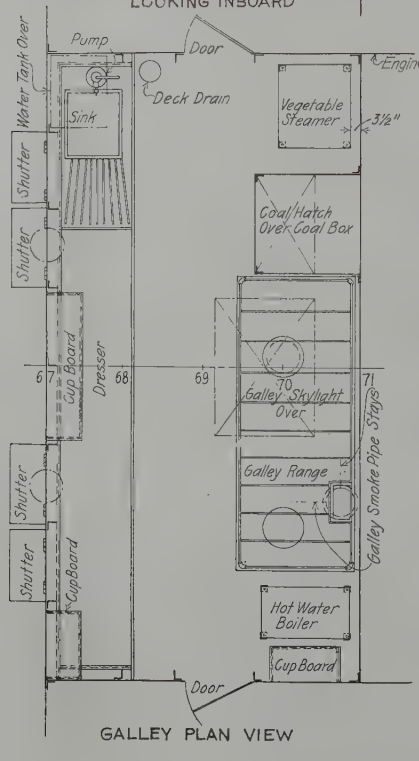


SECTION THRO GALLEY 6'-0" FROM ℄
LOOKING INBOARD

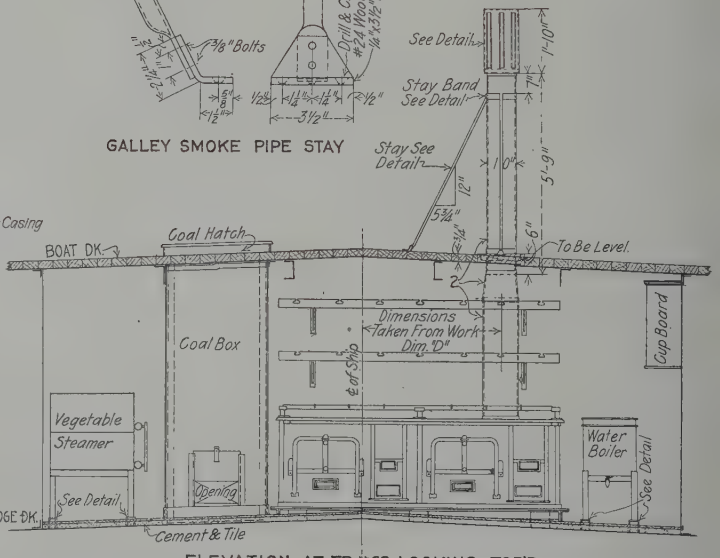




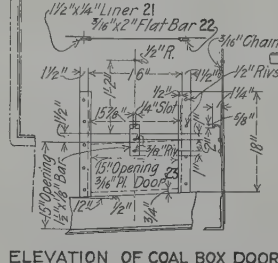
GALLEY SMOKE PIPE STAY



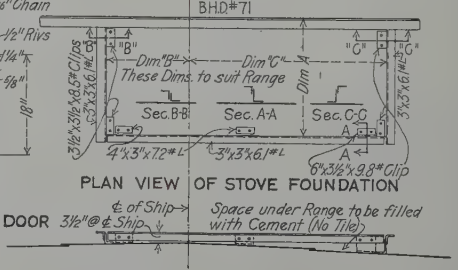
GALLEY PLAN VIEW



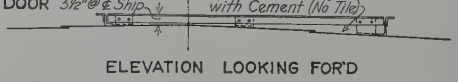
ELEVATION AT FR #69 LOOKING FOR'D



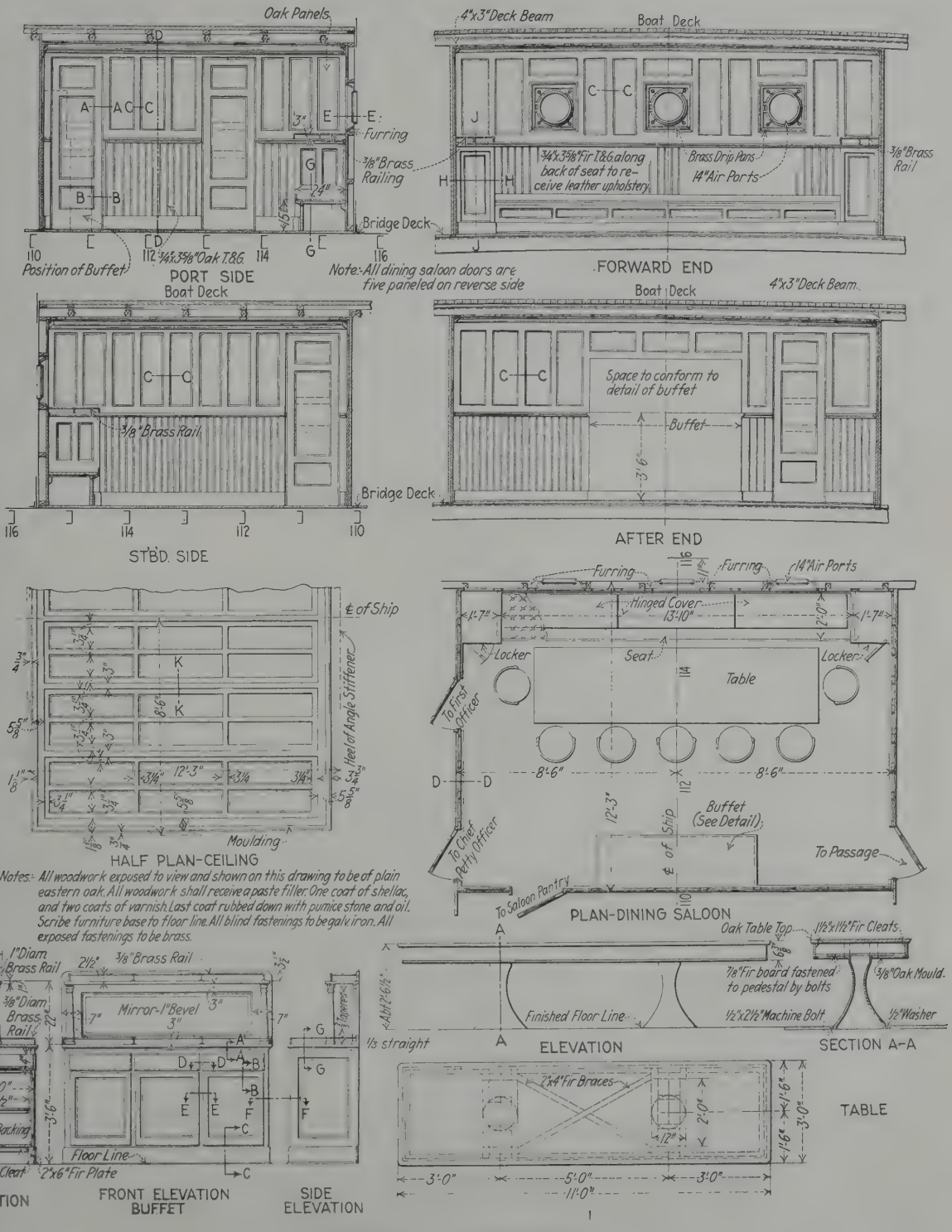
ELEVATION OF COAL BOX DOOR



PLAN VIEW OF STOVE FOUNDATION

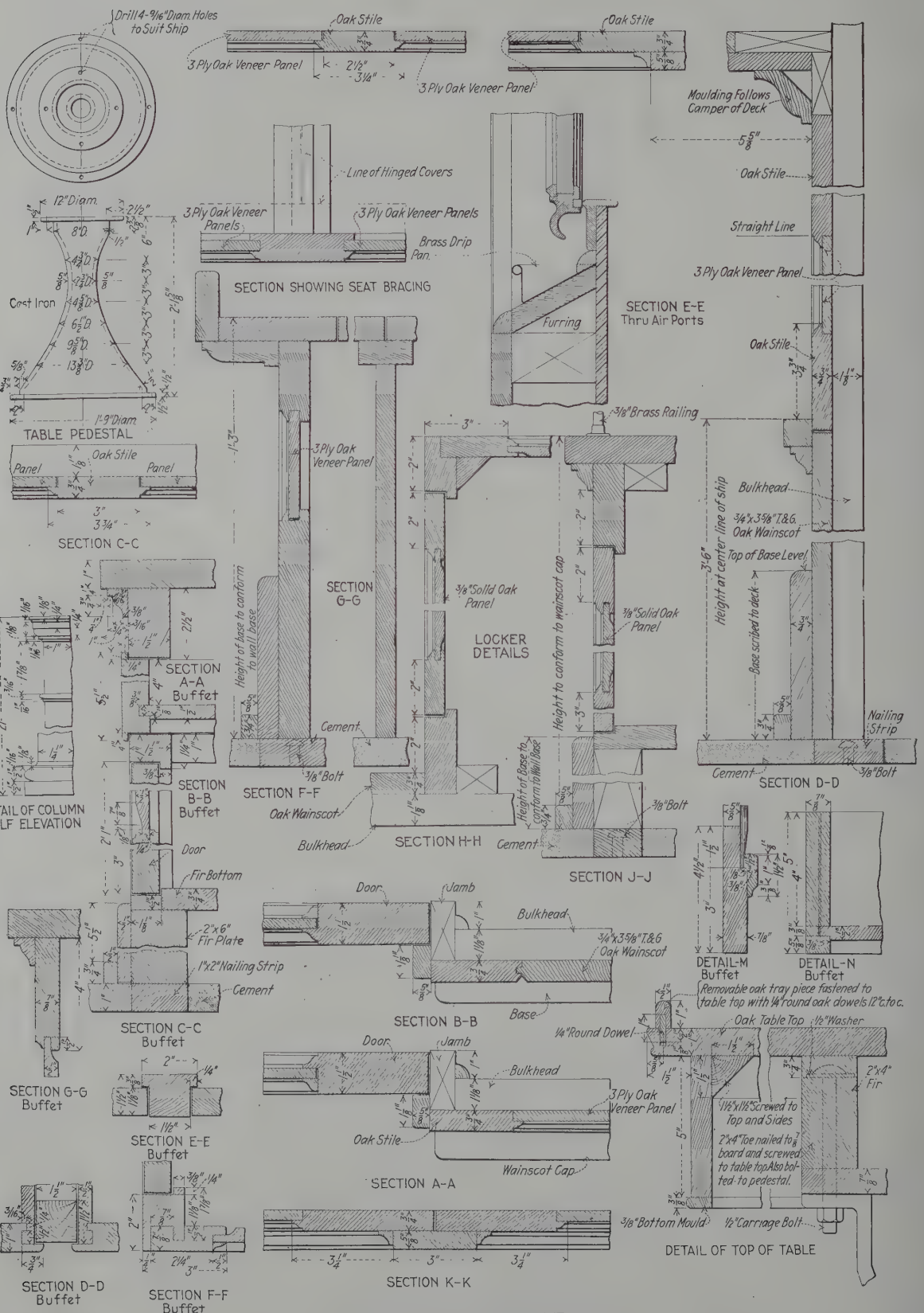


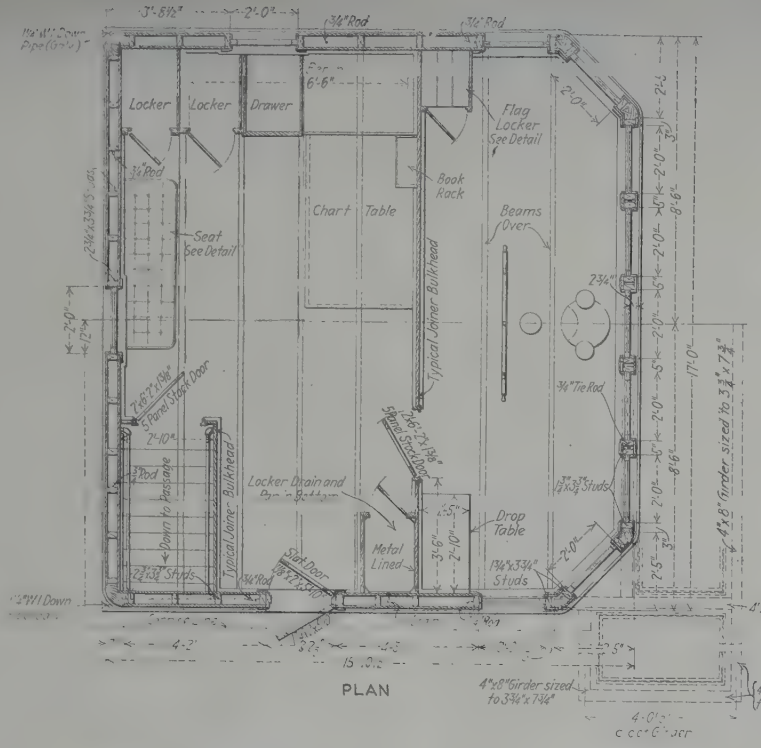
ELEVATION LOOKING FOR'D

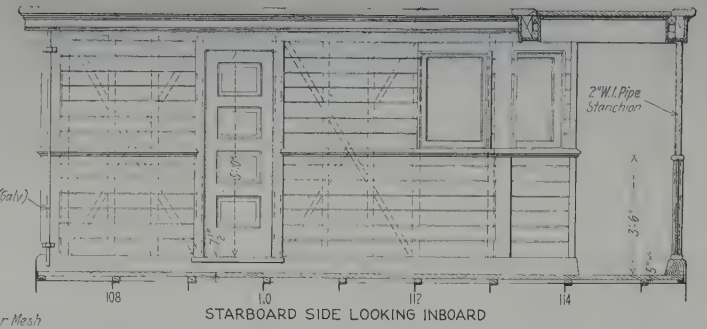


8,800-TON D. W. FREIGHTER

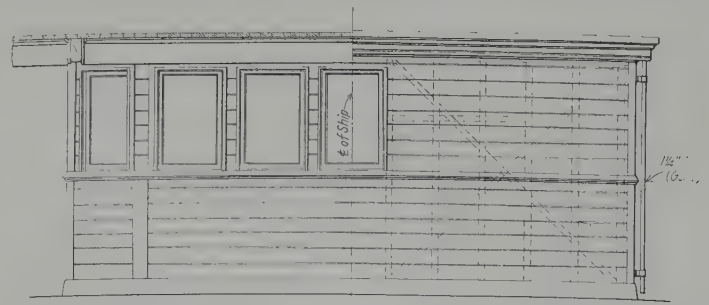
See Page 584

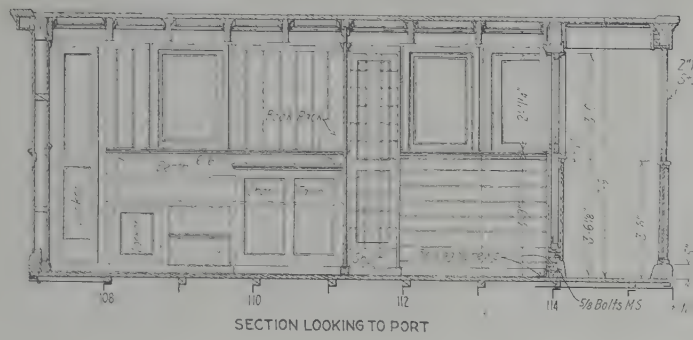

Drill 4-9/16" Diam. Holes to Suit Ship
Oak Stile
3 Ply Oak Veneer Panel
2½"
3¼"
3 Ply Oak Veneer Panel
Oak Stile
Moulding Follows Camper of Deck
5 5/8"
Oak Stile
Straight Line
3 Ply Oak Veneer Panel
Line of Hinged Covers
3 Ply Oak Veneer Panels
3 Ply Oak Veneer Panels
Brass Drip Pan
SECTION SHOWING SEAT BRACING
Furring
SECTION E-E
Thru Air Ports
Oak Stile
3/8" Brass Railing
Bulkhead
¾"x3⅝" T.&G. Oak Wainscot
Top of Base Level
Height at center line of ship
3'-6"
Base scribed to deck
Nailing Strip
Cement
3/8" Bolt
SECTION D-D
12" Diam.
Cast Iron
8"D
4½"D
3⅜"D
5"D
6½"D
9⅝"D
13⅜"D
1'-9" Diam.
TABLE PEDESTAL
Oak Stile
Panel
Panel
3"
3¾"
SECTION C-C
3 Ply Oak Veneer Panel
1'-3"
SECTION G-G
3/8" Solid Oak Panel
LOCKER DETAILS
3/8" Solid Oak Panel
Height of base to conform to wall base
Height to conform to wainscot cap
Cement
3/8" Bolt
SECTION F-F
Oak Wainscot
Bulkhead
SECTION H-H
Height of base to conform to Wall Base
3/8" Bolt
Cement
SECTION J-J
SECTION A-A Buffet
DETAIL OF COLUMN HALF ELEVATION
SECTION B-B Buffet
Door
Fir Bottom
2"x6" Fir Plate
1"x2" Nailing Strip
Cement
SECTION C-C Buffet
Door
Jamb
Bulkhead
¾"x3⅝" T.&G. Oak Wainscot
Base
SECTION B-B
DETAIL-M Buffet
DETAIL-N Buffet
Removable oak tray piece fastened to table top with ¼" round oak dowels 12" c. to c.
Oak Table Top
½" Washer
¼" Round Dowel
2"x4" Fir
1½"x1½" Screwed to Top and Sides
2"x4" Toe nailed to board and screwed to table top. Also bolted to pedestal.
3/8" Bottom Mould
½" Carriage Bolt
DETAIL OF TOP OF TABLE
SECTION G-G Buffet
SECTION E-E Buffet
Door
Jamb
Bulkhead
3 Ply Oak Veneer Panel
Oak Stile
Wainscot Cap
SECTION A-A
SECTION D-D Buffet
SECTION F-F Buffet
3¼"
3"
3¼"
SECTION K-K

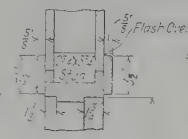

Locker
Locker
Drawer
Chart Table
Book Rack
Flag Locker See Detail
Seat See Detail
Typical Joiner Bulkhead
Beams Over
Drop Table
Metal Lined
Slat Door
Locker Drain and Pan in Bottom
Down to Passage
2"W.I. Down Pipe (Galv.)
3/4" Rod
3/4" Tie Rod
2¾"x3¾" Studs
4"x8" Girder sized to 3¾"x7¾"
PLAN

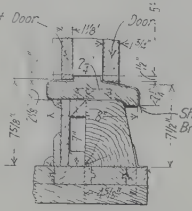

2"W.I. Pipe Stanchion
1½"W.I. Pipe (Galv.)
STARBOARD SIDE LOOKING INBOARD

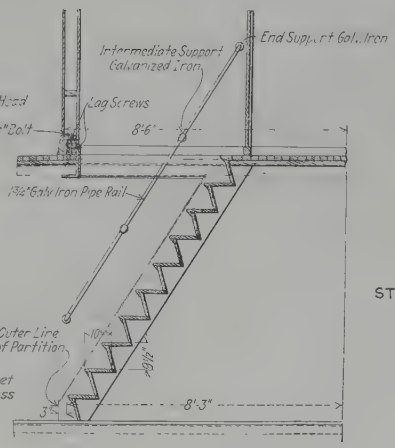
Copper Mesh
SLAT DOOR
W.t.L. Copper Mesh

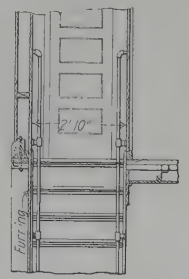

FORWARD END LOOKING AFT
AFTER END LOOKING FORWARD


2"W.I. Pipe Stanchion
SECTION LOOKING TO PORT

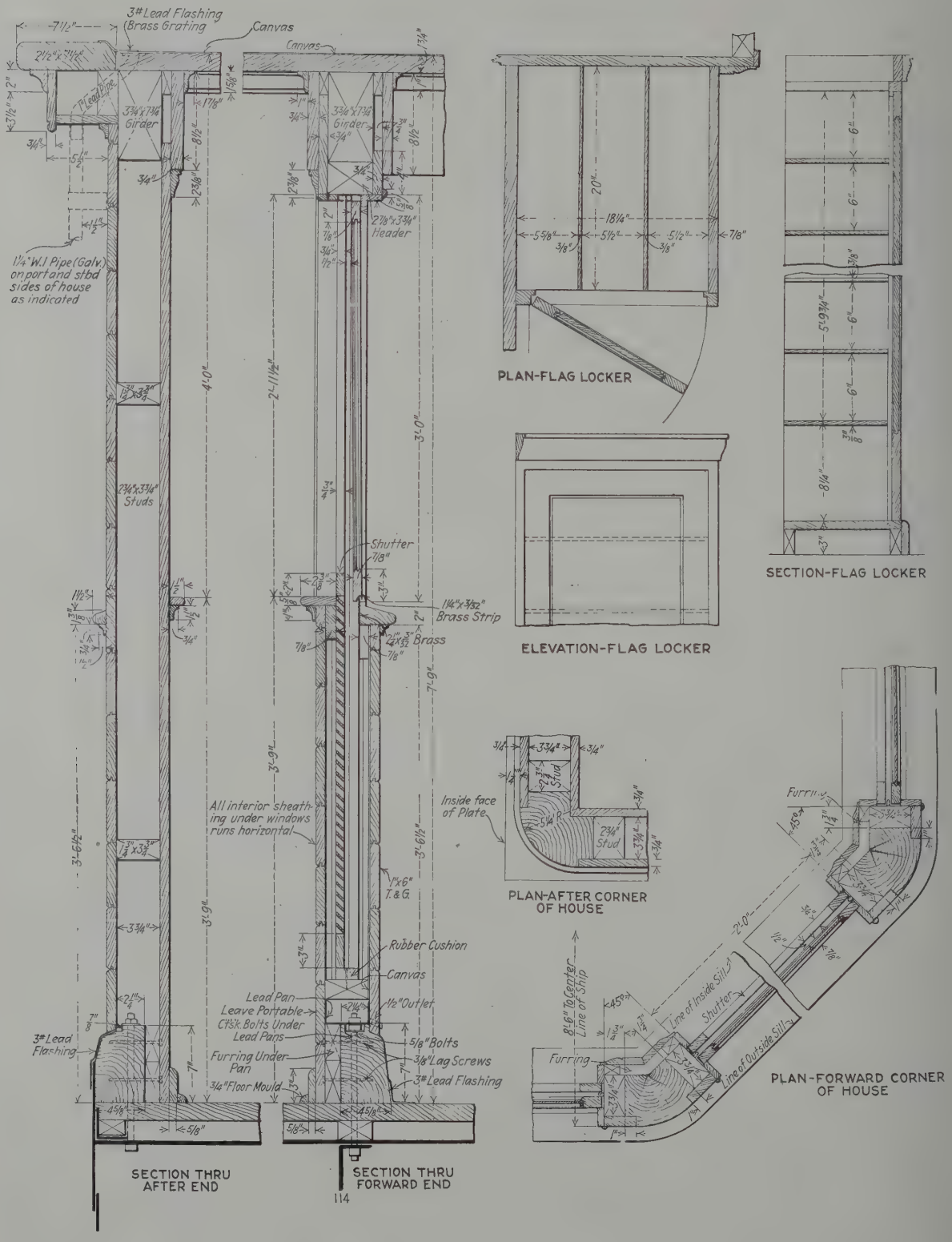

Flash Over Head
SECTION THRU JAMB & HEAD


Slat Door
Door
Sheet Brass
SECTION THRU DOOR SILL
of House

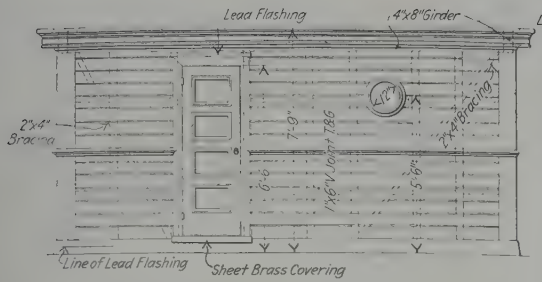

Intermediate Support Galvanized Iron
End Support Gal. Iron
Lag Screws
5/8" Bolt
1¾" Galv Iron Pipe Rail
Outer Line of Partition
SECTION THRU STAIR

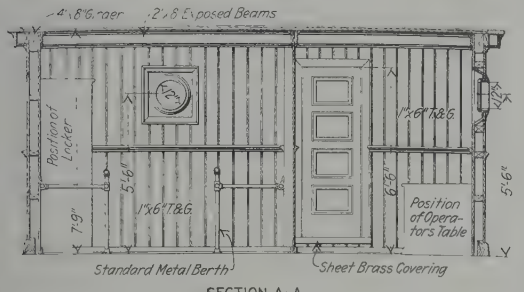

STAIR LOOKING TO PORT

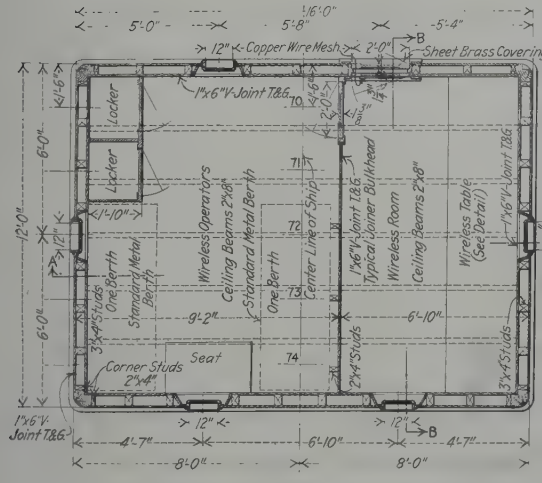
See Page 586

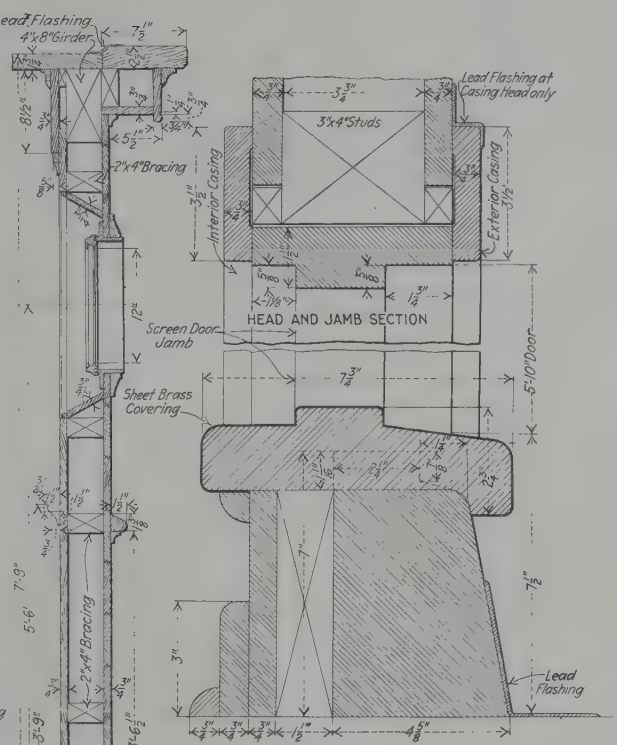

3# Lead Flashing (Brass Grating
Canvas
Canvas
7½"
2½"x7½"
3¾"x7¾" Girder
3¾"x7¾" Girder
2⅞"x3¾" Header
1¼" W.I. Pipe (Galv) on port and stbd sides of house as indicated
2¾"x3¾" Studs
Shutter 7/8"
1¼"x3½" Brass Strip
2"x⅝" Brass
All interior sheathing under windows runs horizontal
1"x6" T. & G.
Rubber Cushion
Canvas
Lead Pan
Leave Portable
⅝" Bolts Under Lead Pans
⅜" Lag Screws
Furring Under Pan
3# Lead Flashing
¾" Floor Mould
3# Lead Flashing
½" Outlet
SECTION THRU AFTER END
SECTION THRU FORWARD END
PLAN-FLAG LOCKER
ELEVATION-FLAG LOCKER
SECTION-FLAG LOCKER
Inside face of Plate
2¾" Stud
PLAN-AFTER CORNER OF HOUSE
Furring
8'-6" To Center Line of Ship
Line of Inside Sill
Shutter
Furring
Line of Outside Sill
PLAN-FORWARD CORNER OF HOUSE

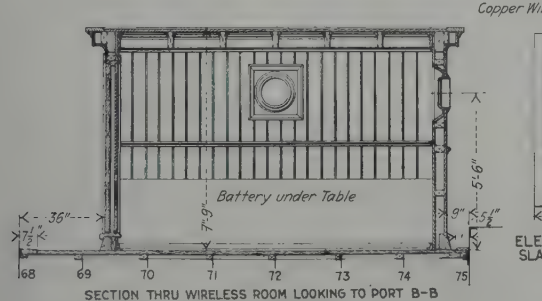
See Page 585

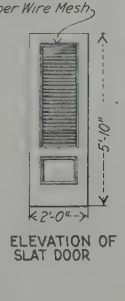

Lead Flashing
4"x8" Girder
2"x4" Bracing
2"x4" Bracing
1"x6" V Joint T&G
Line of Lead Flashing
Sheet Brass Covering
LOOKING FORWARD
LOOKING AFT.

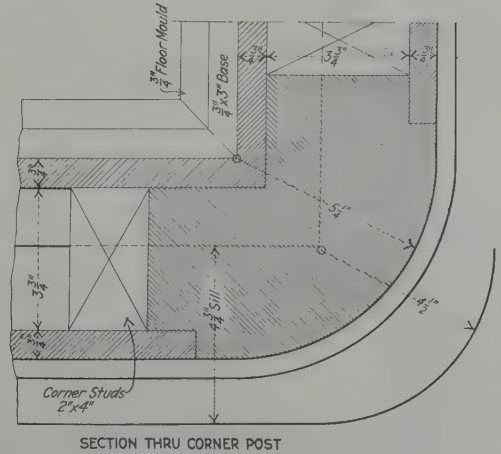

4"x8" Girder
2"x8" Exposed Beams
Position of Locker
1"x6" T&G
1"x6" T&G
Position of Operator's Table
Standard Metal Berth
Sheet Brass Covering
SECTION A-A

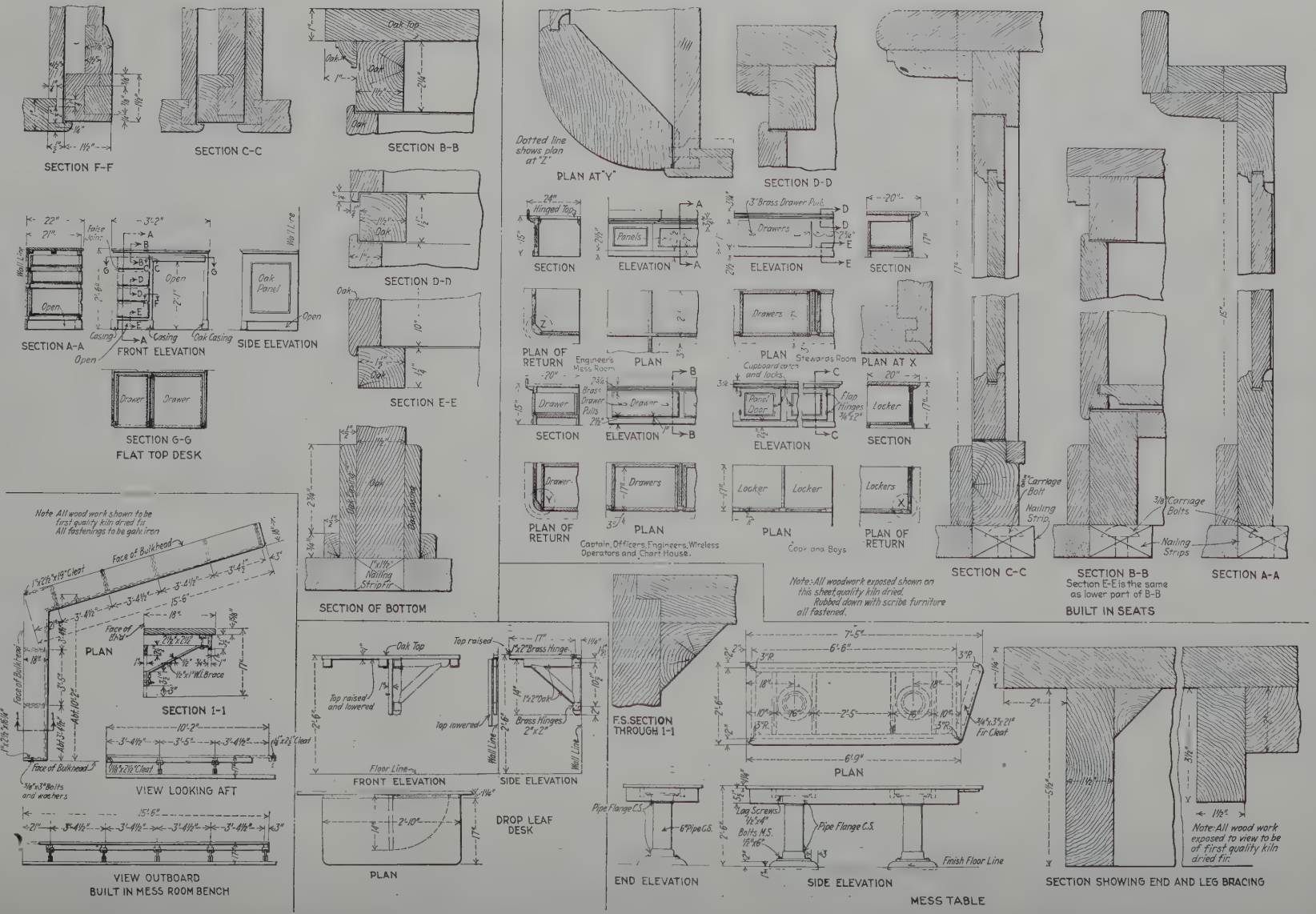

Copper Wire Mesh
Sheet Brass Covering
1"x6" V Joint T&G
Locker
Locker
Wireless Operators
Ceiling Beams 2"x8"
Standard Metal Berth
One Berth
Center Line of Ship
1"x6" V Joint T&G
Typical Joiner Bulkhead
Wireless Room
Ceiling Beams 2"x8"
Wireless Table (See Detail)
1"x6" V Joint T&G
Standard Metal Berth
One Berth
3"x4" Studs
Corner Studs 2"x4"
Seat
2"x4" Studs
3"x4" Studs
1"x6" V Joint T&G
PLAN

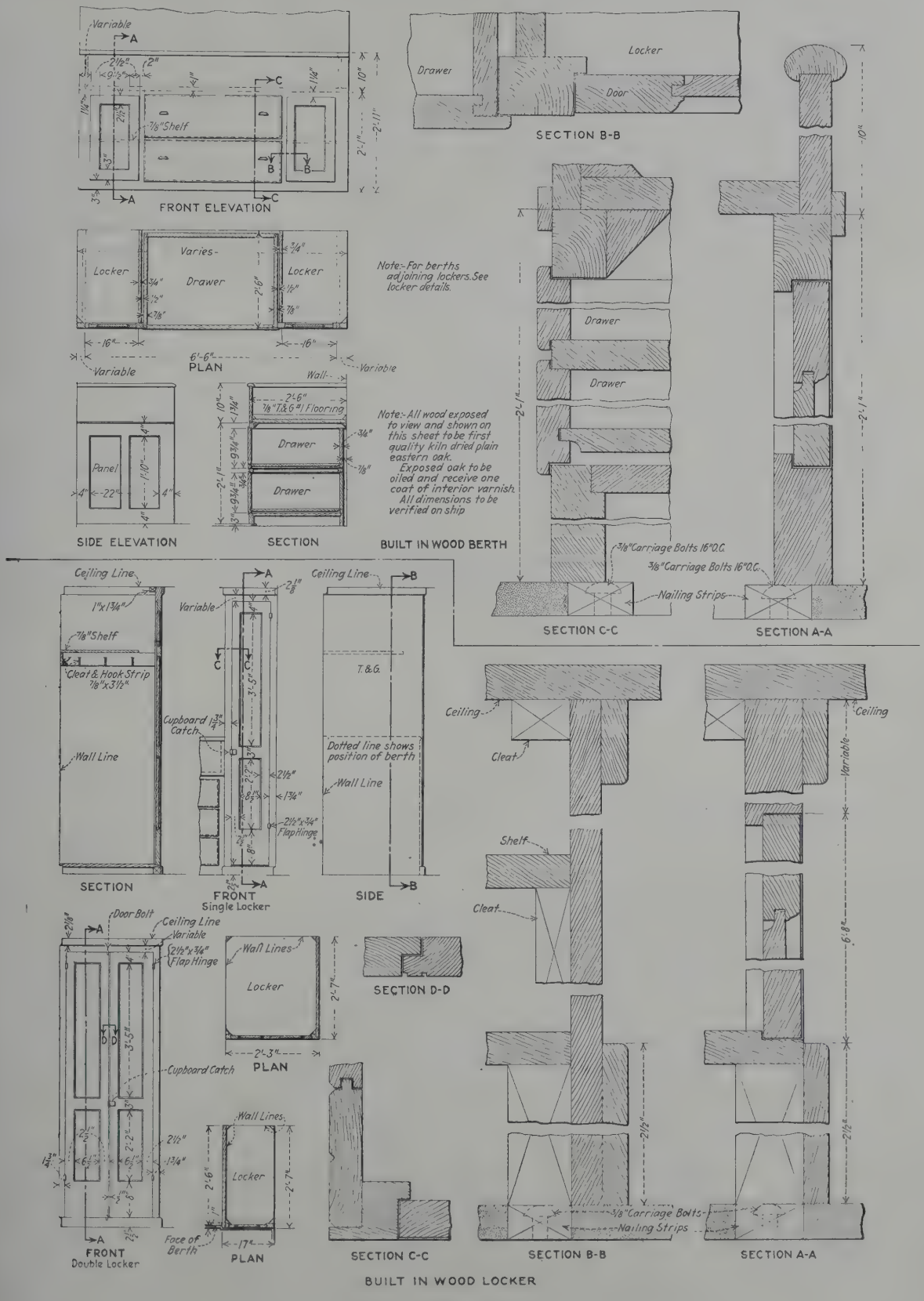

Lead Flashing
4"x8" Girder
2"x4" Bracing
2"x4" Bracing
Screen Door Jamb
Sheet Brass Covering
Blocking
Lead Flashing
Lead Flashing at Casing Head only
3"x4" Studs
Interior Casing
Exterior Casing
HEAD AND JAMB SECTION
5'-10" Door
Lead Flashing
SECTION THRU DOOR SILL
DETAIL OF INTERIOR DOOR AND JAMB

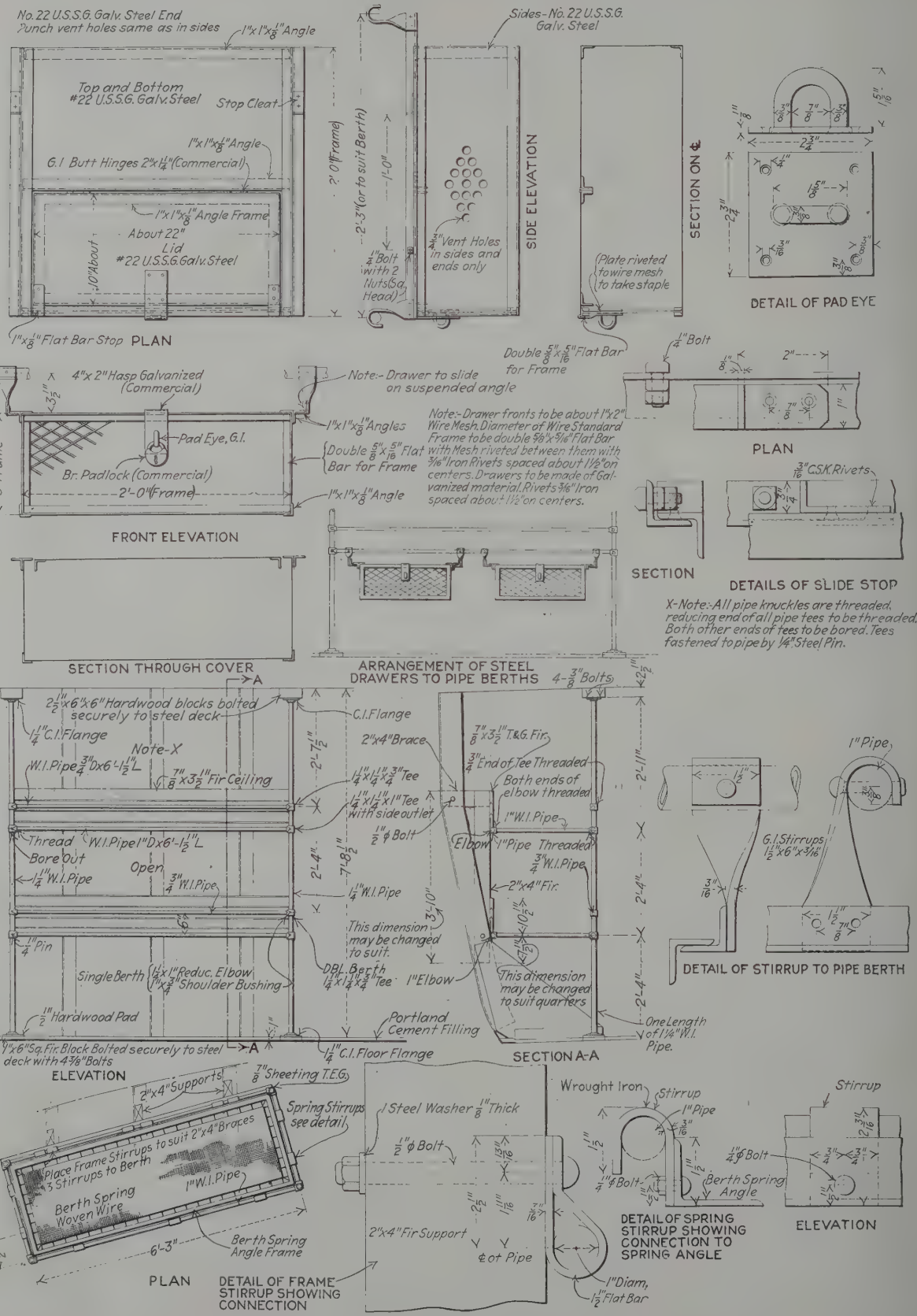

Battery under Table
36"
68
69
70
71
72
73
74
75
SECTION THRU WIRELESS ROOM LOOKING TO PORT B-B


Copper Wire Mesh
2'-0"
ELEVATION OF SLAT DOOR

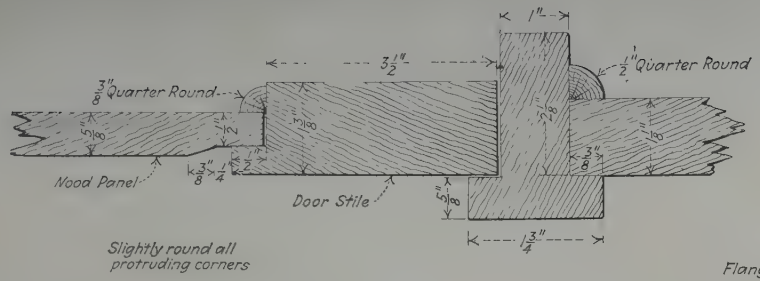

Floor Mould
Base
Sill
Corner Studs 2"x4"
SECTION THRU CORNER POST


SECTION F-F
SECTION C-C
SECTION B-B
SECTION D-D
SECTION E-E
SECTION A-A
FRONT ELEVATION
SIDE ELEVATION
SECTION G-G
FLAT TOP DESK
SECTION OF BOTTOM
Note All wood work shown to be first quality kiln dried fir. All fastenings to be galv. iron
PLAN
SECTION 1-1
VIEW LOOKING AFT
VIEW OUTBOARD
BUILT IN MESS ROOM BENCH
Dotted line shows plan at "Z"
PLAN AT "Y"
SECTION D-D
PLAN OF RETURN
Engineers Mess Room
Captain, Officers, Engineers, Wireless Operators and Chart House.
Stewards Room
PLAN AT X
Cupboard catch and locks.
Flap Hinges
Crew and Boys
Note: All woodwork exposed shown on this sheet quality kiln dried. Rubbed down with scribe furniture all fastened.
SECTION C-C
SECTION B-B
Section E-E is the same as lower part of B-B
SECTION A-A
BUILT IN SEATS
Top raised and lowered
Top lowered
Brass Hinges
Floor Line
FRONT ELEVATION
SIDE ELEVATION
DROP LEAF DESK
PLAN
F.S. SECTION THROUGH 1-1
PLAN
END ELEVATION
SIDE ELEVATION
MESS TABLE
SECTION SHOWING END AND LEG BRACING
Note: All wood work exposed to view to be of first quality kiln dried fir.

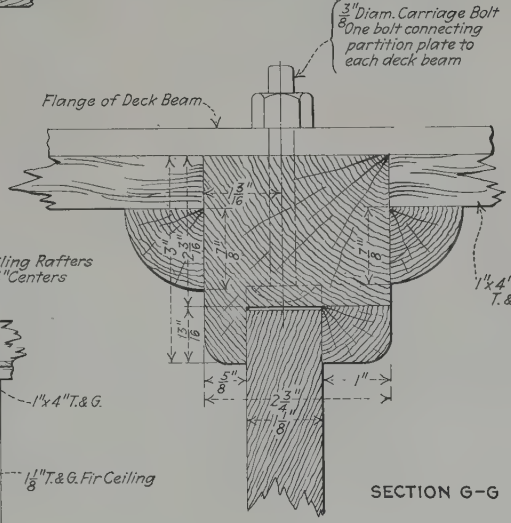

Variable
A
2½"
2"
9½"
4"
C
1¼"
10"
1¼"
2½"
7/8" Shelf
2'-1"
2'-11"
B
B
3"
A
C
FRONT ELEVATION
Drawer
Locker
Door
SECTION B-B
Varies
Locker
Drawer
Locker
¾"
¾"
½"
7/8"
2'6"
½"
7/8"
16"
16"
6'-6"
PLAN
Variable
Variable
Wall
Note:-For berths adjoining lockers. See locker details.
Drawer
Drawer
2'-1¼"
2'-1¼"
10"
Panel
1'10"
4"
22"
4"
4"
2'-6"
7/8" T.& G.d Flooring
10"
1¾"
9¾"
¾"
7/8"
Drawer
Drawer
2'-1¼"
9¾"
¾"
3"
Note:-All wood exposed to view and shown on this sheet to be first quality kiln dried plain eastern oak. Exposed oak to be oiled and receive one coat of interior varnish. All dimensions to be verified on ship
SIDE ELEVATION
SECTION
BUILT IN WOOD BERTH
⅜" Carriage Bolts 16" O.C.
⅜" Carriage Bolts 16" O.C.
Nailing Strips
SECTION C-C
SECTION A-A
Ceiling Line
1"x1¾"
7/8" Shelf
Cleat & Hook Strip 7/8"x3½"
Wall Line
SECTION
A
Variable
2½"
C
C
3'-5"
Cupboard Catch
1¾"
2½"
1¾"
2½"x¾" Flap Hinge
8"
A
FRONT
Single Locker
Ceiling Line
B
T.& G.
Dotted line shows position of berth
Wall Line
B
SIDE
Ceiling
Cleat
Shelf
Cleat
Ceiling
Variable
6'-8"
2½"
2½"
⅜" Carriage Bolts
Nailing Strips
SECTION B-B
SECTION A-A
2½"
Door Bolt
A
Ceiling Line
Variable
2½"x¾" Flap Hinge
D
D
3'-5"
Cupboard Catch
Wall Lines
Locker
2'-7½"
SECTION D-D
2'-3"
PLAN
Wall Lines
2½"
1¾"
2½"
1¾"
2'-6"
Locker
2'-7½"
A
FRONT
Double Locker
Face of Berth
17"
PLAN
SECTION C-C
BUILT IN WOOD LOCKER


No. 22 U.S.S.G. Galv. Steel End
Punch vent holes same as in sides
1"x1"x⅛" Angle
Top and Bottom #22 U.S.S.G. Galv. Steel
Stop Cleat
1"x1"x⅛" Angle
G.I. Butt Hinges 2"x1¼" (Commercial)
1"x1"x⅛" Angle Frame
About 22" Lid #22 U.S.S.G. Galv. Steel
10" About
1"x⅛" Flat Bar Stop
PLAN
2'-0" (Frame)
2'-3" (or to suit Berth)
1'-0"
¾" Vent Holes in sides and ends only
¼" Bolt with 2 Nuts (Sq. Head)
Sides-No. 22 U.S.S.G. Galv. Steel
SIDE ELEVATION
(Plate riveted to wire mesh to take staple
SECTION ON ℄
DETAIL OF PAD EYE
Double ⅝"x⅝" Flat Bar for Frame
¼" Bolt
PLAN
4"x2" Hasp Galvanized (Commercial)
Note:- Drawer to slide on suspended angle
1"x1"x⅛" Angles
Pad Eye, G.I.
Br. Padlock (Commercial)
2'-0" (Frame)
9" Frame
1"x1"x⅛" Angle
Note:- Drawer fronts to be about 1"x2" Wire Mesh. Diameter of Wire Standard Frame to be double ⅝"x⅝" Flat Bar with Mesh riveted between them with ⅜" Iron Rivets spaced about 1½" on centers. Drawers to be made of Galvanized material. Rivets ⅜" Iron spaced about 1½" on centers.
FRONT ELEVATION
3/16" C.S.K. Rivets
SECTION
DETAILS OF SLIDE STOP
X-Note:- All pipe knuckles are threaded, reducing end of all pipe tees to be threaded. Both other ends of tees to be bored. Tees fastened to pipe by ¼" Steel Pin.
SECTION THROUGH COVER
ARRANGEMENT OF STEEL DRAWERS TO PIPE BERTHS
2½"x6"x6" Hardwood blocks bolted securely to steel deck
¼" C.I. Flange
Note-X
W.I. Pipe ¾" Dx6'-1½" L
⅞"x3½" Fir Ceiling
Thread
W.I. Pipe 1" Dx6'-1½" L
Bore Out
¼" W.I. Pipe
Open
¾" W.I. Pipe
¼" Pin
Single Berth
1¼"x1"x⅜" Reduc. Elbow
1"x¾" Shoulder Bushing
½" Hardwood Pad
1"x6" Sq. Fir. Block Bolted securely to steel deck with 4 ⅜" Bolts
A
A
C.I. Flange
2"x4" Brace
¼"x1¼"x¾" Tee
¼"x¼"x1" Tee with side outlet
½" ϕ Bolt
¼" W.I. Pipe
This dimension may be changed to suit.
DBL. Berth
¼"x1¼"x¾" Tee
1" Elbow
4-⅜" Bolts
⅞"x3½" T.&G. Fir
¾" End of Tee Threaded
Both ends of elbow threaded
1" W.I. Pipe
Elbow
1" Pipe Threaded
¾" W.I. Pipe
2"x4" Fir.
This dimension may be changed to suit quarters
One Length of 1¼" W.I. Pipe.
Portland Cement Filling
¼" C.I. Floor Flange
ELEVATION
SECTION A-A
1" Pipe
G.I. Stirrups 1½"x6"x3/16
DETAIL OF STIRRUP TO PIPE BERTH
2"x4" Supports
⅞" Sheeting T.E.G.
Spring Stirrups see detail
Place Frame Stirrups to suit 2"x4" Braces
3 Stirrups to Berth
1" W.I. Pipe
Berth Spring Woven Wire
6'-3"
Berth Spring Angle Frame
PLAN
DETAIL OF FRAME STIRRUP SHOWING CONNECTION
1 Steel Washer ⅛" Thick
½" ϕ Bolt
2"x4" Fir Support
℄ of Pipe
1" Diam., ½" Flat Bar
Wrought Iron Stirrup
1" Pipe
¼" ϕ Bolt
Berth Spring Angle
DETAIL OF SPRING STIRRUP SHOWING CONNECTION TO SPRING ANGLE
Stirrup
1¼" ϕ Bolt
Berth Spring Angle
ELEVATION

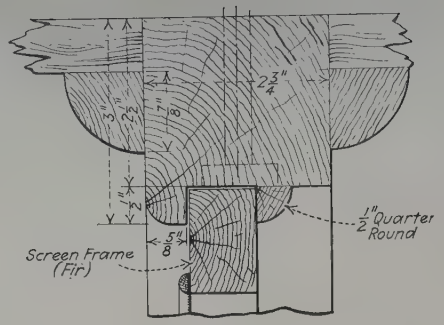
Note:- All wood shown on this sheet shall be first quality kiln dried fir. Except where noted.
All woodwork to receive a primer, two coats of lead and oil, and one coat of white enamel.
All concealed fastenings - Galv. Iron
All exposed fastenings - Brass



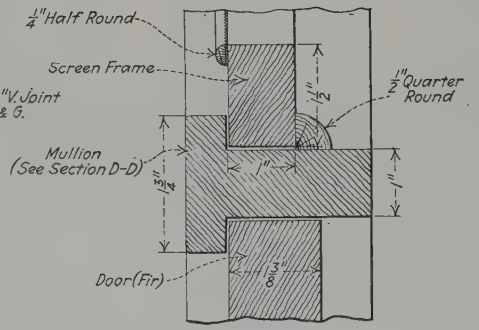
SECTION D-D



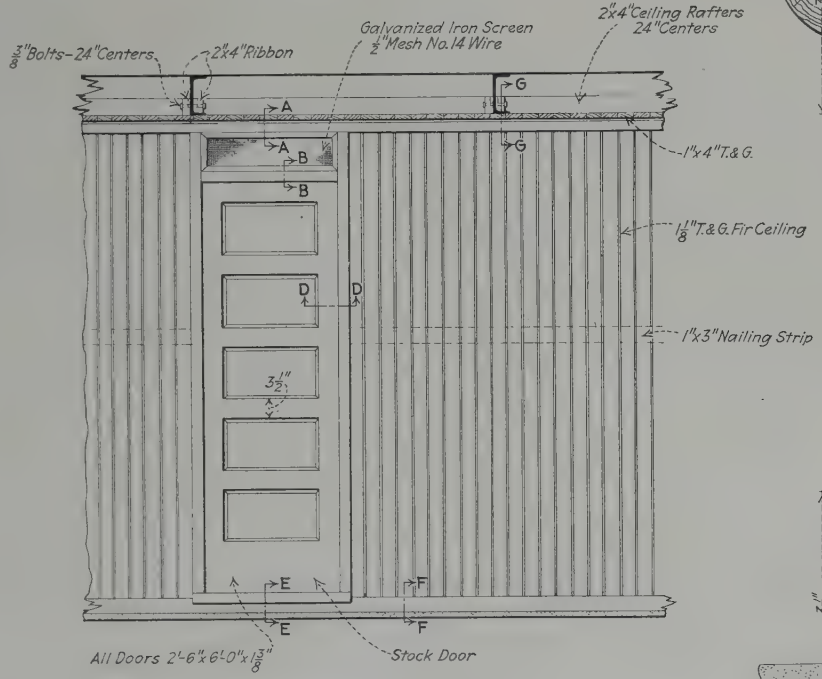
SECTION G-G



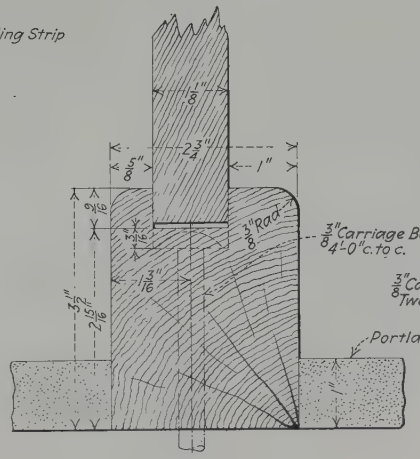
SECTION A-A



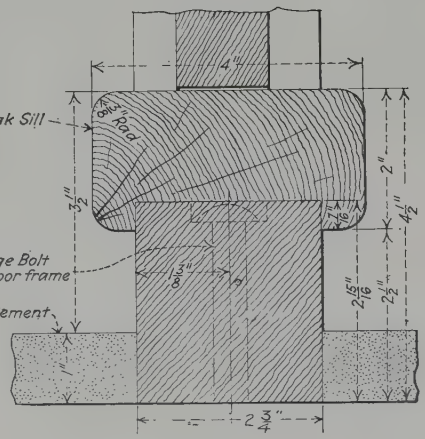
SECTION B-B
Through Mullion


3/8" Bolts - 24" Centers
2"x4" Ribbon
Galvanized Iron Screen 1/2" Mesh No. 14 Wire
2"x4" Ceiling Rafters 24" Centers
1"x4" T. & G.
1/8" T. & G. Fir Ceiling
1"x3" Nailing Strip
3 1/2"
All Doors 2'-6" x 6'-0" x 1 3/8"
Stock Door

TYPICAL ELEVATION OF BULKHEAD AND DOORS IN CREWS QUARTERS
From Passage Side



SECTION F-F



SECTION E-E

3,500-TON D. W. COMPOSITE FREIGHTER

For Arrangement Plan
See Opposite Page

Owner or Operator's Room

Two Built-in Berths, Drawers and Lockers under.
Settee with Drawers under.
Lockers, built-in with Shelf and 6 Coat Hooks each.
Flat Top Desk.
Bent Wood Desk Chair.
Lavatory.
Mirror.
Toilet Rack.
Four Hat and Coat Hooks.
Life Preservers in Rack Overhead.

Owner or Operator's Room

Built-in Berth, 2 Drawers under.
Settee with Drawers under.
Lockers, built-in with Shelf and 6 Coat Hooks each.
Lavatory.
Mirror.
Toilet Rack.
Three Hat and Coat Hooks.
Flat Top Desk.
Bent Wood Desk Chair.
Life Preservers in Rack Overhead.

Captain's Room

Built-in Berth with Chest of Drawers under.
Settee with Drawers under.
Locker, Built-in with Shelf and 6 Coat Hooks.
Book Rack, Oak.
Roll Top Desk.
Revolving Desk Chair.
Morris Chair, Oak.
Four Hat and Coat Hooks.
Life Preserver in Rack Overhead.

Captain's Bath Room

Bathtub, Enameled Iron.
Water Closet, Enameled Iron, Straight Hopper.
Lavatory, Water Heater, Supply Cock.
Mirror, Shower Hd. with Ring and Curtain.
Towel Rack, Distributing Cock.
Sponge and Soap Fixture.
Paper Holder.
Tooth Brush Holder.
Tumbler Holder.
Grab Rod.
Comb and Brush Holder.
Two Coat Hooks.
All Fittings Brass, Nickel Plated.

Chart Room

Two built-in Lockers, one fitted with Galvanized Iron Drip Pan for Oil Skins.
Chart Table with Drawers.
Book Rack.
Chronometer Box.
Keyboard.
Roll Top Desk.
Revolving Chair.
Six Coat and Hat Hooks.

First Officer's Room

Built-in Berth with Drawers under.
Lockers, built-in, Drawers under with Shelf and 6 Coat Hooks each.
Settee with Drawers under.
Flat Top Desk.
Bent Wood Desk Chair.
Keyboard.
Lavatory.
Mirror.
Toilet Rack.
Three Coat and Hat Hooks.
Life Preserver in Rack Overhead.

Officer's Toilet

Two Water Closets, Enameled Iron, Straight Hopper.
Urinal.
Lavatory, Enameled Iron.
Mirror.
Shower and Heater Combination.
Towel Rack.
Paper Holders—2.
Soap Dish 1, Water Heater.

Officer's Toilet—Continued

Two Grab Rods.
Three Coat Hooks.
Tumbler Holder.
All Fittings Brass, Nickel-plated.

Second Officer's Room

Built-in Berth, Drawers under.
Settee with Drawers under
Lockers, built-in with Shelf and 6 Coat Hooks each.
Lavatory.
Mirror.
Toilet Rack.
Two Hat and Coat Hooks.
Bent Wood Desk Chair.
Life Preserver in Rack Overhead.

Third Officer's Room

Built-in Berth, Drawers under.
Settee with Drawers under.
Locker, built-in with Shelf and 6 Coat Hooks.
Lavatory.
Mirror.
Toilet Rack.
Two Hat and Coat Hooks.
Bent Wood Desk Chair.
Life Preservers in Rack Overhead.
Flat Top Desk.

Hospital

4 Metal Pipe Berths.
4 Metal Lockers.
Lavatory.
Mirror.
Toilet Rack.
Seat.
4 Life Preservers in Rack Overhead.

Radio Room

Revolving Desk Chair.
Instrument Table, 4 Drawers under.
Four Hat and Coat Hooks.
Panel for Radio and Storage Battery.
Two Life Preservers in Rack Overhead.

Quartermaster's Room

Three Built-in Berths, Drawers under.
Lockers, Metal, 3 with Shelf and 4 Coat Hooks.
Seat, Stool.
Lavatory.
Mirror.
Toilet Rack.
Six Hat and Coat Hooks.
Three Life Preservers in Rack Overhead.

Linoleum, 3/16 in. Thick to Be Laid in the Following Rooms:

Captain's Room.
Chart Room.
1st Officer's Room.
2nd Officer's Room.
3rd Officer's Room.
Owner or Operator's Room.
Quartermaster's Room.
Hospital.
Radio Room.

Vitrified Tiling of Hexagonal Shape to Be Laid in the Following Room:

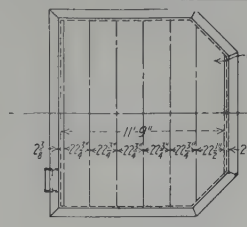
Captain's Bath Room.

Note

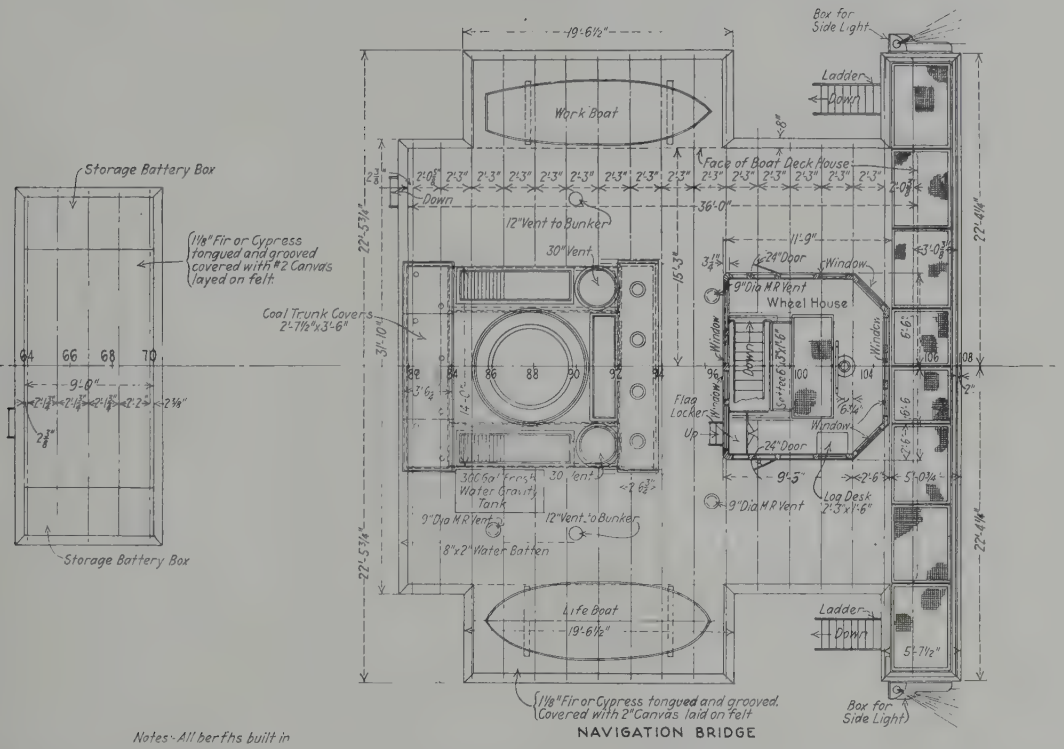
Where Cement or Tiling is fitted, Deck to be lined with Sheet Lead. Flashed up at sides, and tested before tiling or cement is laid.

Doors

All Doors to Rooms, except otherwise noted, to have 24-inch clear openings.

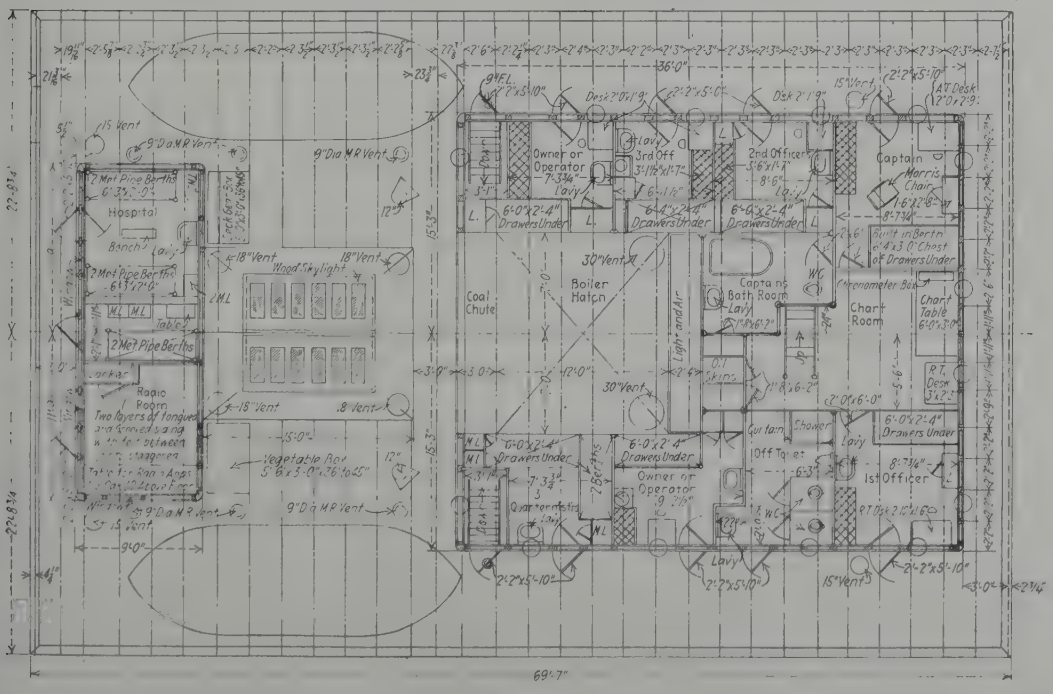


WHEEL HOUSE TOP



NAVIGATION BRIDGE

Notes:-All berths built in



BOAT DECK HOUSE

3,500-TON D. W. COMPOSITE FREIGHTER

See Opposite Page

3,500-TON D. W. COMPOSITE FREIGHTER

For Arrangement Plan
See Opposite Page

Chief Engineer's Room

Built-in berth, drawers under
Lockers built in, with shelf and 6 coat hooks each
Settee, with drawers under
Flat top desk
Revolving desk chair, oak
Keyboard
Book rack over berth
4 Coat and hat hooks
Life preserver in rack overhead

1st Assistant Engineer's Room

Built-in berths, drawers under
Locker built in, with shelf and 6 coat hooks
Settee, with drawers under
Flat top desk
Lavatory
Mirror
Toilet rack
Bent wood desk chair
3 Hat and coat hooks
Life preserver in rack overhead
Keyboard
Book rack over berth, oak

2nd Assistant Engineer's Room

Built-in berth, drawers under
Lockers built in, with shelf and 6 coat hooks
Settee with lockers under
Flat top desk
Bent wood desk chair
Lavatory
Mirror
Toilet rack
3 Hat and coat hooks
Life preserver in rack overhead

3rd Assistant Engineer's Room

Same as 2nd assistant engineer

Oiler's Room

3 metal pipe berths, drawers under
3 metal lockers, with shelf and 4 coat hooks each
Seat, with locker under
Lavatory
Mirror
Toilet rack
6 Hat and coat hooks
3 Life preservers in rack overhead

Chief Engineer's Toilet

Water closet
Lavatory, enameled iron
Shower bath with curtain and heater combination
Mirror
Towel rack
Soap dish
Tumbler holder
Coat hook
All fittings brass, nickel plated
Water heater
Paper holder
Tooth brush holder
Grab rod
Comb and brush holder

Owner or Operator's Toilet

2 Water closets
Shower bath with curtains
Lavatory, enameled iron
Towel rack
Soap dish
Tumbler holder
Mirror
4 Coat and hat hooks
All fittings brass, nickel plated
2 Paper Holders
1 Water heater
2 Grab rods

Engineer's Toilet

2 Water closets
Shower bath, with curtain
Lavatory, enameled iron
Towel rack
Soap dish
Tumbler holder
Mirror
4 Coat and hat hooks
All fittings brass, nickel plated
2 Paper holders
1 Water heater
2 Grab rods

Officers' Mess Room

Table 12′—0″ x 2′—9″ with rack
8 Revolving chairs
Settee
Sideboard, built in, 4′—6″ x 1′—9″
Sideboard, built in, 2′—3″ x 1′—9″
Mirror
Clock
Medicine chest
Inkstand
Water cooler shelf
14 Hat and coat hooks
Serving table
Dresser
Urn, 4 gallon, coffee
Urn, 4 gallon, hot water

3rd Officer, 3rd Engineer and Radio-Man's Mess

Table, 6′—0″ x 2′—6″
5 Revolving chairs
6 Hat and coat hooks

Firemen's Mess Room

Table, 5′—0″ x 2′—0″
2 Benches, 5′—0″ x 12″
Dish rack
6 Coat and hat hooks

Sailors' Mess Room

Table, 5′—0″ x 2′—0″
2 Benches, 5′—0″ x 12″
Dish rack
6 Coat and hat hooks

Messmen's Room

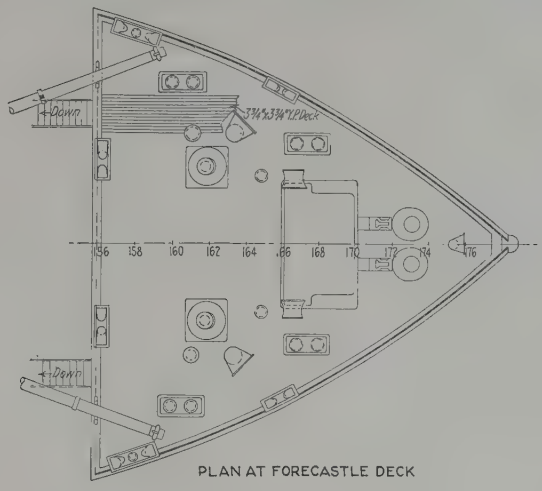
2 Built-in berths, drawers under
Locker, built in, with shelf and 4 coat hooks
Settee, locker under
Lavatory
Mirror
Toilet rack
6 Hat and coat hooks
2 Life preservers, in rack overhead

Cooks' Room

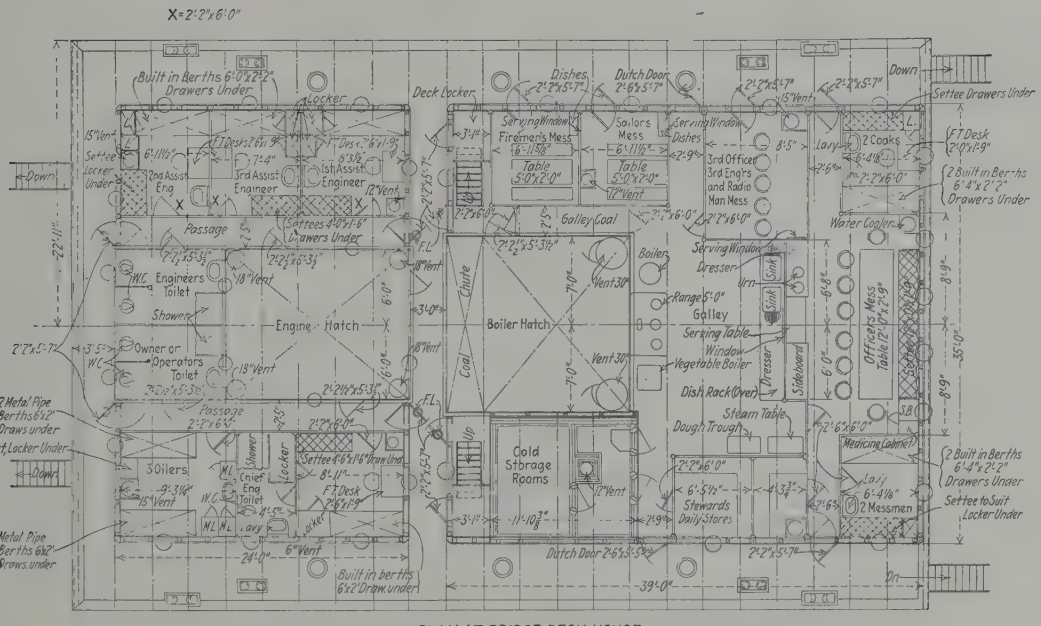
2 built-in berths, drawers under
Settee, drawers under
Locker, built in, with shelf and 6 coat hooks
Keyboard
Lavatory
Mirror
Toilet rack
6 Hat and coat hooks
Flat top desk
Bent wood desk chair.
2 Life preservers, in rack overhead

Galley

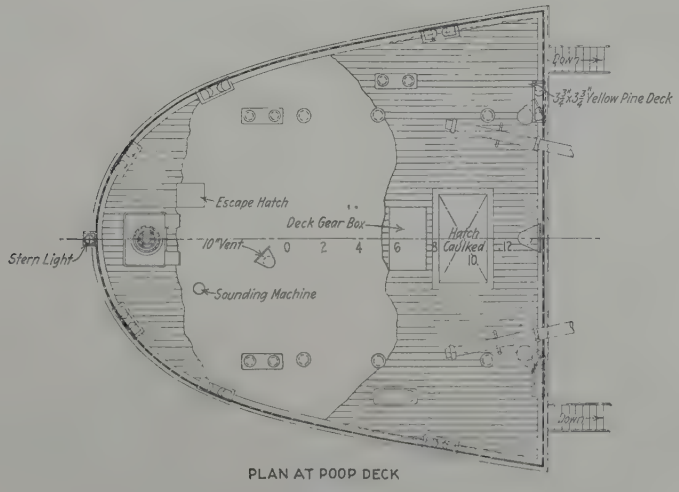
Range 5′—0″
Boiler
Vegetable boiler 24″ x 24″
Dough trough
Steam table 3′—0″
2 Sinks
Dresser
Dish rack



PLAN AT FORECASTLE DECK



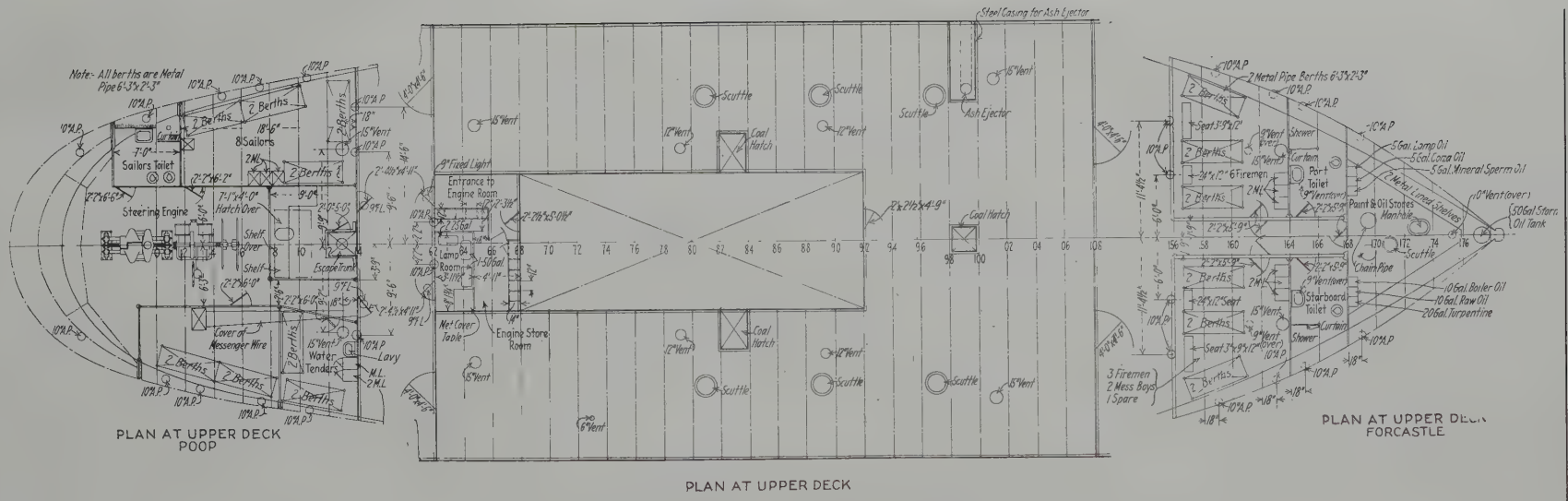
PLAN AT BRIDGE DECK HOUSE



PLAN AT POOP DECK

3,500-TON D. W. COMPOSITE FREIGHTER

See Opposite Page



3,500-TON D. W. COMPOSITE FREIGHTER

Sailors' Toilet

2 Water Closets
1 Wash Sink
1 Water Heater
1 Shower and Heater Combination
3 Soap Dishes
2 Paper Holders
1 Mirror
2 Grab Rods
4 Coat Hooks

Sailors' Room

8 Metal Pipe Berths
8 Metal Lockers with Shelf and 8 Coat Hooks
Seat
Mirror
Toilet Rack
8 Hat and Coat Hooks
8 Life Preservers in Rack Overhead

Steering Engine Space

Bins and Shelves

Lamp Room

2 50 Gallon Oil Cans, Galvanized
2 25 Gallon Oil Cans, Galvanized
1 Metal Covered Table

Entrance to Engine Room

Work Bench

Water Tenders' Room

3 Metal Pipe Berths
3 Metal Lockers with Shelf and 3 Coat Hooks
Mirror
Toilet Rack
Lavatory
3 Hat and Coat Hooks
3 Life Preservers in Rack Overhead

Port Toilet

Water Closet
Lavatory
Shower Bath with Curtain

Firemen's Room

6 Metal Pipe Berths
6 Metal Lockers
2 Seats
1 Mirror
1 Toilet Rack
6 Hat and Coat Hooks
6 Life Preservers in Rack Overhead

Firemen's, Mess Boys and Spare Room

6 Metal Pipe Berths
6 Metal Lockers
2 Seats
1 Mirror
1 Toilet Rack
6 Hat and Coat Hooks
6 Life Preservers in Rack Overhead

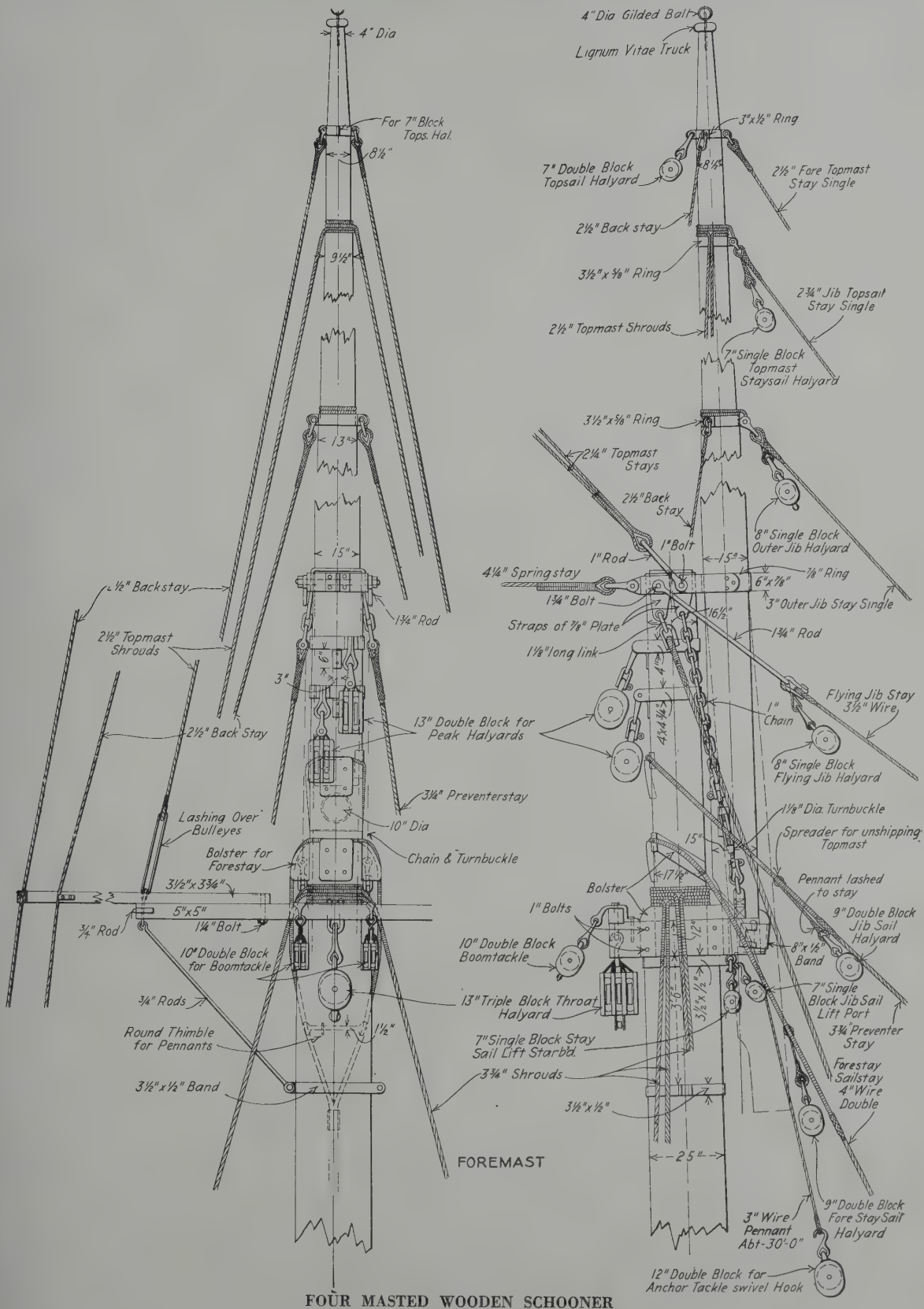
Steward's Stores

Starboard Toilet

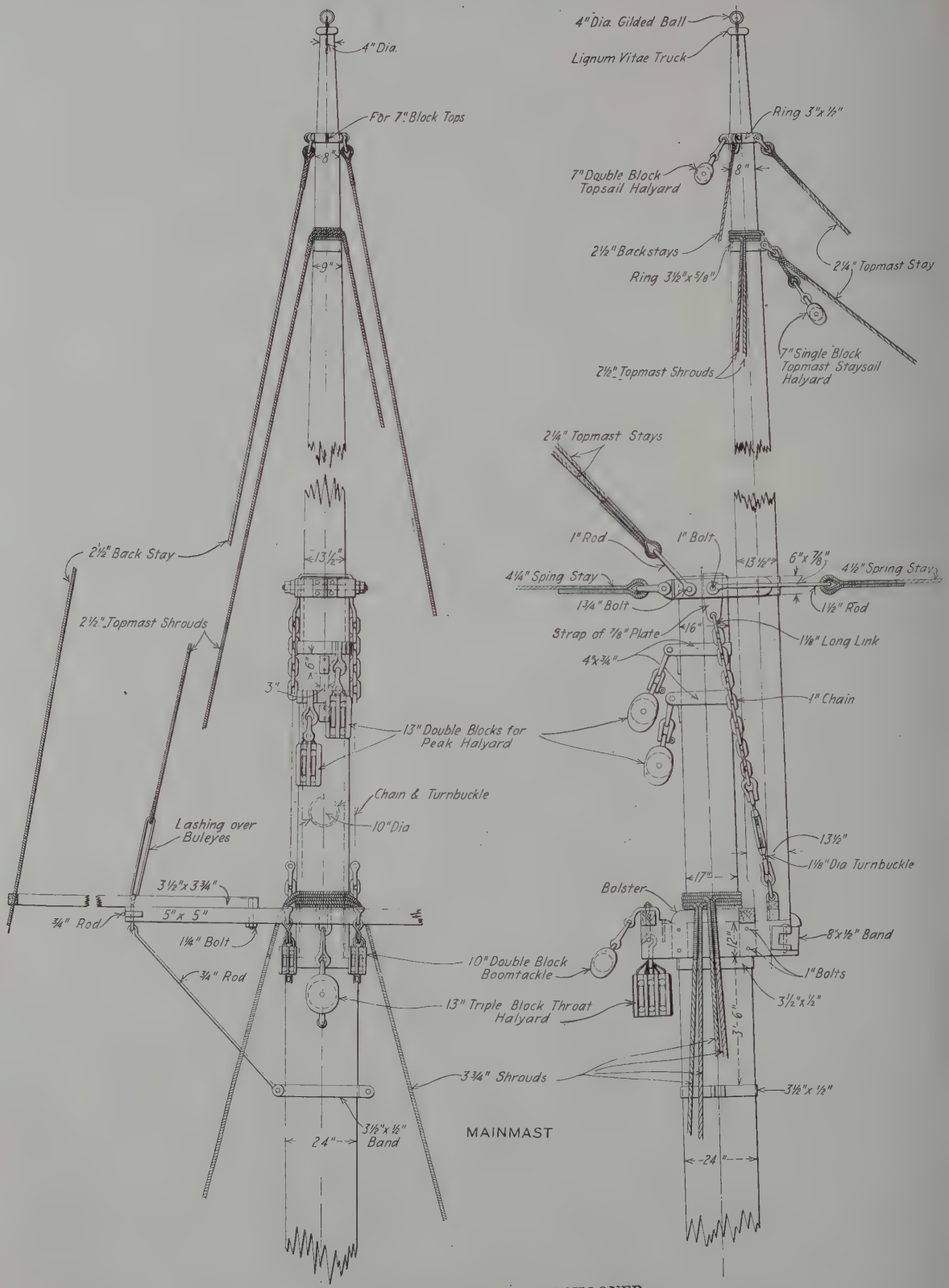
Water Closet
Lavatory
Shower Bath with Curtain

Paint and Oil Stores

1 Galvanized Iron Tank, 10 Gallons, for Boiled Oil
1 Galvanized Iron Tank, 10 Gallons, for Raw Oil
1 Galvanized Iron Tank, 20 Gallons for Turpentine
1 Galvanized Iron Tank, 5 Gallons, for Lamp Oil
1 Galvanized Iron Tank, 5 Gallons, for Colza Oil
1 Galvanized Iron Tank, 5 Gallons, for Mineral Sperm Oil
1 Galvanized Iron Tank, 50 Gallons, for Storm Oil
2 Metal Lined Shelves



FOUR MASTED WOODEN SCHOONER
Designed by Cox & Stevens, New York City



FOUR MASTED WOODEN SCHOONER
Designed by Cox & Stevens, New York City

FOUR MASTED WOODEN SCHOONER
Designed by Cox & Stevens, New York City

9,000-TON D. W. FREIGHTER

For Arrangement Plans See Plate XLIII

Opposite Page 600 and Pages 601-602-603-604-605

LIST OF MATERIAL FOR ONE SHIP

Pc. No.	No. Pcs.	Name	Mat'l	Remarks
A2	1	2½ " x3½" Bilge manifold..	C.I.	
A3	1	3½" Bilge manifold	C.I.	
A4	2	3½" Bilge manifold.....	C.I.	
A6	1	3½" Angle stop valve.....	C.I.	
A7	6	3½" Angle stop ch'k valve..	C.I.	Four without hand-wheels.
A8	1	3½" Globe stop ch'k valve..	C.I.	
A9	1	1½" Globe stop valve.....	Brass.	
A10	2	1½" Globe check valve.....	Brass.	
A11	7	5" Std. 90 degree Ell.....	C.I. galv.	
A12	1	5" Macomb strainer.....	C.I. galv.	
A13	1	3½" Macomb strainer.....	C.I. galv.	
A14	34	3½" Std. 90 degree Ell.....	C.I. galv.	
A15	15	Bilge strainer	Steel.	A—4⅛".
A16	10	1½" Deck plates.....	Yellow brass.	
A17	2	3½" Long radius Ell.....	C.I. galv.	
A18	1	3½"-45 degree Ell-Std.....	C.I. galv.	
A19	2	Bilge strainer	Steel.	A—3".
A20	2	1½" Return bend-¾" pipe tap	C.I. galv.	Close pattern.
A21	150	3½" x 8½" flange.....	C.I. galv.	
A22	24	2½" x 7" flange.....	C.I. galv.	
A23	2	1½" Double boss flange.....	C.I. galv.	
A24	2	4½" x 9¼" flange.....	C.I. galv.	
A25	38	5" x 10" flange.....	C.I. galv.	
A26	12	5" x 5" x ⅜" Striking plate.	Steel.	
A27	9	1½" x 5" flange.....	C.I. galv.	
A29	8	1½" Locknut (Standard)....	C.I. galv.	
A30	16	1½" Wrought coupling.....	W.I.galv.	
A31	2	2" Bilge strainer well.....	C.I. galv.	
A32	1	3½" Bilge strainer well.....	C.I. galv.	
A33	4	1" Deck stuffing box.....	Yellow brass.	
A34	12	1½" Universal joint.....	Steel.	
A35	4	8" Standard handwheels....	C.I.	
A37	4	Bracket	C.I.	
A38	1	3½"-90 degree Ell (scr'd)..	C.I. galv.	
A39	3	5" x 5" x 5" Tee.....	C.I. galv.	
A40	1	5" x 5" x 3½" Tee.....	C.I. galv.	
A41	1	5" x 5" x 2½" Tee.....	C.I. galv.	
A42	1	3½" x 3½" x 3½" Tee.....	C.I. galv.	
A43	380 ft.	1½" I. D. pipe.....	W.I.galv.	
A44	1	3½" x 3½" x 3½" Tee with 3½" side outlet	C.I. galv.	
A45	700 ft.	3½" I. D. pipe.....	W.I.galv.	
A46	7 ft.	0" 4½" I. D. pipe.....	W.I.galv.	
A47	195 ft.	5" I. D. pipe.....	W.I.galv.	
A48	390 ft.	2½" I. D. pipe.....	W.I.galv.	
A49	16	2½" Deck drain.....	C.I.	
A50	1	1½" Ejector (scr'd).....	C.I. galv.	Brass jets.
A51	1	1½" x 1½" x 1½" Tee (scr'd)	C.I. galv.	
A52	4	1½"-Std. 90 degree Ell.....	C.I. galv.	
A54	1	2½" x 2½" x 2½" Tee (scr'd).	C.I. galv.	
A55	6	2½" Std. 90 degree Ell (scr'd)	C.I. galv.	
A56	2	2½" x 2½" x 2½" x 2½" Cross (scr'd)	C.I. galv.	
A57	2	2½" Deck stuffing box.....	Yellow brass.	A—5".
A58	3	2½" Pipe plug.....	W.I.	For Item A56.
B2	2	3½" Ballast manifold.....	C.I.	
B3	1	3½" Ballast manifold.....	C.I.	
B4	1	3½" Ballast manifold.....	C.I.	
B5	1	3½" Globe stop valve.....	C.I.	
B6	1	3½" Angle stop ch'k valve..	C.I.	
B7	3	5" x 5" x 5" Tee.....	C.I. galv.	
B8	1	4½" x 3½" x 4½" Tee.....	C.I. galv.	
B9	4	5"-90 degree Ell.....	C.I. galv.	
B10	56	3½"-90 degree Ell.....	C.I. galv.	
B11	1	5" x 4½" x 4½" Tee.....	C.I. galv	
B12	32	3"-90 degree Ell-R. H. Th'ds.	C.I. galv.	
B13	4	3"-45 degree Ell-R. H. Th'ds.	C.I. galv.	
B14	1	3½"-90 degree Ell-R. H. Th'ds.	C.I. galv.	
B15	2	3½"-45 degree Ell-R. H. Th'ds.	C.I. galv.	
B16	2	3½" Return bends.....	C.I. galv.	Close pattern.
B17	20	3" Return bends.....	C.I. galv.	Close pattern.
B18	20	3½" Std. ballast suct. roses.	C.I. galv.	
B19	6	1½" Std. deck plate.....	Yellow brass.	
B20	10	1½" Std. double boss flange.	C.I. galv.	
B21	1	4½"-90 degree Ell.....	C.I. galv.	
B23	2	3½"-45 degree Ell.....	C.I. galv.	
B24	24	5" x 10" Flange.....	C.I. galv.	
B25	12	4½" x 9¼" flange.....	C.I. galv.	
B26	235	3½" x 8½" flange.....	C.I. galv.	
B27	60	3" x 7½" flange.....	C.I. galv.	
B28	30	1½" x 5" flange.....	C.I. galv.	
B29	6	1½" Pipe caps.....	W.I.galv.	
B30	9 ft.	0" Sash chain.....	Bronze.	
B31	12	¼" Button head cap screw..	Brass.	¼" Long.
B32	12	5" x 5" x ⅜" Striking plate.	Steel.	Imbedded in cement.
B33	2	4½"-90 degree Ell.....	C.I. galv.	One fig. special drilling.
B34	96	3" x 7½" flange.....	C.I. galv.	
B35	105 ft.	5" I. D. pipe.....	W.I.galv.	
B36	65 ft.	4½" I. D. pipe.....	W.I.galv.	

LIST OF MATERIAL FOR ONE SHIP—Continued

Pc. No.	No. Pcs.	Name	Mat'l	Remarks
B37	1025 ft.	3½" I. D. pipe.....	W.I.galv.	
B38	825 ft.	3" I. D. pipe.....	W.I.galv.	
B39	250 ft.	1½" I. D. pipe.....	W.I.galv.	
B40	6	3½" x 8½" flange.....	C.I. galv.	Machine as per sketch.
B41	6	3½" x 8½" flange.....	C.I. galv.	
B42	3	1" Deck stuffing box.....	Yellow brass.	
B43	1	1½" Universal steel joint....	Steel.	
B44	1	8" Std. handwheel.....	C.I.	
B45	1	1½" Universal joint.....	Steel.	
B46	..	Fireproof wire gauze.....	Brass.	Solder to open end of Pc. No. 27.
B47	1	Distance piece	C.I. galv.	
B48	1	7" x 5" x 5" x 5" Cross with 7" side outlet.....	C.I. galv.	
B49	1	7"-90 degree Ell.....	C.I. galv.	
B50	4	7" x 12½" flange.....	C.I. galv.	
B51	10 ft.	7" I. D. pipe.....	W.I.galv.	
D19	1	2½" Angle stop valve.....	C.I.	
D20	1	2½" Cross stop valve.....	C.I.	
D21	2	2½" Long rad. 90 degree Ell.	C.I. galv.	
D22	2	2½" Suction rose	C.I. galv.	
D23	16	2½" x 7" flange.....	C.I. galv.	
D24	4	2" x 6" flange.....	C.I. galv.	Machine as per sketch.
D25	2	2" x 6" flange.....	C.I. galv.	
D26	6	2"-90 degree Ell-R. H.....	C.I. galv.	
D27	2	2" Return bend-R. H.....	C.I. galv.	Close pattern.
D28	80 ft.	2" Std. pipe.....	W.I. galv.	20 ft. lengths.
D29	140 ft.	2½" Std. pipe.....	W.I. galv.	20 ft. lengths.
D30	2	2" Return bend-¾" pipe tap.	C.I. galv.	
D31	2	2" Std. double boss flange...	C.I. galv.	
D32	1	2½" Std. 90 degree Ell.....	C.I. galv.	
D33	2	5" x 5" x ⅜" Striking plate.	Steel.	Imbedded in cement.
D34	2	¾" Std. pipe plugs.....	C.I. galv.	For Item D30.
F3	1	5" x 5" x 5" Tee.....	C.I.	
F4	3	5"-90 degree Ell.....	C.I.	
F5	12	5" x 10" flange.....	C.I.	
F6	2	5" x 10" Blind flange.....	C.I.	
F7	1	5" Globe stop valve.....	C.I.	
F8	1	5" Angle stop valve.....		
F9	1	5" x 11" Reducing flange.....	C.I.	Drill 8 $1\frac{3}{16}$" holes on 9½" P. C.
F10	56 ft.	5" Std. pipe.....	W.I.	
F11	2 ft.	⅜" Chain.....	Steel.	For locking valve on pump Pc. No. F7.
F12	1	Padlock	Brass.	
F14	4	4"-90 degree Ell, scr'd.....	C.I. galv.	
F15	14	4" x 9" flange.....	C.I. galv.	
F16	2	4" Return bends R. H.....	C.I. galv.	
F17	50 ft.	4" I. D. pipe.....	W I.galv.	
F18	8	4" x 9" flange.....	C.I. galv.	Machine as per sketch.
F68	..	Fireproof wire gauze.....	Brass.	Solder to open end of Pc. No. F16.

NOTES.

All pipes to be of W. I. Galvanized.

All valves 2½" and above to be of cast iron bodies, brass mounted.

Manifolds to be of cast iron bodies, brass mounted.

All flanges in pipe lines to be of cast iron galvanized, screwed.

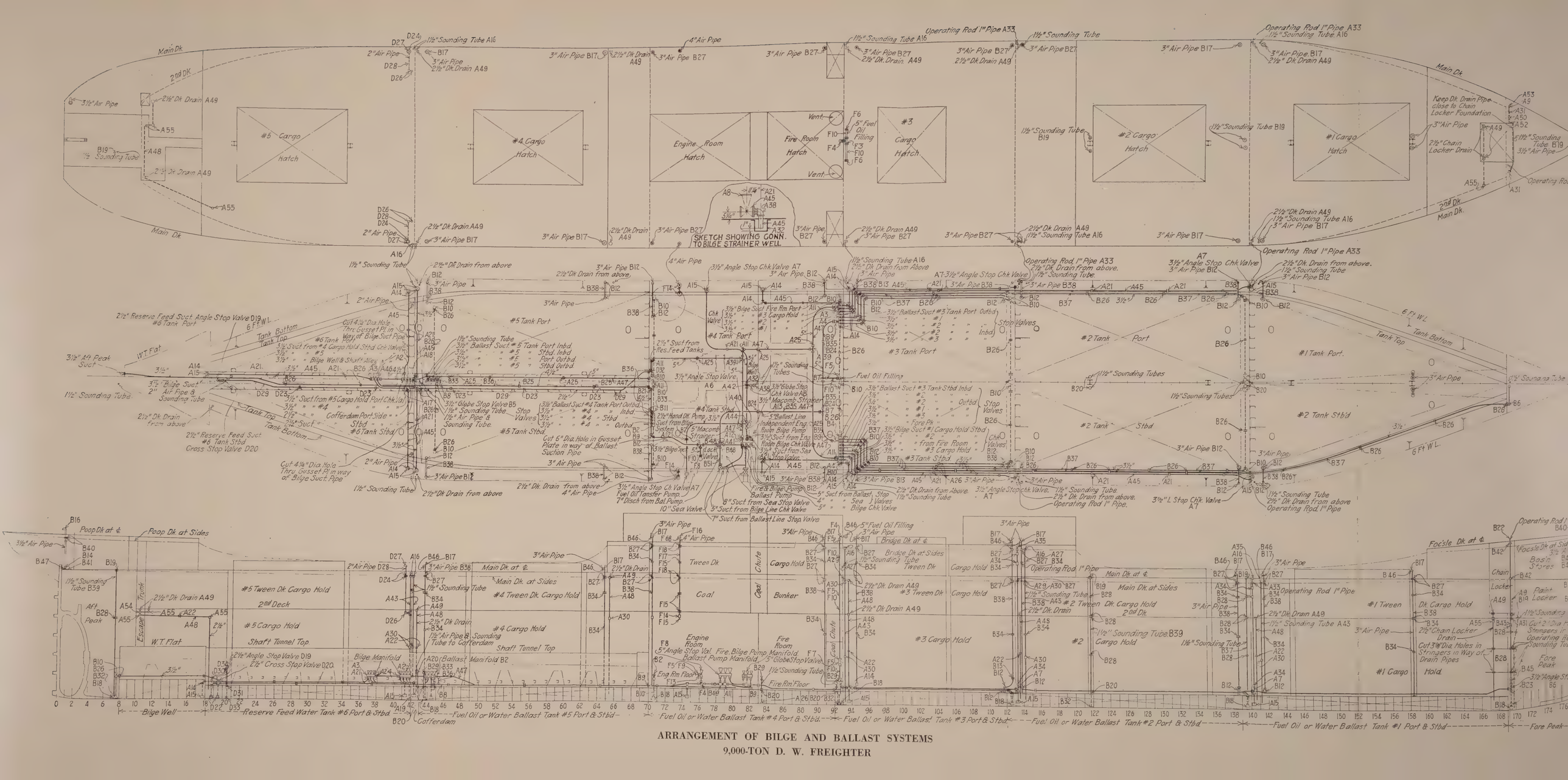
Where pipes pass thru cargo spaces they are to be boxed in with yellow pine planking.

All joints in oil line to be made up with approved water and oil packing.

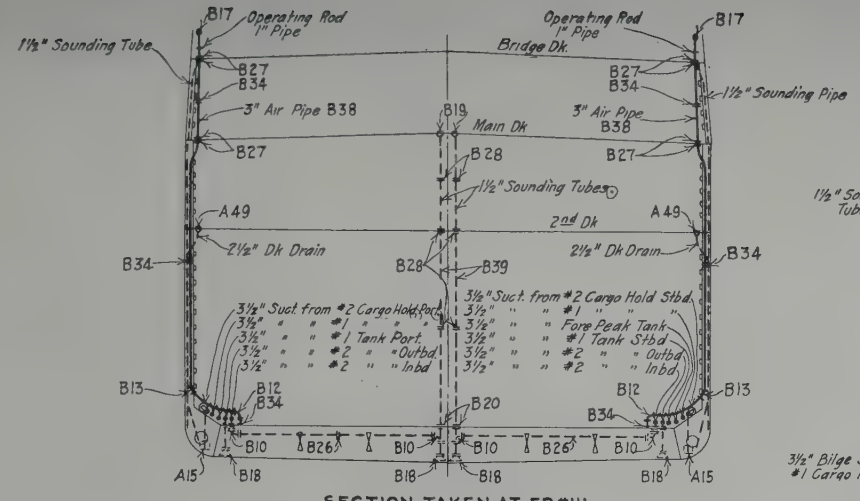
All flanged joints in bilge system to be made up with cloth inserted rubber 1/16" thick, except connections at bulkheads, these will be made up of canvas soaked in red lead and linseed oil.

All cast iron fittings to be galvanized.

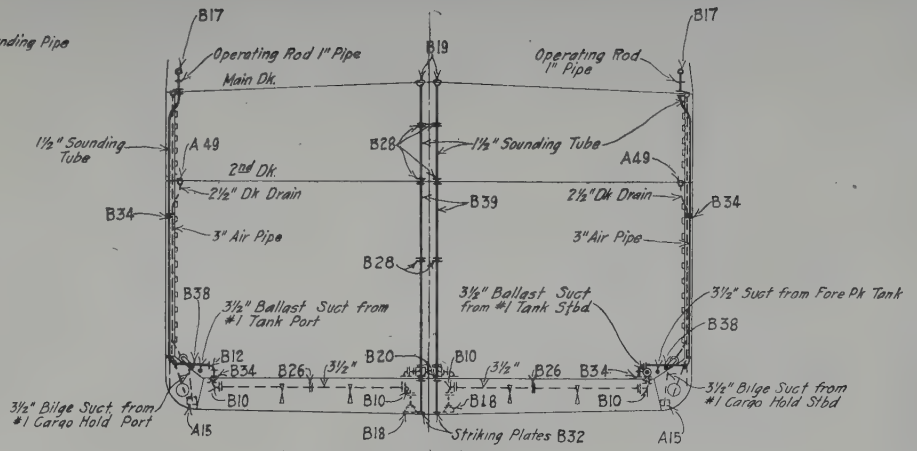
5" x 5" x ⅜" striking plates to be fitted under all sounding tubes, bed in cement.



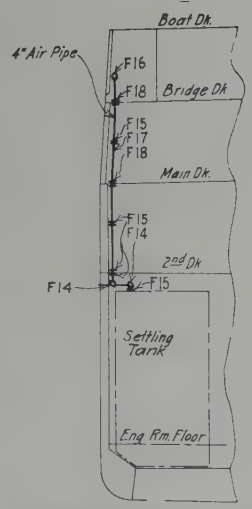
ARRANGEMENT OF BILGE AND BALLAST SYSTEMS
9,000-TON D. W. FREIGHTER



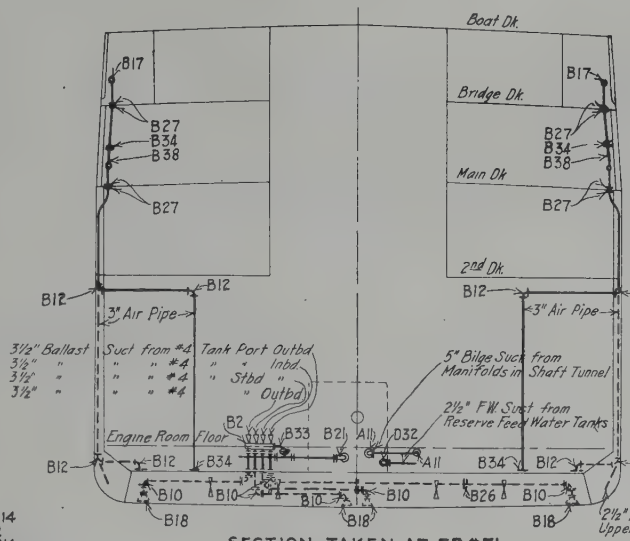
SECTION TAKEN AT FR.#111
LOOKING FORWARD.



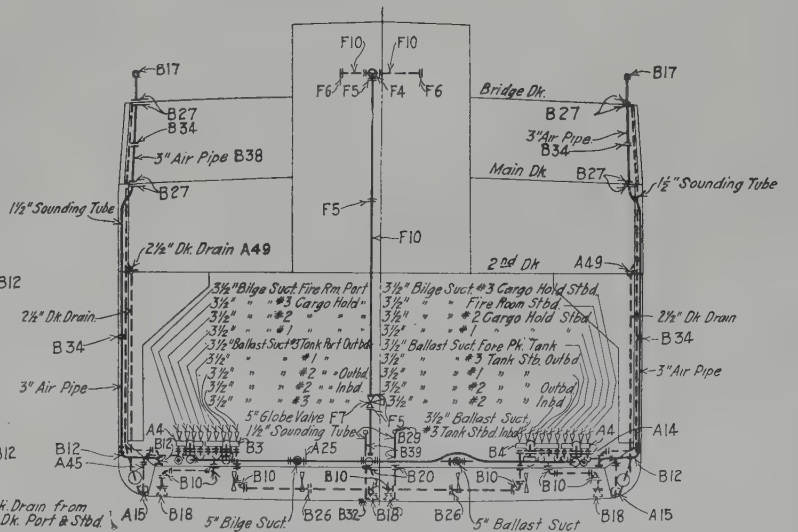
SECTION TAKEN AT FR.#138
LOOKING FORWARD.



SECTION TAKEN AT FR.14
LOOKING AFT, SHOWING AIR
PIPES FROM SETTLING TANK
ST'B'D. SIDE-TO OTHER HAND-PORT



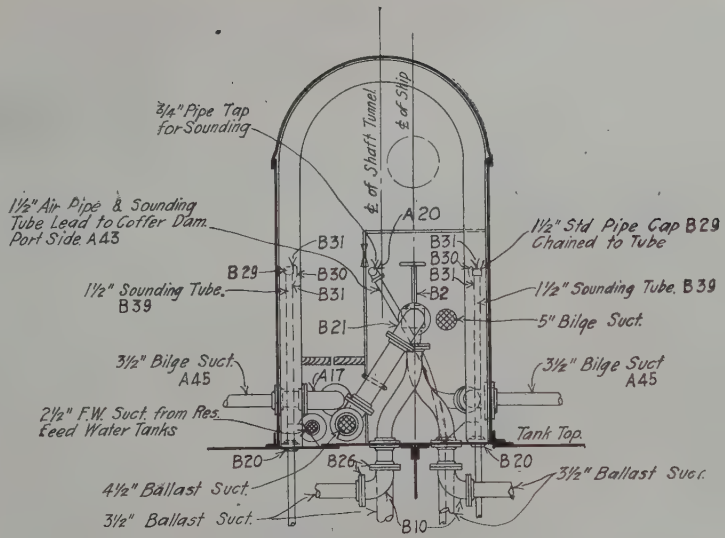
SECTION TAKEN AT FR.#71
LOOKING AFT.



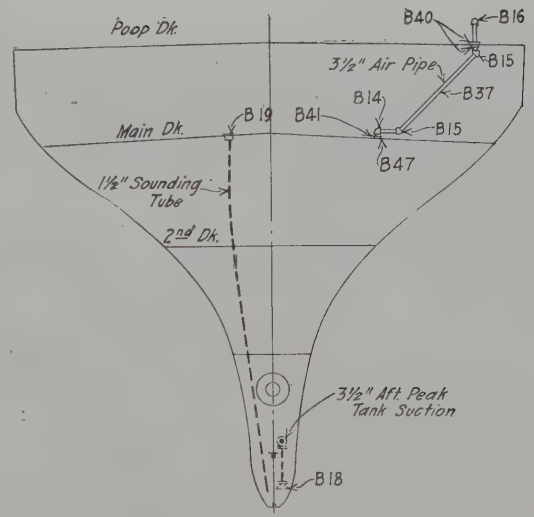
SECTION TAKEN AT FR.#91
LOOKING FORWARD.

9,000-TON D. W. FREIGHTER

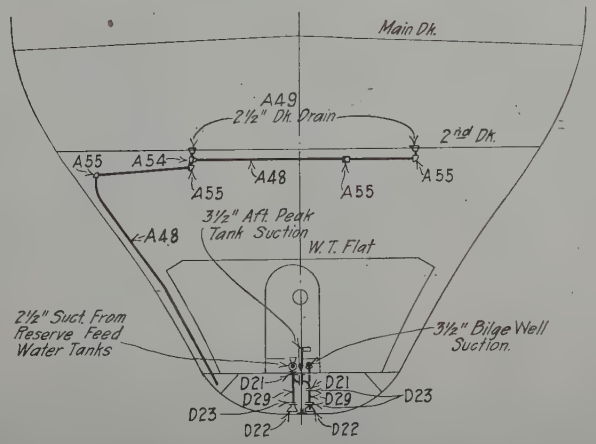
See Page 600



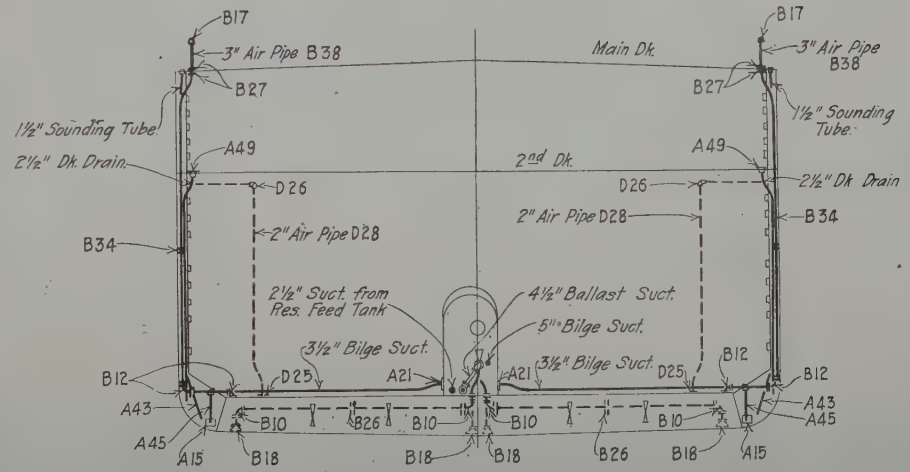
SECTION THRU SHAFT TUNNEL TAKEN AT FR.# 46 LOOKING AFT.



SECTION TAKEN AT FR.#9 LOOKING AFT.



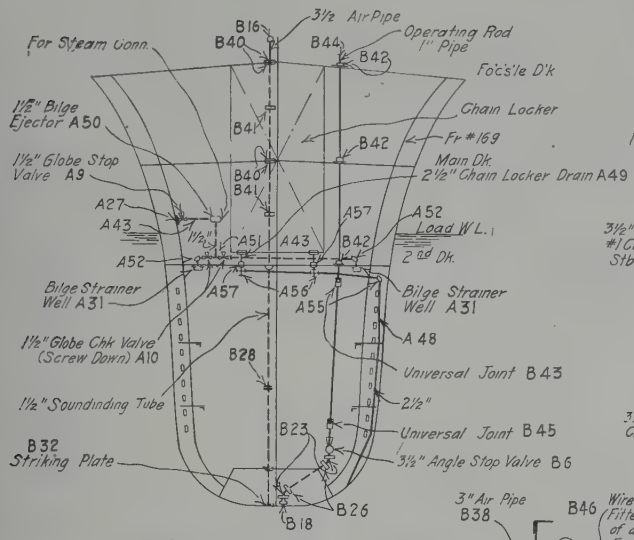
SUCTION TAKEN AT FR.# 20 LOOKING AFT.



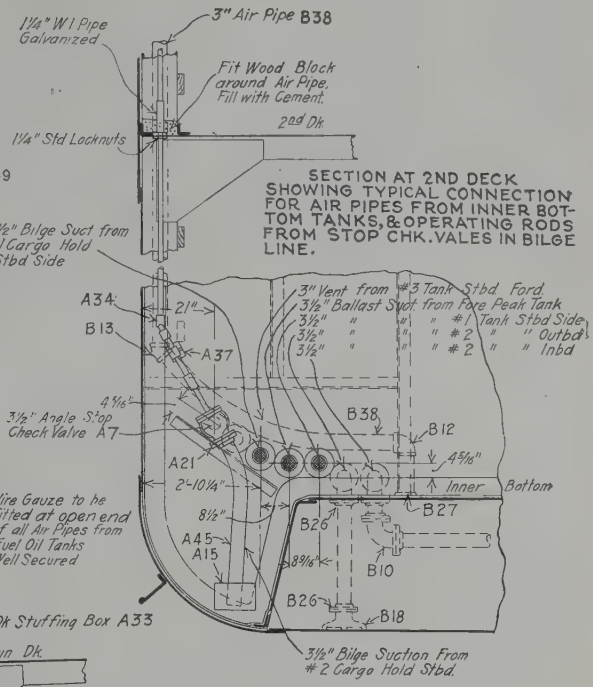
SECTION TAKEN AT FR.#48 LOOKING AFT.

9000-TON D. W. FREIGHTER

See Page 600

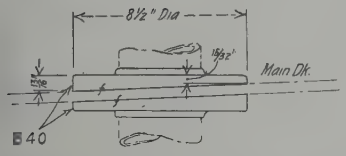


SECTION TAKEN AT FR.#167 LOOKING FORWARD

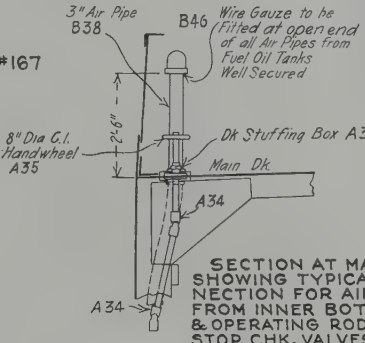


SECTION AT 2ND DECK SHOWING TYPICAL CONNECTION FOR AIR PIPES FROM INNER BOTTOM TANKS, & OPERATING RODS FROM STOP CHK. VALES IN BILGE LINE.

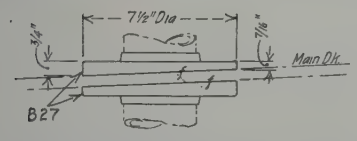
SECTION TAKEN AT FR. #14 STBD. SIDE ONLY, LOOKING AFT.



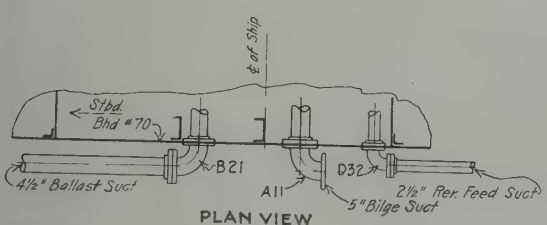
DETAIL OF FLANGE FOR 3½" AIR PIPE CONNECTIONS AT MAIN DECK, FORE & AFT PEAK TANKS ONLY.


3" Air Pipe B38
B46
Wire Gauze to be Fitted at open end of all Air Pipes from Fuel Oil Tanks Well Secured
2'-6"
8" Dia C.I. Handwheel A35
Dk Stuffing Box A33
Main Dk.
A34
A34

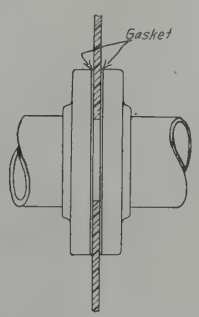
SECTION AT MAIN DK. SHOWING TYPICAL CONNECTION FOR AIR PIPES FROM INNER BOTTOM TANKS, & OPERATING RODS FROM STOP CHK. VALVES IN BILGE LINE.



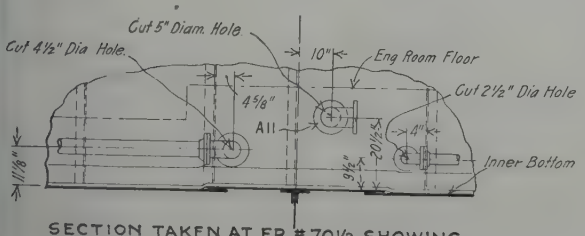
DETAIL OF FLANGE FOR 3" AIR PIPE CONNECTIONS AT MAIN DECK, TANK #1, 2, 3, 4, & 5 PORT & STB'D.



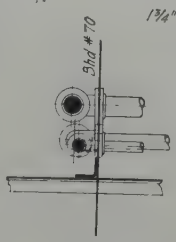
PLAN VIEW

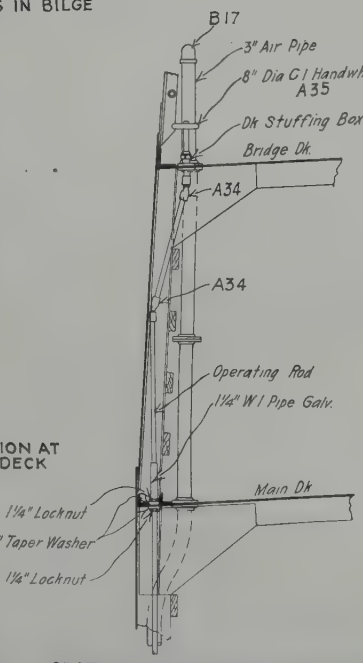


TYPE OF PIPE CONNECTION AT ALL BULKHEADS AND DECK



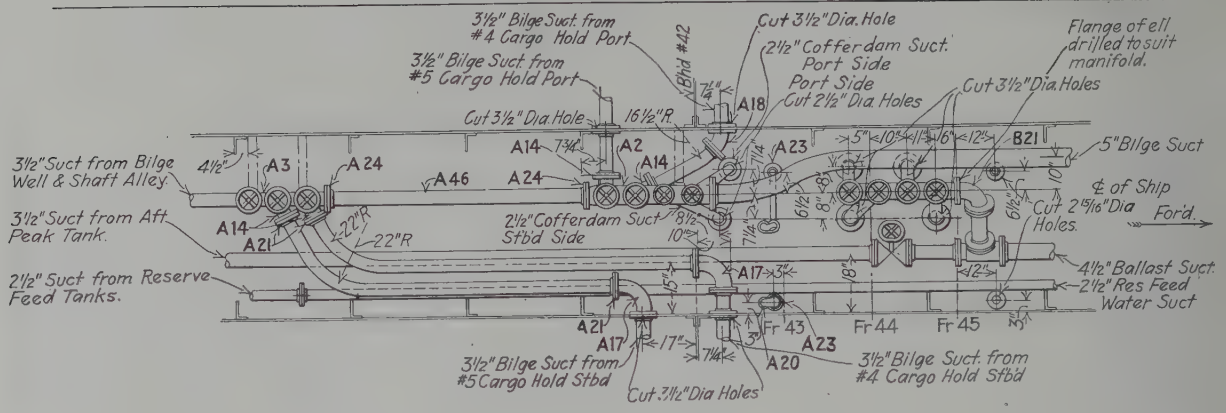
SECTION TAKEN AT FR #70½ SHOWING CONNECTIONS THRU BHD. #70 LOOKING AFT.

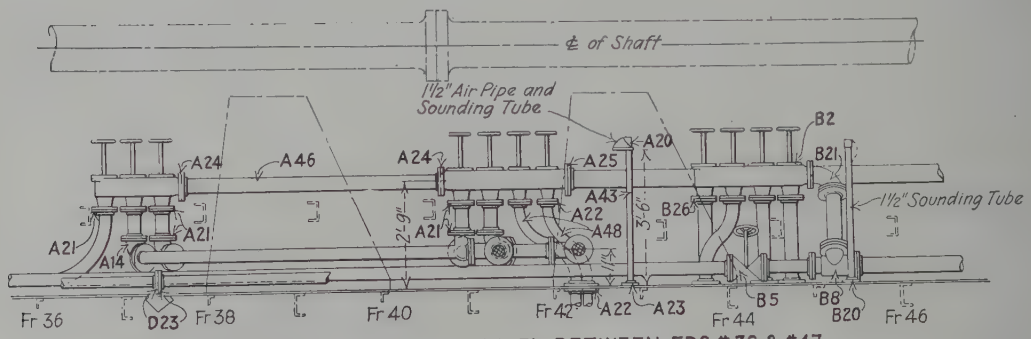




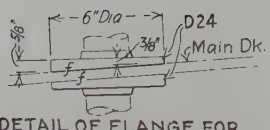
SECTION AT MAIN & BRIDGE DKS. SHOWING TYPICIAL CONNECTION FOR AIR PIPES FROM INNER BOTTOM & OPERATING RODS FROM STOP CH'K. VALVES IN BILGE LINE.

See Page 600

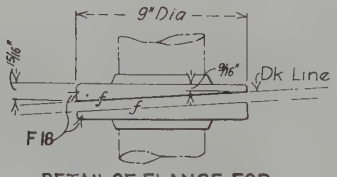

3½" Bilge Suct. from #4 Cargo Hold Port
3½" Bilge Suct from #5 Cargo Hold Port
Cut 3½" Dia. Hole
2½" Cofferdam Suct. Port Side
Cut 2½" Dia Holes
Flange of ell drilled to suit manifold.
Cut 3½" Dia. Holes
5" Bilge Suct
℄ of Ship
Ford.
Cut 2 15/16" Dia Holes
3½" Suct from Bilge Well & Shaft Alley.
3½" Suct from Aft Peak Tank.
2½" Suct from Reserve Feed Tanks.
2½" Cofferdam Suct Stb'd Side
4½" Ballast Suct.
2½" Res Feed Water Suct
3½" Bilge Suct from #5 Cargo Hold Stbd
Cut 3½" Dia Holes
3½" Bilge Suct. from #4 Cargo Hold St'bd
Fr 43
Fr 44
Fr 45



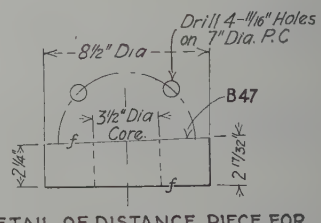
PLAN & SECTION THRU SHAFT TUNNEL BETWEEN FRS. # 36 & # 47



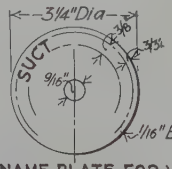
DETAIL OF FLANGE FOR 2" AIR PIPE CONNECTIONS AT MAIN DECK FOR RESERVE FEED TANK PORT & ST'B'D.



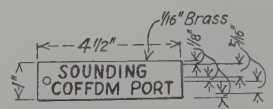
DETAIL OF FLANGE FOR 4" AIR PIPE CONNECTIONS AT MAIN & BRIDGE DECKS FOR FUEL OIL SETTLING TANK.



DETAIL OF DISTANCE PIECE FOR AIR PIPE, AFT PEAK TANK



DETAIL OF NAME PLATE FOR VALVES FITTED UNDER HANDWHEEL NUTS

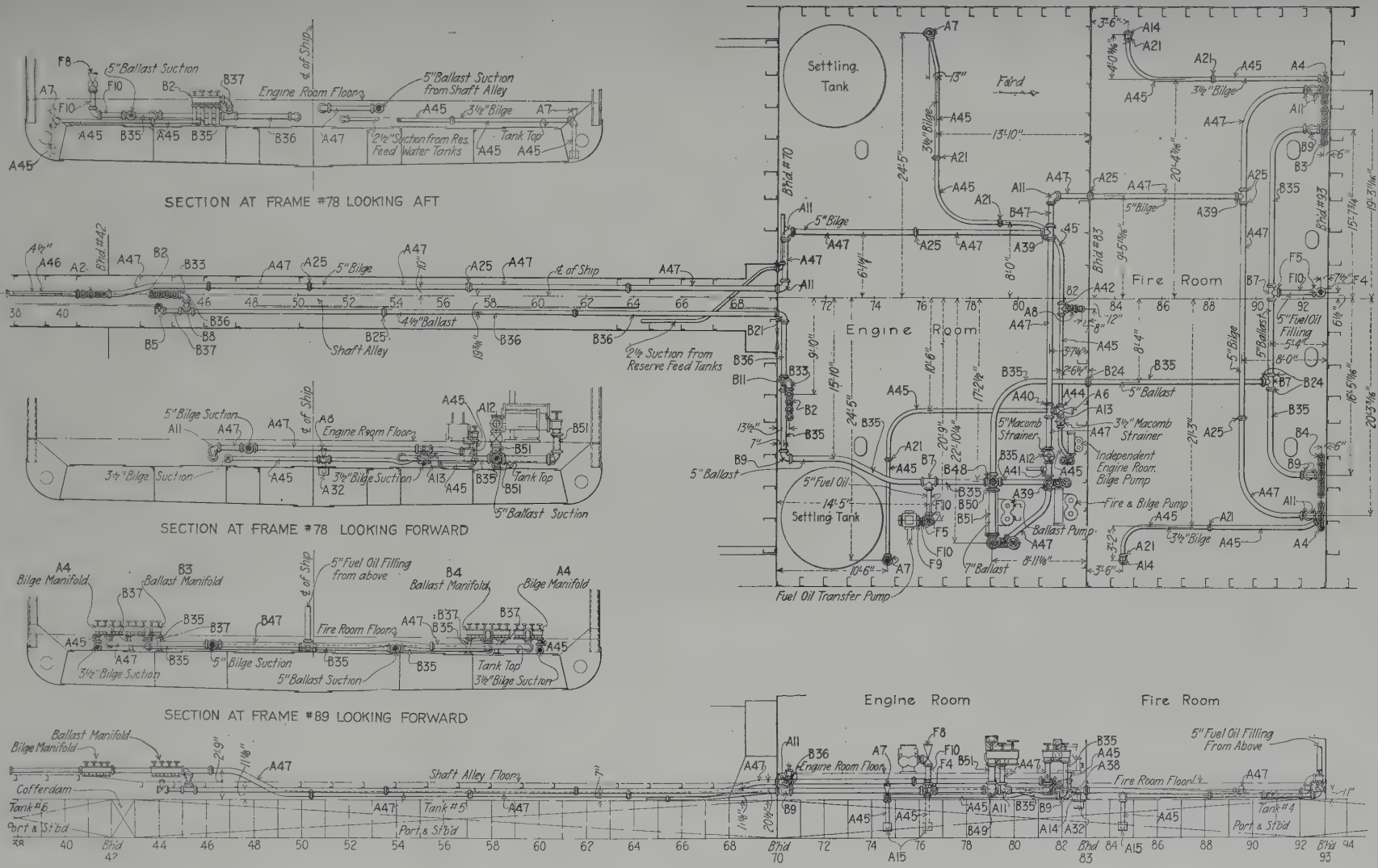


DETAIL OF NAME PLATE FOR SOUNDING TUBE

TABLE OF NAME PLATES			
No. Pcs.	Pc. No.	Marking	Mat'l.
1	A6-1	Suct. Eng. Rm. Bilge P. & S.	1/16" Brass
1	A7-1	Suct. Eng. Rm. Bilge Port	1/16" Brass
1	A7-2	Suct. Eng. Rm. Bilge St'bd.	1/16" Brass
1	A8-1	Suct. Eng. Rm. Tank Top	1/16" Brass
1	A9-1	Paint L. Disch. Ov'b'd.	1/16" Brass
1	B5-1	Suct. Aft Peak Tank	1/16" Brass
1	F7-1	Filling Fuel Oil	1/16" Brass
1	F8-1	Suct. Fuel Oil	1/16" Brass

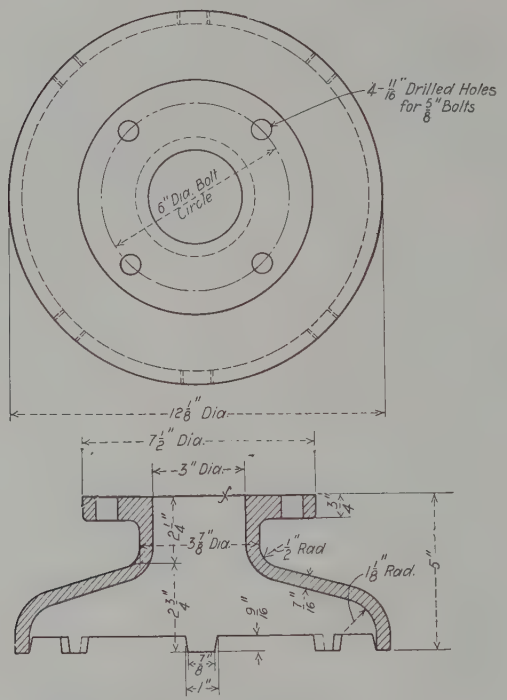
TABLE OF NAME PLATES			
No. Pcs.	Pc. No.	Marking	Mat'L
1	A-20-1	Sounding Coffdm. Port	1/16" Brass
1	A20-2	Sounding Coffdm. St'bd	1/16" Brass
1	D30-1	Sounding #6 Tank. Port	1/16" Brass
1	D30-2	Sounding #6 Tank St'bd.	1/16" Brass
1	B30-1	Sounding #3 Tank. Port	1/16" Brass
1	B30-2	Sounding #3 Tank. St'bd.	1/16" Brass
1	B30-3	Sounding #4 Tank. Port	1/16" Brass
1	B30-4	Sounding #4 Tank. St'bd.	1/16" Brass
1	B30-5	Sounding #5 Tank. Port	1/16" Brass
1	B30-6	Sounding #5 Tank. St'bd.	1/16" Brass

See Page 600

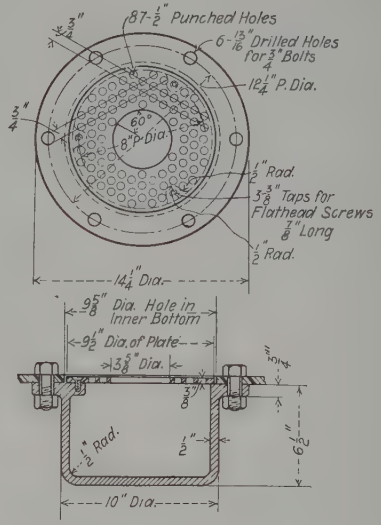


9,000-TON D. W. FREIGHTER

See Page 600

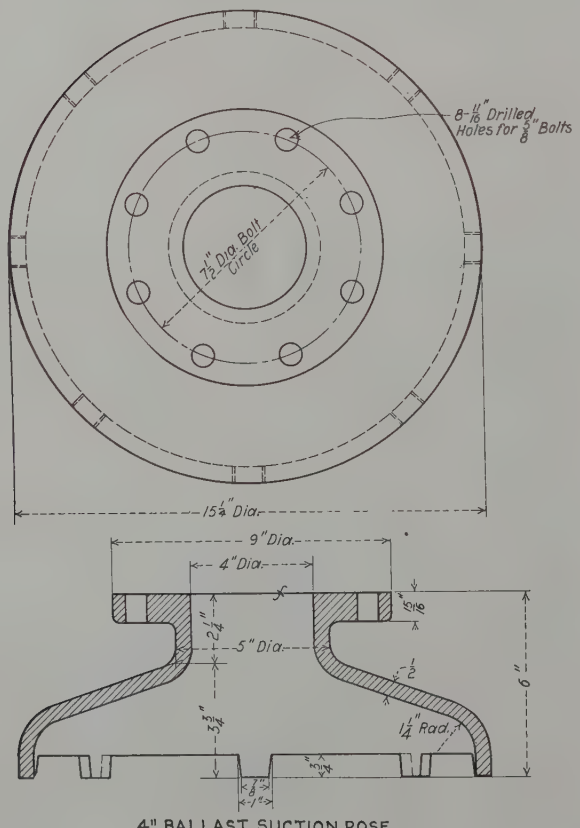


3" BALLAST SUCTION ROSE

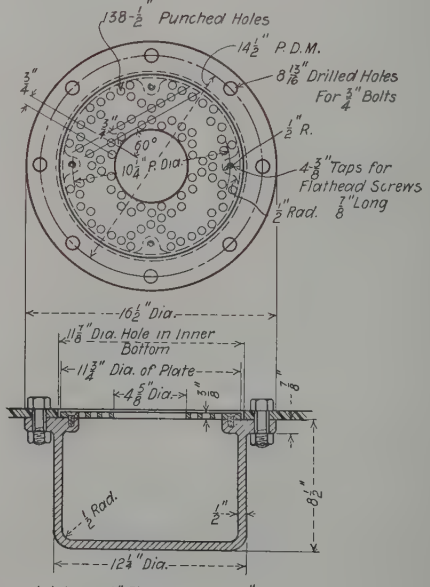


Int. Area 3" Pipe 7.393 □"
Area 87-1/2" Holes - 17.052 □"
Ratio = 2.30

3" BILGE STRAINER WELL



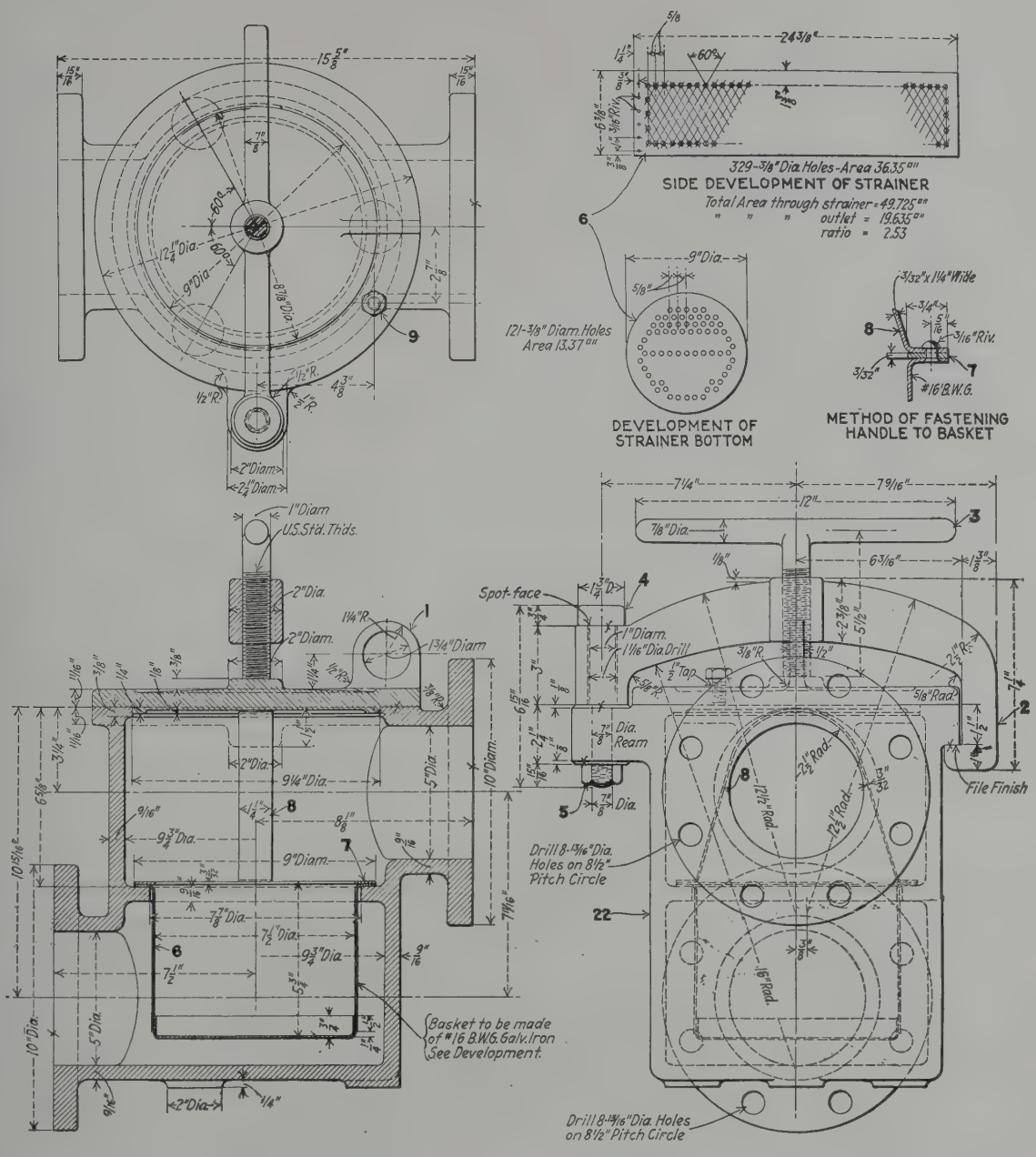
4" BALLAST SUCTION ROSE



Int. Area 4" Pipe = 12.730 □"
Area 138- 1/2" Holes = 27.048 □"
Ratio = 2.12

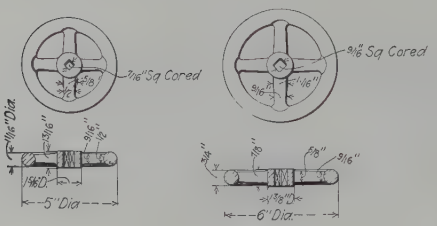
4" BILGE STRAINER WELL

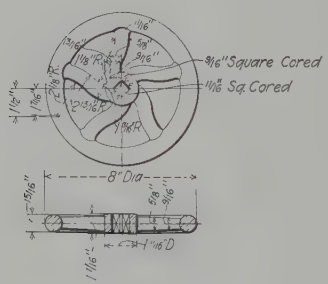
5-INCH MACOMB STRAINER

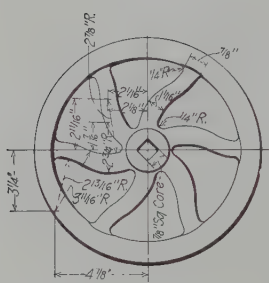

SIDE DEVELOPMENT OF STRAINER
329-3/8" Dia. Holes-Area 36.35 sq in
Total Area through strainer = 49.725 sq in
" " " outlet = 19.635 sq in
ratio = 2.53
DEVELOPMENT OF STRAINER BOTTOM
121-3/8" Diam. Holes Area 13.37 sq in
METHOD OF FASTENING HANDLE TO BASKET
Basket to be made of #16 B.W.G. Galv. Iron See Development
Drill 8-13/16" Dia. Holes on 8 1/2" Pitch Circle
Drill 8-13/16" Dia. Holes on 8 1/2" Pitch Circle
File Finish

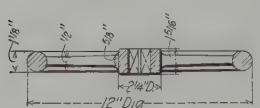
MATERIAL FOR ONE STRAINER

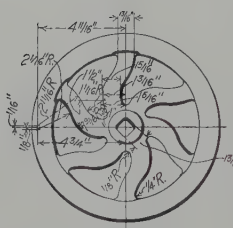
Pc. No.	No. Pcs.	Name	Material	Remarks
1	1	Cover	C. I. Galv.	
2	1	Clamp	W. I. Galv.	
3	1	Holding Down Screw	W. I. Galv.	Smooth Forged
4	1	Special Bolt	Steel	Finish all over
5	1	7/8" St'd. Nut	W. I.	
6	1	Basket (Complete)	Galv. Iron	#16 B. W. G.
7	1	Stiffening Ring	Galv. Iron	3/32" Thick
8	1	Handle	Galv. Iron	3/32" B. W. G. x 1¼" x 18" Long
9	1	½" Tap Bolt	Steel	1" Long
22	1	Strainer Body	C. I. Galv.	

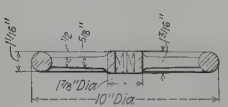

7/16" Sq Cored
9/16 Sq Cored
11/16" Dia.
5" Dia
6" Dia.

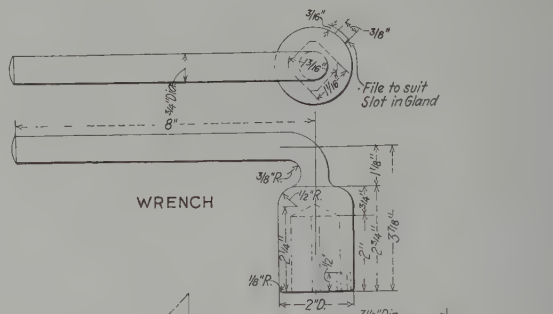

9/16" Square Cored
11/16" Sq Cored
8" Dia
1 11/16" D

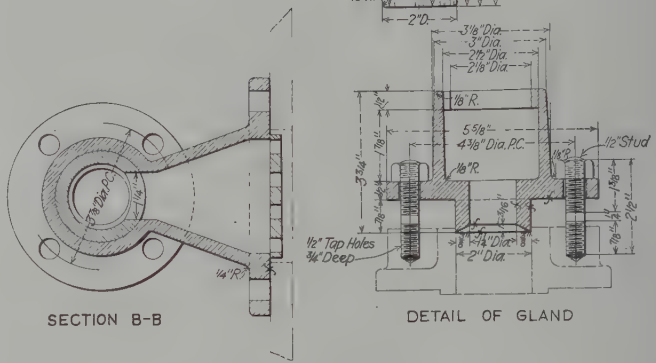

2 7/8" R
1/4" R.
4 1/8"

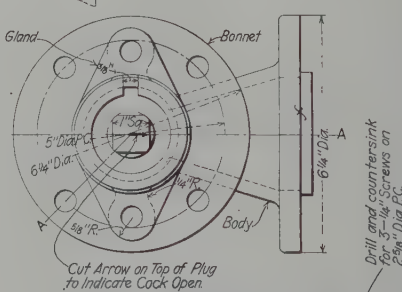

12" Dia

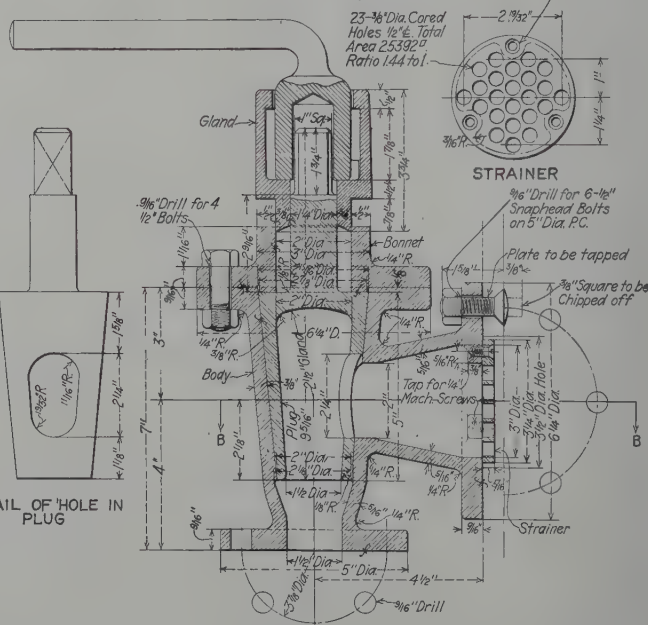

4 11/16"
2 7/16" R
13/16" Sq Cored
4 3/4"


17/8" Dia
10" Dia

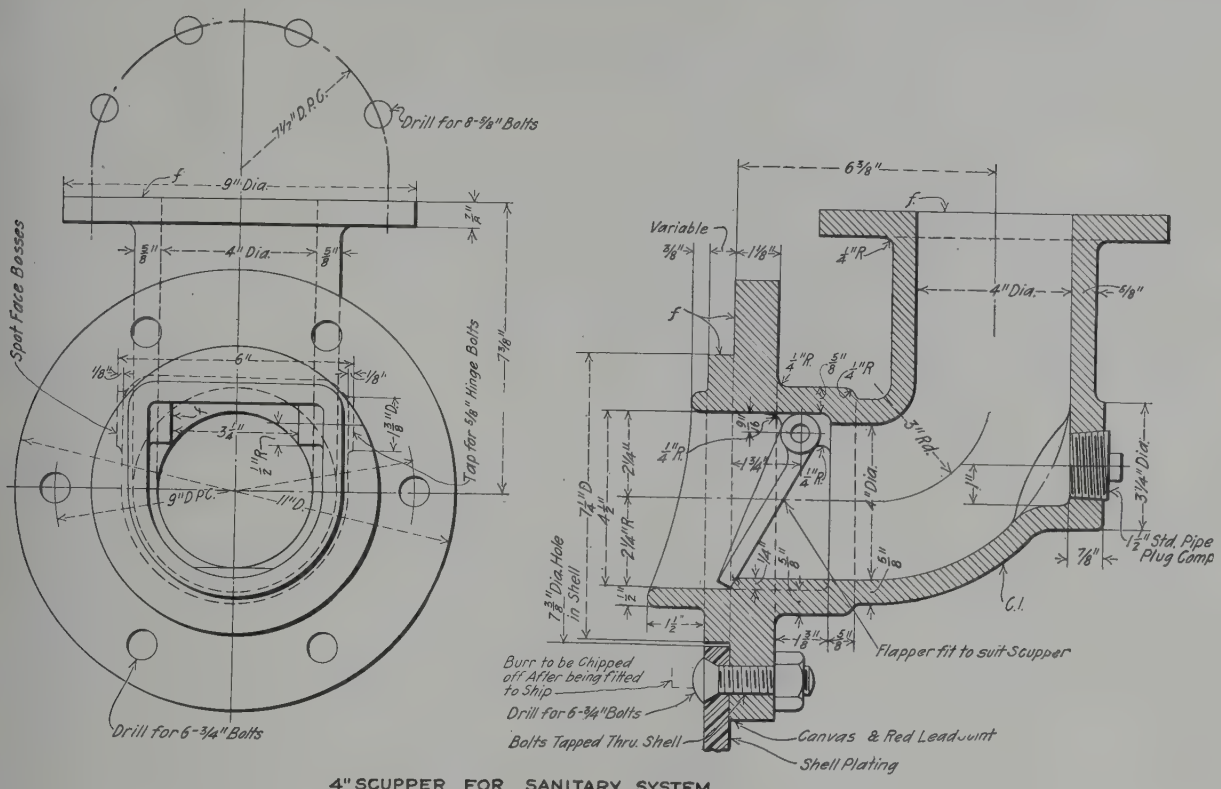

WRENCH
File to suit Slot in Gland
8"
2" D


SECTION B-B
DETAIL OF GLAND
1/2" Tap Holes 3/4" Deep
1/2" Stud
4 3/8" Dia. P.C.
2" Dia.

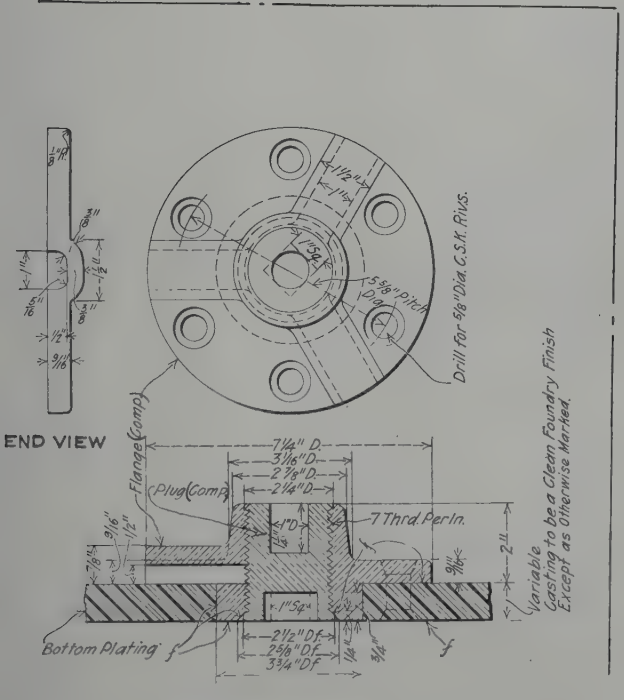

Gland
Bonnet
Body
5" Dia P.C.
6 1/4" Dia.
Cut Arrow on Top of Plug to Indicate Cock Open.
Drill and countersink for 3—1/4" Screws on 2 5/8" Dia. P.C.


23—1/8" Dia. Cored Holes 1/2" ℄ Total Area 2.5392" Ratio 1.44 to 1
STRAINER
Gland
Bonnet
Body
9/16" Drill for 4 1/2" Bolts
9/16" Drill for 6-1/2" Snaphead Bolts on 5" Dia. P.C.
Plate to be tapped
3/8" Square to be Chipped off
Tap for 1/4" Mach. Screws
Plug
DETAIL OF HOLE IN PLUG
Strainer
SECTION A-A

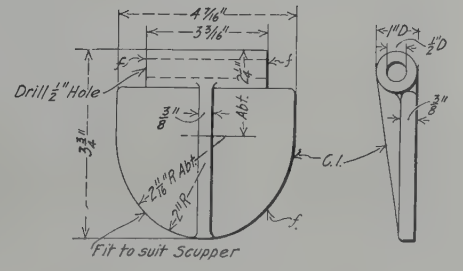
DOCKING PLUG AND 4" SCUPPER



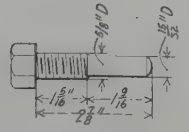
4" SCUPPER FOR SANITARY SYSTEM



DOCKING PLUG



FLAPPER



5/8" HINGE BOLT FOR FLAPPER

9,000-TON D. W. FREIGHTER

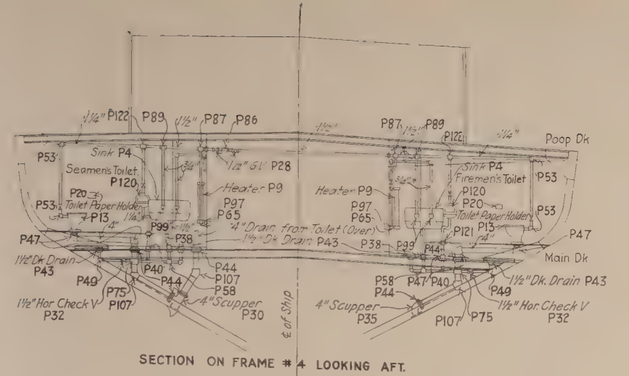
For Arrangement Plans See Plates XLIV and XLV
Opposite Page 610

LIST OF MATERIAL FOR ONE SHIP

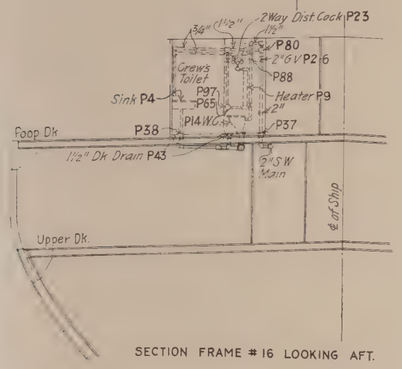
Pc. No.	No. Pcs.	Name	Mat'l	Remarks
P1	2	20"x18" Lavatories	Porcelain.	Captain, ch. engineer.
P2	3	19"x16" Lavatories	Porcelain.	P. off., officers and engrs.
P3	1	Lavatory	Porcelain.	Hospital.
P4	3	36"x20" Wash sink	En. iron.	Firemen, seamen and crew.
P5	2	24"x20"x12" Sink	Galv. iron.	Galley and pantry.
P6	1	4' 6"x30" Bath tub	En. iron.	Captain.
P7	1	5" Shower	N. P. brass.	Captain.
P8	4	Combined shower and heater.	N. P. brass.	Ch. eng., eng., off., p. off.
P9	3	Combined shower and heater.	Pol. brass.	Firemen, seamen and crew.
P10	1	Water heater	N. P. brass.	Captain.
P11	1	Water heater	Pol. brass.	Hospital.
P12	6	Water closets	Porcelain.	Capt., ch. eng., off., eng., p. off., hospital.
P13	2	Water closets	En. iron.	Firemen, seamen.
P14	2	Water closets	En. iron.	Crew.
P15	2	24"x18" Mirrors		Capt., ch. eng. off., p. off., eng.
P16	3	20"x16" Mirrors		
P17	4	Towel rack	N. P. brass.	Capt., ch. eng., p. off., off.
P18	2	Tumbler holder	N. P. brass.	Capt., ch. eng.
P19	5	Grab rod	N. P. brass.	Capt., ch, eng., off., p. off., hospital.
P20	10	Toilet paper holder	N. P. brass.	Off. crew, hospital.
P21	1	Hand pump	Brass.	Galley.
P22	1	Three-way dist. cock	N. P. brass.	Captain.
P23	7	Two-way dist. cock	Pol. brass.	Off., eng., p. off., firemen, seamen, crew.
P24	1	¾" Self-closing faucet	Pol. brass.	F. W. sink in pantry.
P25	2	½" Self-closing faucet	Pol. brass.	F. W. main dk. pass. & galley.
P26	4	2" Globe stop valve, scr.	Brass.	S. W. main.
P27	2	2" Angle stop hose valve, scr.	Brass.	F. W. filling.
P28	12	1½" Globe stop valve, scr.	Brass.	Fresh and S. W.
P29	2	1½" Angle stop valve, scr.	Brass.	F. W. to Galley.
P30	1	4" Scupper	C.I.	Drain seamen and crew.
P31	5	¾" Globe stop valve, scr.	Brass.	F. W. to lav. and scuttle butt.
P32	9	1½" Horizontal swing check valve, scr.	Brass.	F. W. and dk. drains.
P33	1	1½" Angle valve	Brass.	F. W. Ford.
P34	3	4" Scupper	C.I.	Drain p. off., eng., off.
P35	1	4" Scupper	C.I.	Drain firemen.
P36	2	1½" Deck plate	C.I.	Sounding tube F. W. tanks.
P37	3	2" Dk. fitting. A = 3", B = 1¼", C = 4¼".	C.I.	Dr. capt. bathtub, S. W. to crew and off. toilet.
P38	7	1½" Dk. fitting, A = 3", B = 1¼", C = 4¼".	C.I.	S. & F. W. to capt. dr. pantry and galley sink, and sea'n and fire'n, S. W. to P. O.
P39	2	1½" Dk. fitting, A = 3", B = 1¼", C = 4¼".	C.I.	F. W. to galley.
P40	8	1¼" Dk. fitting, A = 3", B = 1¼", C = 4¼".	C.I.	Dr. lav. capt., hospital, off., ch. eng., eng., p. o., dr. urinals, firemen and sea'n.
P41	1	¾" Dk. fitting, A = 3", B = 1", C = 4".	C.I.	F. W. to Scuttle butt.
P42	1	½" Dk. fitting, A = 3", B = 1", C = 4".	C.I.	F. W. to galley sink.
P43	12	1½" Dk. drain	C.I.	
P44	24	4" Std. flange	C.I.	
P45	1	1½" Std. flange	C.I.	
P46	4	2" Return bend, scr.	C.I. galv.	Air pipe on F. W. tanks.
P47	10	4" Ell, scr.	C.I. galv.	Drainage.
P48	2	2" Ell, scr.	C.I. galv.	Drainage.
P49	16	1½" Ell, scr.	C.I. galv.	Drainage.
P50	5	1¼" Ell, scr.	C.I. galv.	Drainage

LIST OF MATERIAL FOR ONE SHIP—Continued

Pc. No.	No. Pcs.	Name	Mat'l	Remarks
P51	25	2" Ell, scr.	C.I.galv.	
P52	39	1½" Ell, scr.	C.I.galv.	
P53	14	1¼" Ell, scr.	C.I.galv.	
P54	60	¾" Ell, scr.	C.I.galv.	
P55	4	½" Ell, scr.	C.I.galv.	
P56	3	4" Tee, scr.	C.I. galv.	Drainage.
P57	1	F. W. tank for scuttle butt.	Steel galv.	
P58	4	1½" Tee, scr.	C.I. galv.	Drainage.
P59	3	4" 45 Degree ell, scr.	C.I. galv.	Drainage.
P60	1	1½" 45 Degree ell, scr.	C.I. galv.	Drainage.
P61	1	2" 45 Degree ell, scr.	C.I. galv.	Drainage.
P62	3	¾" 45 Degree ell, scr.	C.I.galv.	
P63	5	2" 45 Degree ell, scr.	C.I.galv.	
P64	4	2" Std. pipe plug	C.I.galv.	
P65	10	½" Std. pipe plug	C.I.galv.	
P66	2	2" Tee, scr.	C.I.galv.	
P67	2	1½" Tee, scr.	C.I.galv.	
P68	5	¾" Tee, scr.	C.I.galv.	
P69	1	4" Y fitting, scr.	C.I. galv.	Drainage.
P70	1	4"x4"x3" Y fitting, scr.	C.I. galv.	Drainage.
P71	1	4" Y fitting, scr.	C.I. galv.	Drainage bush. for 4"x4"x2".
P72	1	4" Y fitting, scr.	C.I. galv.	Drainage bush. for 4"x4"x2".
P73	5	4"x2"x4" Tee, scr.	C.I. galv.	Drainage.
P74	1	4"x4"x1½" Tee, scr.	C.I. galv.	Drainage.
P75	2	4"x4"x1½"x1½" Cross, scr.	C.I. galv.	Drainage.
P76	1	3"x1½"x2½" Y fitting, scr.	C.I. galv.	Drainage.
P77	1	2½"x2"x1¼" Y fitting, scr.	C.I. galv.	Drainage.
P78	1	2"x2"x1¼" Tee, scr.	C.I. galv.	Drainage.
P79	1	2"x1½"x2" Tee, scr.	C.I.galv.	
P80	1	2"x1½"x1½" Tee, scr.	C.I.galv.	
P81	1	2"x1½"1¼" Y fitting, scr.	C.I. galv.	Drainage.
P82	1	2"x1¼"x1½" Tee, scr.	C.I. galv.	Drainage.
P83	1	2"x1¼"x1½" Tee, scr.	C.I.galv.	
P84	1	2"x1½"x1½" Tee, scr.	C.I.galv.	
P85	1	2"x1½"x1½"x1½" Cross, scr.	C.I. galv.	Drainage.
P86	1	1½"x1¼"x2" Tee, scr.	C.I.galv.	
P87	4	1½"x1½"x¾" Tee, scr.	C.I.galv.	
P88	2	1½"x1¼"x1¼" Tee, scr.	C.I.galv.	
P89	3	1½"x1¼"x¾" Tee, scr.	C.I.galv.	
P90	2	1½"x¾"x1¼" Tee, scr.	C.I.galv.	
P91	2	1½"x¾"x1¼" Tee, scr.	C.I.galv.	
P92	1	1½"x¾"x¾" Tee, scr.	C.I.galv.	
P93	1	1¼"x1¼"x1¼" Y fitting, scr.	C.I. galv.	Drainage.
P94	1	1"x1"x¾" Tee, scr.	Pol. brass.	At galley hand pump.
P95	1	¾"x¾"x1½" Tee, scr.	C.I.galv.	
P96	1	¾"x½"x½" Tee, scr.	C.I.galv.	
P97	9	¾"x½"x¾" Tee, scr.	C.I.galv.	
P98	2	2"x1½" Reducing, bushing.	C.I.galv.	
P99	13	¾"x½" Reducing ell, scr.	C.I.galv.	
P100	2	1½" 45 Degree ell.	C.I.galv.	
P101	1	1½" 4-Branch manifold, scr.	C.I.galv.	
P102	1	2½"x2"x2" Tee, scr.	C.I. galv.	S. W. Main.
P103	1	2"x2"x1¼" Tee, scr.	C.I.galv.	
P104	3	1½"x1½"x1¼" Tee, scr.	C.I. galv.	Drainage.
P105	2	4" 22½ Degree ell, scr.	C.I. galv.	Drainage.
P106	1	2"x½"x2" Tee, scr.	C.I. galv.	S. W. main aft.
P107	3	4" 60 Degree ells, scr.	C.I. galv.	Drainage.
P108	22	2" Locknuts	M.I.galv.	
P109	24	1½" Locknuts	M.I.galv.	
P110	2	¾" Locknuts	M.I.galv.	
P111	2	½" Locknuts	M.I.galv.	
P112	150 ft.	4" Pipe	W.I.galv.	
P113	2 ft.	3" Pipe	W.I.galv.	
P114	13 ft.	2½" Pipe	W I.galv.	
P115	375 ft.	2" Pipe	W.I.galv.	
P116	425 ft.	1½" Pipe	W.I.galv.	
P117	125 ft.	1¼" Pipe	W.I.galv.	
P118	325 ft.	¾" Pipe	W.I.galv.	
P119	18 ft.	½" Pipe	W.I.galv.	
P120	2	Urinals	Enaml. iron.	Firemen's & seamen's toilets.
P121	4	1¼" Locknuts	M.I.galv.	
P122	2	1¼"x1¼"x½" Tee, scr.	C.I.galv.	



SECTION ON FRAME # 4 LOOKING AFT.



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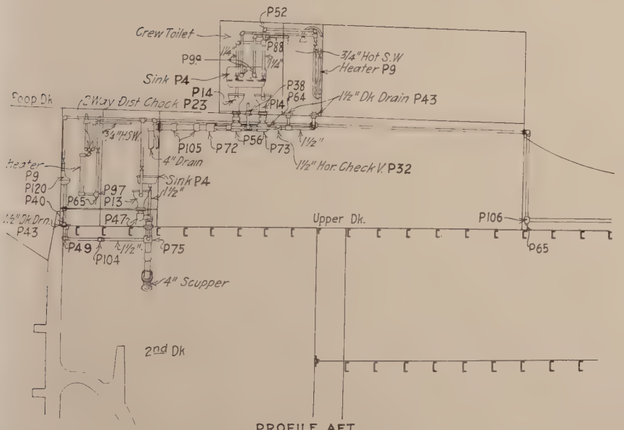
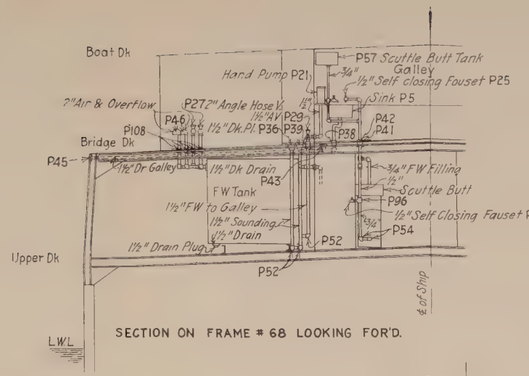


PROFILE AFT.



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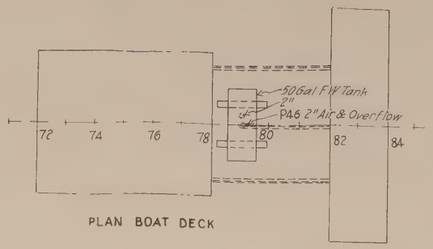
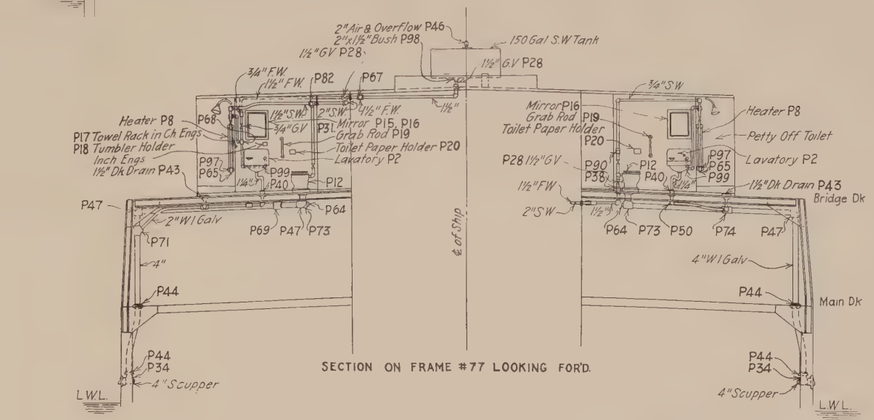


PLAN BOAT DECK



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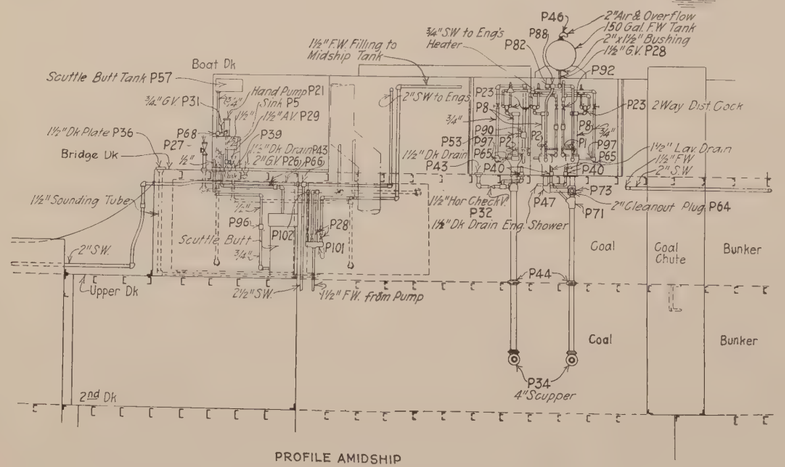
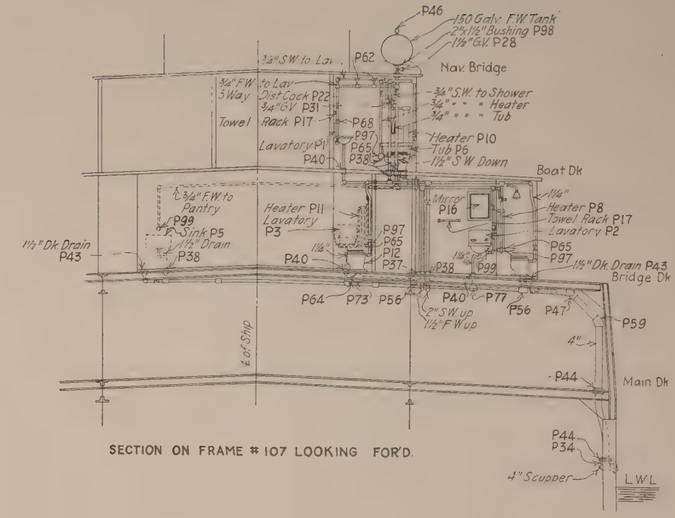


PROFILE AMIDSHIP



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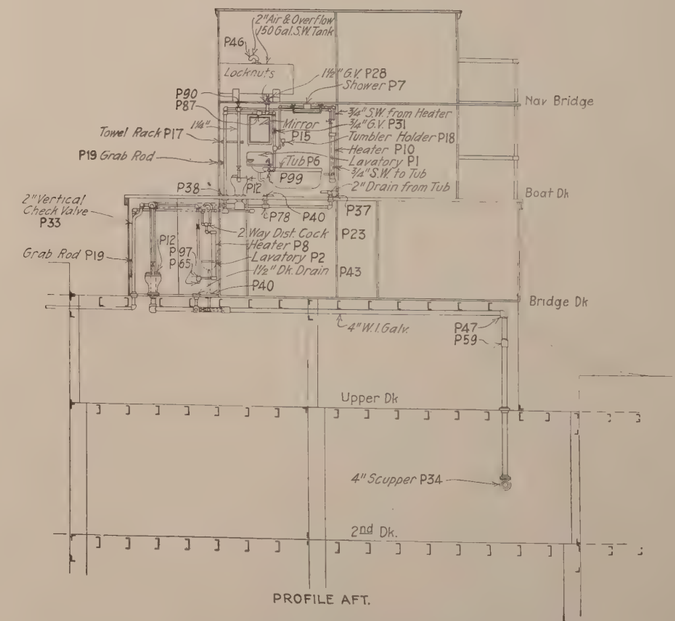
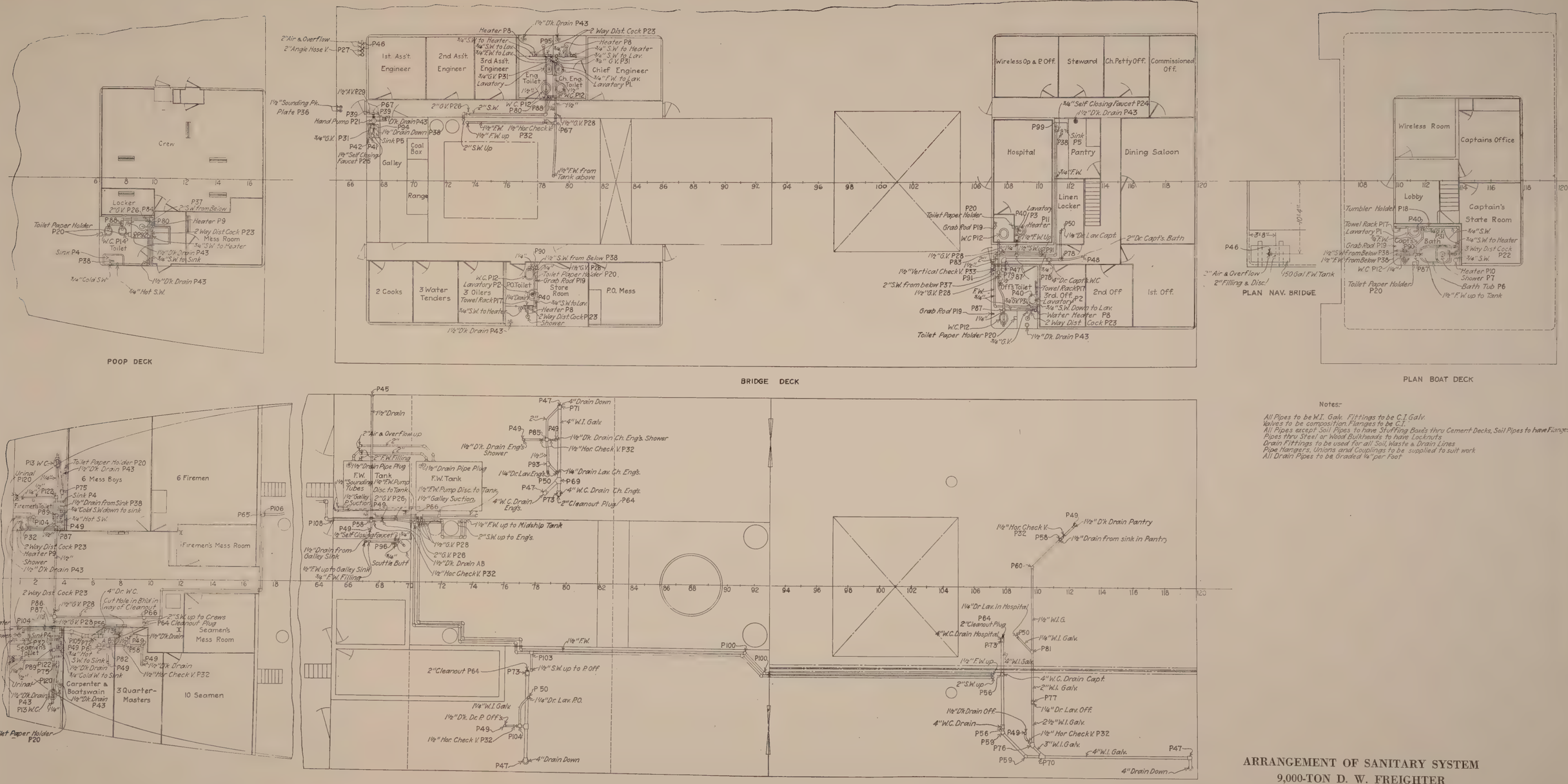


PROFILE AFT.

ARRANGEMENT OF SANITARY SYSTEM
9,000-TON D. W. FREIGHTER

PLATE XLIV

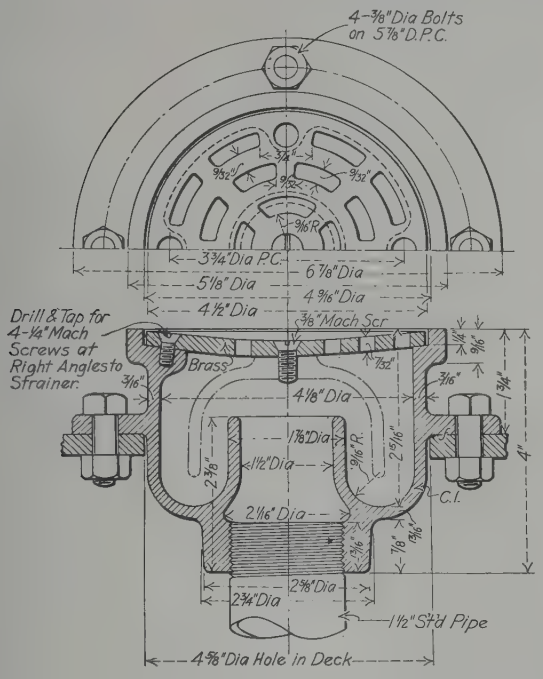


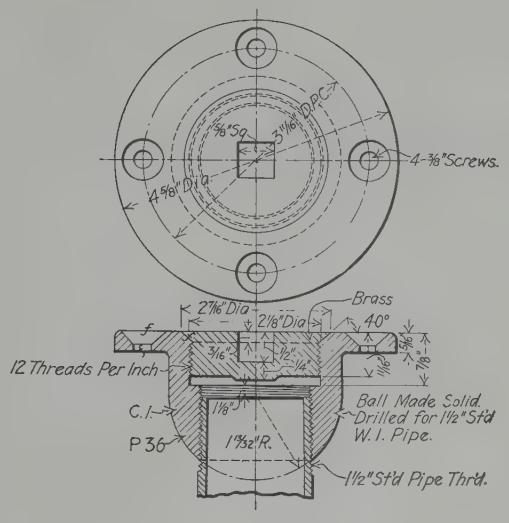
Notes:-

All Pipes to be W.I. Galv. Fittings to be C.I. Galv.
Valves to be composition. Flanges to be C.I.
All Pipes except Soil Pipes to have Stuffing Boxes thru Cement Decks, Soil Pipes to have Flanges
Pipes thru Steel or Wood Bulkheads to have Locknuts
Drain Fittings to be used for all Soil, Waste & Drain Lines
Pipe Hangers, Unions and Couplings to be supplied to suit work
All Drain Pipes to be Graded ¼" per Foot

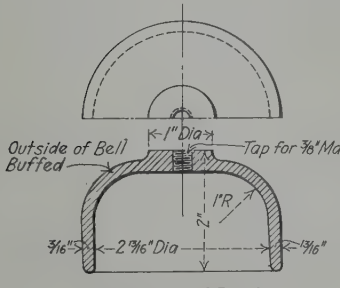
ARRANGEMENT OF SANITARY SYSTEM
9,000-TON D. W. FREIGHTER

PLATE XLV

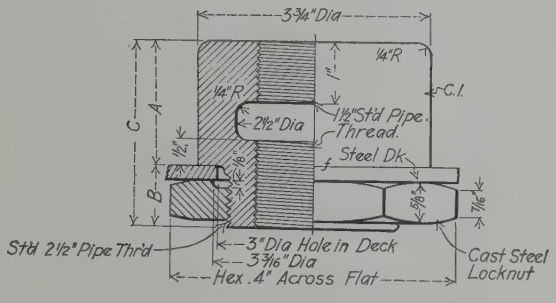




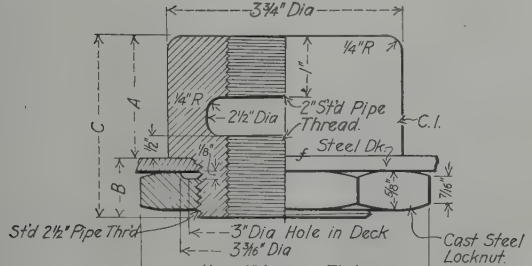
1½" DECK PLATE



1½" DECK DRAIN



1½" DECK FITTING



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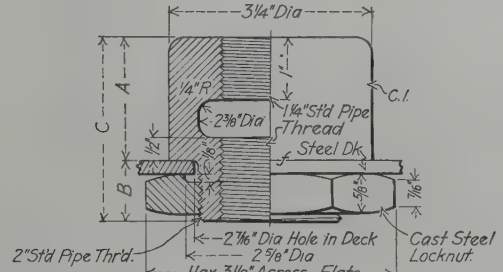

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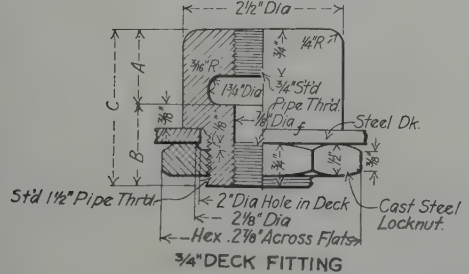
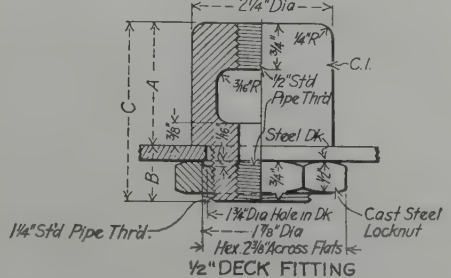


¾" DECK FITTING



½" DECK FITTING

9,000-TON D. W. FREIGHTER

9,000-TON D. W. FREIGHTER

For Arrangement Plans
See Opposite Page

LIST OF RADIATORS AND SHIELDS

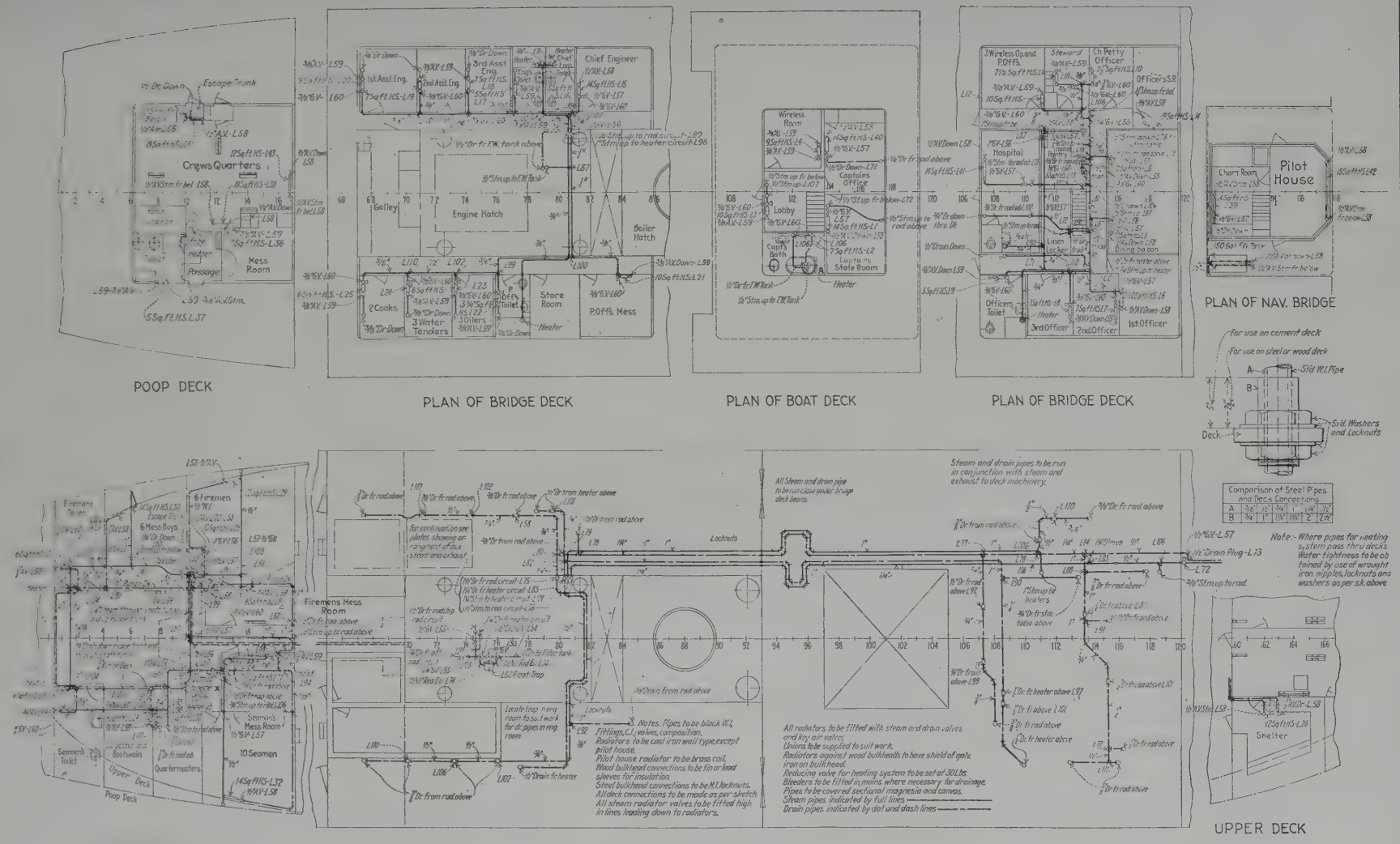
Pc. No. of No.	Pcs.	Name	Mat'l	Remarks
L1	1	14 sq. ft. Radiator	C.I.	Captain's stateroom.
L2	1	7 sq. ft. Radiator	C.I.	Captain's bathroom.
L3	1	10 sq. ft. Radiator	C.I.	Captain's lobby
L4	1	9 sq. ft. Radiator	C.I.	Wireless room.
L5	2	12 sq. ft. Radiator	C.I.	Officers' dining saloon.
L6	1	12 sq. ft. Radiator	C.I.	1st officer's stateroom.
L7	1	7 sq. ft. Radiator	C.I.	2nd officer's stateroom.
L8	1	7 sq. ft. Radiator	C.I.	3rd officer's stateroom.
L9	1	5 sq. ft. Radiator	C.I.	Officer's toilet.
L10	1	7½ sq. ft. Radiator	C.I.	Petty officer's stateroom.
L11	1	7½ sq. ft. Radiator	C.I.	Steward's stateroom.
L12	1	10 sq. ft. Radiator	C.I.	Wireless operator's stateroom.
L13	1	5 sq. ft. Radiator	C.I.	Pantry.
L14	1	9 sq. ft. Radiator	C.I.	Officer's stateroom.
L15	1	14 sq. ft. Radiator	C.I.	Ch. eng. stateroom.
L16	1	5 sq. ft. Radiator	C.I.	Ch. eng. toilet.
L17	1	5 sq. ft. Radiator	C.I.	Engineer's toilet.
L18	1	7 sq. ft. Radiator	C.I.	3rd asst. eng. stateroom.
L19	1	7 sq. ft. Radiator	C.I.	2nd asst. eng. stateroom.
L20	1	9 sq. ft. Radiator	C.I.	1st asst. eng. stateroom.
L21	1	10 sq. ft. Radiator	C.I.	Petty off. mess room.
L22	1	3¾ sq. ft. Radiator	C.I.	Petty off. toilet.
L23	1	6 sq. ft. Radiator	C.I.	3 oilers' quarters.
L24	1	6 sq. ft. Radiator	C.I.	3 water tenders' quarters.
L25	1	6 sq. ft. Radiator	C.I.	2 cooks' quarters.
L26	1	12 sq. ft. Radiator	C.I.	Shelter.
L27	1	7½ sq. ft. Radiator	C.I.	Seamen's mess room.
L28	1	6 sq. ft. Radiator	C.I.	Firemen's mess room.
L29	2	12 sq. ft. Radiator	C.I.	Firemen's quarters.
L30	1	14 sq. ft. Radiator	C.I.	6 mess boys' quarters.
L31	1	6 sq. ft. Radiator	C.I.	Firemen's toilets.
L32	1	14 sq. ft. Radiator	C.I.	Seamen's quarters.
L33	1	7 sq. ft. Radiator	C.I.	Quartermaster's quarters.
L34	1	9 sq. ft. Radiator	C.I.	Carpenter and boatswain's quarters.
L35	1	6 sq. ft. Radiator	C.I.	Seamen's toilet.
L36	1	7 sq. ft. Radiator	C.I.	Mess room.
L37	1	5 sq. ft. Radiator	C.I.	Toilet.
L38	2	18 sq. ft. Radiator	C.I.	Crew's quarters.
L39	1	14 sq. ft. Radiator	C.I.	Chart room.
L40	1	14 sq. ft. Radiator	C.I.	Captain's office.
L41	1	14 sq. ft. Radiator	C.I.	Hospital.
L42	1	18 sq. ft. Radiator	Brass W. I. pipe size.	Pilot house.
L43	1	12 sq. ft. Radiator	C.I.	Quarters.
L44	3	25"x29" Radiator shield No. 26 gauge.	Galv. iron.	2—Off. dining saloon. 1—1st off. stateroom.
L45	5	28"x29" Radiator shield No. 26 gauge.	Galv. iron.	Capt. stateroom, Ch. engr. stateroom, chart room, capt. office, hospital.
L46	2	28"x30" Radiator shield No. 26 gauge.	Galv. iron.	Crew's quarters.
L47	7	25"x16" Radiator shield No. 26 gauge.	Galv. iron.	Petty off. stateroom, st'w'd. stateroom, wireless oper. stateroom, 3 oilers, 3 water tenders, 2 cooks, firemen's mess room.
L48	6	28"x16" Radiator shield No. 26 gauge.	Galv. iron.	2nd and 3rd off., 2nd and 3rd asst. eng. s. r., gunners' mess, quartermasters.
L49	6	28"x17" Radiator shield No. 26 gauge.	Galv. iron.	Capt. lobby, wireless room, ch. petty off. stateroom, 1st asst. engr., petty off. mess, carpenter and boatswain.

LIST OF RADIATORS AND SHIELDS—Continued

Pc. No. of No.	Pcs.	Name	Mat'l	Remarks
L50	1	21"x16" Radiator shield No. 26 gauge.	Galv. iron.	Pantry.
L51	1	8' 0"x20" Radiator shield No. 26 gauge.	Sheet brass.	Pilot house

LIST OF VALVES, PIPES AND FITTINGS

Pc. No. of No.	Pcs.	Name	Mat'l	Remarks
L52	1	1" Steam trap float type	C.I.	In engine room.
L53	2	1½" Globe stop valve scr	Comp.	At trap in engine room.
L54	2	1½" Cross stop valve scr	Comp.	At trap in engine room.
L55	2	1¼" Globe stop valve scr	Comp.	
L56	9	1" Globe stop valve scr	Comp.	
L57	16	½" Globe stop valve scr	Comp.	
L58	27	½" Angle stop valve scr	Comp.	
L59	30	⅜" Angle stop valve scr	Comp.	
L60	28	⅜" Globe stop valve scr	Comp.	
L61	46	⅛" Key air valve	Brass.	For air valves on rad. 1 male scr. end.
L62	6	Keys	Brass.	For key valves.
L63	14	1¼" Ell	C.I.	
L64	20	1" Ell	C.I.	
L65	26	¾" Ell	C.I.	
L66	85	½" Ell	C.I.	
L67	80	⅜" Ell	C.I.	
L68	2	¾" 45 Degree ell	C.I.	
L69	4	½" 45 Degree ell	C.I.	
L70	2	⅜" 45 Degree ell	C.I.	
L71	3	¾" Tee	C.I.	
L72	8	½" Tee	C.I.	
L73	2	½" Pipe plug	C.I.	
L74	2	1½"x1" Reducing ell	C.I.	
L75	1	1½"x1¼"x1¼"x1¼" Cross	C.I.	Bush 1½"x½"x1¼"x1".
L76	1	1½"x1¼"x1¼" Tee	C.I.	
L77	1	1¼"x1¼"x¾" Tee	C.I.	
L78	6	1¼"x1¼"x½" Tee	C.I.	
L79	4	1¼"x1¼"x⅜" Tee	C.I.	
L80	1	1¼"x¾"x1¼" Tee	C.I.	
L81	1	1¼"x1"x½" Tee	C.I.	
L82	1	1¼"x¾"x1" Tee	C.I.	
L83	4	1¼"x½"x1¼" Tee	C.I.	
L84	1	1¼"x½"x1" Tee	C.I.	
L85	1	1¼"x1"x1"x1" Cross	C.I.	
L86	1	1½"x1½"x1½" Tee	C.I.	
L87	7	1"x1"x½" Tee	C.I.	
L88	3	1"x1"x⅜" Tee	C.I.	
L89	2	1"x1"x1¼" Tee	C.I.	
L90	2	1"x¾"x¾" Tee	C.I.	
L91	5	1"x¾"x½" Tee	C.I.	
L92	1	1"x¾"x½" Tee	C.I.	Bush 1"x¾"x¾".
L93	1	1"x⅜"x1" Tee	C.I.	Bush 1"x⅜"x¾".
L94	1	1"x½"x½" Tee	C.I.	
L95	1	1"x1"x1"x1" Cross	C.I.	Bush 1"x¾"x1" x1".
L96	2	¾"x¾"x1" Tee	C.I.	
L97	2	¾"x¾"x½" Tee	C.I.	
L98	2	¾"x¾"x⅜" Tee	C.I.	
L99	2	¾"x¾"x¾" Tee	C.I.	
L100	1	¾"x½"x1" Tee	C.I.	Bush ¾"x⅜"x1".
L101	4	¾"x½"x½" Tee	C.I.	
L102	6	¾"x½"x½" Tee	C.I	Bush ¾"x½"x⅜".
L103	1	¾"x⅜"x⅜" Tee	C.I.	
L104	2	¾"x¾"x¾"x¾" Cross	C.I.	Bush ¾"x½"x¾"x⅜".
L105	1	¾" Ell, with ⅜" side outlet.	C.I.	
L106	11	½"x½"x⅜" Tee	C.I.	
L107	2	½"x⅜"x½" Tee	C.I.	
L108	1	½"x½"x¾" Tee	C.I.	Bush ½"x⅜"x¾".
L109	1	½"x½"x1" Tee	C.I.	Bush ½"x⅜"x1".
L110	9	½"x⅜"x¾" Tee	C.I.	
L111	2	⅜"x⅜"x½" Tee	C.I.	
L112	2	2" Locknuts	M.I.	
L113	16	1¼" Locknuts	M.I.	
L114	82	1" Locknuts	M.I.	
L115	76	¾" Locknuts	M.I.	
L116	44	½" Locknuts	M.I.	
L117	38	⅜" Locknuts	M.I.	
L118	500 ft.	1¼" Pipe	W.I.	
L119	325 ft.	1" Pipe	W.I.	
L120	325 ft.	¾" Pipe	W.I.	
L121	900 ft.	½" Pipe	W.I.	
L122	450 ft.	⅜" Pipe	W.I.	
L123	1	1½"x1¼"x1½" Tee	C.I.	
L124	1	1¼"x1"x1" Tee	C.I.	


POOP DECK
PLAN OF BRIDGE DECK
PLAN OF BOAT DECK
PLAN OF BRIDGE DECK
PLAN OF NAV. BRIDGE
UPPER DECK
UPPER DECK
Crews Quarters
Mess Room
Engine Hatch
Boiler Hatch
Store Room
Lobby
Captains State Room
Hospital
Linen Locker
Officers Toilet
Chart Room
Pilot House
Firemens Mess Room
Seamens Mess Room
Shelter
Deck
Comparison of Steel Pipes and Deck Connections
Note:- Where pipes for heating systems pass thru decks Water tightness to be obtained by use of wrought iron nipples, locknuts and washers as per sk above
Steam and drain pipes to be run in conjunction with steam and exhaust to deck machinery.
All Steam and drain pipe to be run close under beams.
All radiators to be fitted with steam and drain valves and key air valves.
Unions to be supplied to suit work.
Radiators against wood bulkheads to have shield of galv. iron on bulkhead.
Reducing valve for heating system to be set at 30 Lbs.
Bleeders to be fitted in mains where necessary for drainage.
Pipes to be covered sectional magnesia and canvas.
Steam pipes indicated by full lines
Drain pipes indicated by dot and dash lines
Notes. Pipes to be black W.I. Fittings, C.I. valves, composition. Radiators to be cast iron wall type, except pilot house. Pilot house radiator to be brass coil. Wood bulkhead connections to be tin or lead sleeves for insulation. Steel bulkhead connections to be M.I. locknuts. All deck connections to be made as per sketch All steam radiator valves to be fitted high in lines leading down to radiators.

UPPER DECK

9,000-TON D. W. FREIGHTER

See Opposite Page

10,000-TON D. W. STANDARD TANKER

For Arrangement Plans
See Pages 616-617-618-619 and 620

LIST OF MATERIAL FOR ONE SHIP

Pc. No.	No. Pcs.	Name	Mat'l	Remarks
1	2	10" Angle valve	C.I.	For use at sea chest.
2	18	5" Vacuum & pressure valve	Comp.	For use on expansion trunks.
3	10	3" Vacuum & pressure valve	Comp.	For use on expansion trunks.
4	2	5" Relief valve	C.I.	For use on pump discharge.
5	24	10" Gate valve with handwheel	C.I.	For use in pump room.
6	2	10" Gate valve without handwheel	C.I.	For use on main line.
7	18	8" Gate valve without handwheel	C.I.	For use at tank suctions.
8	2	9" Diameter handwheel	C.I.	For operating rods on upper & poop decks.
9	2	16" Diameter handwheel	C.I.	For operating rods on upper & poop decks.
10	2	24" Ventilators	Steel	
11	1	10" Sea chest	C.I.	Cargo oil—water injection from sea.
12	1	10" Sea chest	C.I.	Cargo oil—water injection from sea.
14	6	10" Flange for copper pipe	C.I.	On main line in pump room.
15	4	10" Flange, special	C.I.	
16	128	10" Flange, standard	C.I.	
17	80	8" Flange	C.I.	
18	28	5" Flange	C.I.	For use on pump relief & pressure & vacuum valves.
20	6	10" Blank flange	Steel	At loading and discharging conn.
21	10	3" Flange, standard	C.I.	For use on pressure and vacuum valves.
22	24	Label plates	1/16" brass	Fitted under handwheel nuts.
23	30	Labels		Engraved on stuffing boxes.
26	14	10"x10"x8" Expansion joint	C.I.	For use on main line.
27	2	10"x8"x10" Tee	C.I.	For use on main line.
28	3	10"x10"x10" Tee	C.I.	For use on main line in pump room.
29	8	10" Ell, 90°	C.I.	
30	20	8" Ell, 90°	C.I.	
31	18	8" Bell mouth	C.I.	
32	23	Stuffing box for 1¼" rod.	C.I.	On upper and poop decks.
33	12	Stuffing box for 1" rod	C.I.	On upper and poop decks.
35	2	10"x10"x10" Tee, 10" side outlet	C.I.	In pump room.
36	2	10"x10"x8" Tee	C.I.	On main line.
37	2	10" Cross	C.I.	In pump room.
38	2	10" Cross	C.I.	In pump room.
39	1	10"x10"x10" Tee	C.I.	In pump room.
40	16	10" Bulkhead casting	C.I.	On main line.
41	10	4" Drain valve	C.I.	On main deck at side.
42	2	10" Cross, 10" side outlet.	C.I.	In pump room.
43	2	10" Cross	C.I.	In pump room.
44	4	10"—90° Ell, 1¼" connection	C.I.	In pump room.
45	4	10"—45° Ell	C.I.	In pump room.
46	2	10"—90° Ell	C.I.	In pump room.
47	5	10"—30° Ell	C.I.	In pump room.
49	1	10"—90° Bulkhead ell, 10" side outlet	C.I.	Discharge conn.
50	2	10"—90° Ell, 5" side outlet	C.I.	In pump room.

LIST OF MATERIAL FOR ONE SHIP—Continued

Pc. No.	No. Pcs.	Name	Mat'l	Remarks
51	2	5"—90° Ell	C.I.	In pump room.
52	2	5"—60° Ell	C.I.	In pump room.
53	2	10"—90° Ell, 5" side outlet	C.I.	In pump room.
54	1	10"—90° Bulkhead ell, 10" side outlet	C.I.	To other hand of Pc. No. 49.
56	2	10" Strainer	C.I.	In pump room.
57	11	Bracket	C.I.	For operating rods.
58	94	Bracket	C.I.	For operating rods.
59	2	10"—90° Bulkhead ell	C.I.	Discharge conn'ction.
60	20	1" Coupling	Steel	Connecting 1" operating rods.
61	2	3½" Angle irons	W.I.	14' 2" long.
62	42	Brackets	W.I.	⅜"x4" Plate, length to suit work.
63	5	3" Special casting	C.I. galv.	On upper decks.
70	40	1¼" Universal joints	Steel	
71	3	1¼" Rod	W.I.	12' 9" long.
72	6	1¼" Rod	W.I.	4' 9" long.
73	8	1¾" Rod	W.I.	7' 9" long.
74	3	1¼" Rod	W.I.	8' 3" long.
75	2	1" Rod	W.I.	16' 0" long.
76	8	1" Rod	W.I.	8' 0" long.
77	20	1¼" Rod	W.I.	Lengths cut to suit work.
78	18	1¼" Pipe couplings	W.I.	For use with st. cls.
96	2	Copper bend, # 8 B.W.G.	Copper	14' 7" long.
97	1	Copper bend, # 8 B.W.G.	Copper	15' 1" long.
101	18	8" Pipe	Steel	4' 3" long.
102	16	8" Pipe	Steel	4' 10" long.
103	2	8" Pipe	Steel	4' 11" long.
104	14	10" Pipe	Steel	19' 0" long.
105	8	10" Pipe, extra heavy	Steel	2' 3¼" long.
106	6	10" Pipe, extra heavy	Steel	2' 1¾" long.
107	2	10" Pipe	Steel	2' 8" long.
108	1	10" Pipe	Steel	6' 7" long.
109	1	10" Pipe	Steel	5' 6½" long.
110	1	10" Pipe	Steel	6' 6¾" long.
111	1	10" Pipe	Steel	5' 6¼" long.
112	2	10" Pipe	Steel	21" long.
113	2	10" Pipe	Steel	4' 0" long.
114	2	10" Pipe	Steel	12' 6" long.
115	2	10" Pipe	Steel	2' 9" long.
116	1	10" Pipe	Steel	13' 9" long.
117	2	10" Pipe	Steel	15' 9" long.
118	2	10" Pipe	Steel	22" long.
119	1	10" Pipe	Steel	22" long.
120	1	10" Pipe	Steel	12' 6" long.
121	2	10" Pipe	Steel	10' 11" long.
122	3	10" Pipe	Steel	14' 8" long.
123	2	10" Pipe	Steel	3' 2" long.
124	2	10" Pipe	Steel	22" long.
125	2	10" Pipe	Steel	2' 2" long.
126	2	10" Pipe	Steel	4' 5" long.
127	2	10" Pipe	Steel	5' 9" long.
128	2	10" Pipe	Steel	14" long.
129	2	5" Pipe	Steel	23" long.
130	2	5" Pipe	Steel	6' 1" long.
131	2	10" Pipe	Steel	2' 5" long.
132	2	10" Pipe	Steel	17' 0" long.
A11	1	2½" Angle valve	C.I.	Outboard delivery.
A13	1	2½" Special casting	C.I.	

(Continued on Next Page)

10,000-TON D. W. STANDARD TANKER

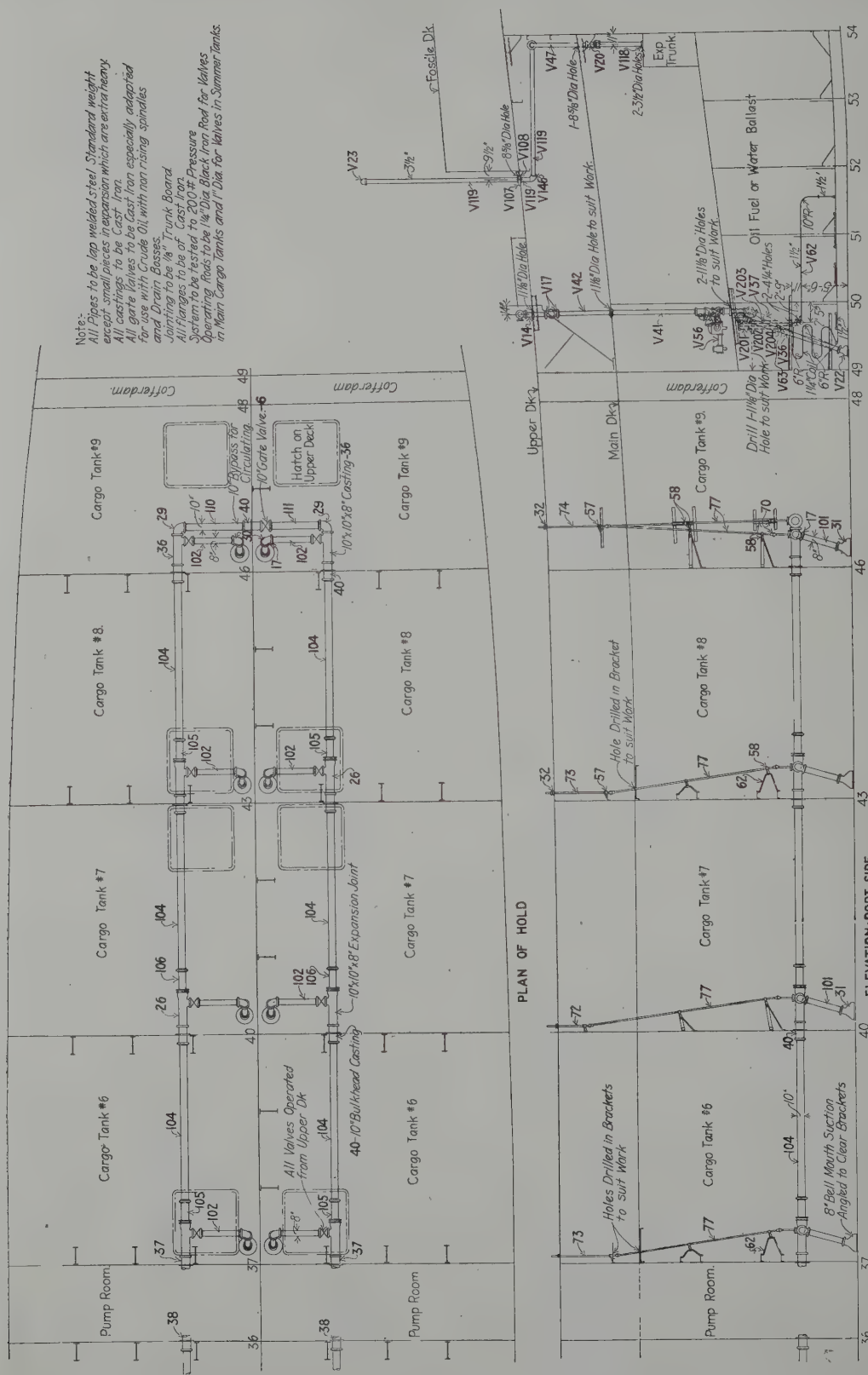
For Arrangement Plans
See Pages 616-617-618-619 and 620

LIST OF PIPES FOR ONE SHIP—Continued

Pc. No.	No. Pcs.	Name	Mat'l	Remarks
A14	2	3½" Standard flange	C.I. galv.	Suction pipe to bell mouth and to pump.
A15	2	2½" Standard flange	C.I. galv.	Discharge pipe to main deck and to pump.
A20	1	2½" Deck flange	C.I. galv.	Discharge pipe to main deck.
A27	1	3½" Standard ell	C.I. galv.	Suction line to pump.
A28	1	2½" Standard ell	C.I. galv.	Discharge line to pump.
A29	1	3½" Bell mouth	C.I. galv.	
A61	2	3½" Standard screwed ell	C.I. galv.	Suction line.
A62	2	2½" Standard screwed ell	C.I. galv.	Discharge line.
A63	1	2½" Standard 45° screwed ell	C.I. galv.	Discharge line.
A76	17′	3½" Pipe, standard	Steel galv.	Suction line.
A77	42′	2½" Pipe, standard	Steel galv.	Discharge line.
V9	1	4" Standard elbow	C.I.	In for'd pump room.
V10	1	3" Standard elbow	C.I.	In for'd pump room.
V11	1	3" Standard elbow	C.I.	In for'd pump room.
V12	1	6"x6"x3" Tee	C.I.	In for'd pump room.
V13	1	6" Tee, 3" side outlet....	C.I.	On upper deck, for'd.
V14	1	6" Special casting	C.I.	On upper deck, for'd.
V15	2	6" Special casting	C.I.	In for'd pump room.
V16	1	6" Ell—4" side outlet....	C.I.	In for'd pump room.
V17	5	6" Standard ell	C.I. galv.	On 6" fuel oil line.
V18	1	6" Special ell	C.I. galv.	On 6" fuel oil line.
V19	1	6" Special ell	C.I. galv.	On 6" fuel oil line.
V20	1	3½" Lateral	C.I. galv.	On for'd 3½" air escape.
V21	1	6"—45° Standard ell	C.I. galv.	On 6" fuel oil line.
V22	2	6" Bell mouth	C.I. galv.	On 6" fuel oil line.
V23	2	3½" Screw return bend..	C.I. galv.	Open pattern.
V24	1	6" Angle valve	C.I. galv.	125 lbs. pressure.
V25	1	6" Cross valve	C.I. galv.	125 lbs. pressure.
V26	3	6" Gate valve	C.I.	150 lbs. pressure.
V27	1	4" Gate valve	C.I.	150 lbs. pressure.
V28	4	3" Gate valve	C.I.	150 lbs. pressure.
V30	33	6" Standard flange	C.I. galv.	
V31	4	6" Blank flange	Steel galv.	On discharge connection.
V32	4	1¼" Screw angle valve...	Comp.	250 lbs. pressure
V33	2	1¼" Screw tees, ex. h'vy.	C.I. galv.	Heating coils.
V34	9	1¼" Screw 90°—Ell. ex. h'vy.	C.I. galv.	Heating coils.
V35	2	1¼" Unions	Brass	Heating coils.
V36	1	6" Pipe, standard	Brass	12′ 0" long—6" Fuel oil line.
V37	1	6" Pipe, standard	Brass	11′ 3" long—6" Fuel oil line.
V38	1	6" Pipe, standard	Brass	8′ 9" long—6" Fuel oil line.
V39	3	6" Pipe, standard	Brass	8′ 6" long—6" Fuel oil line.

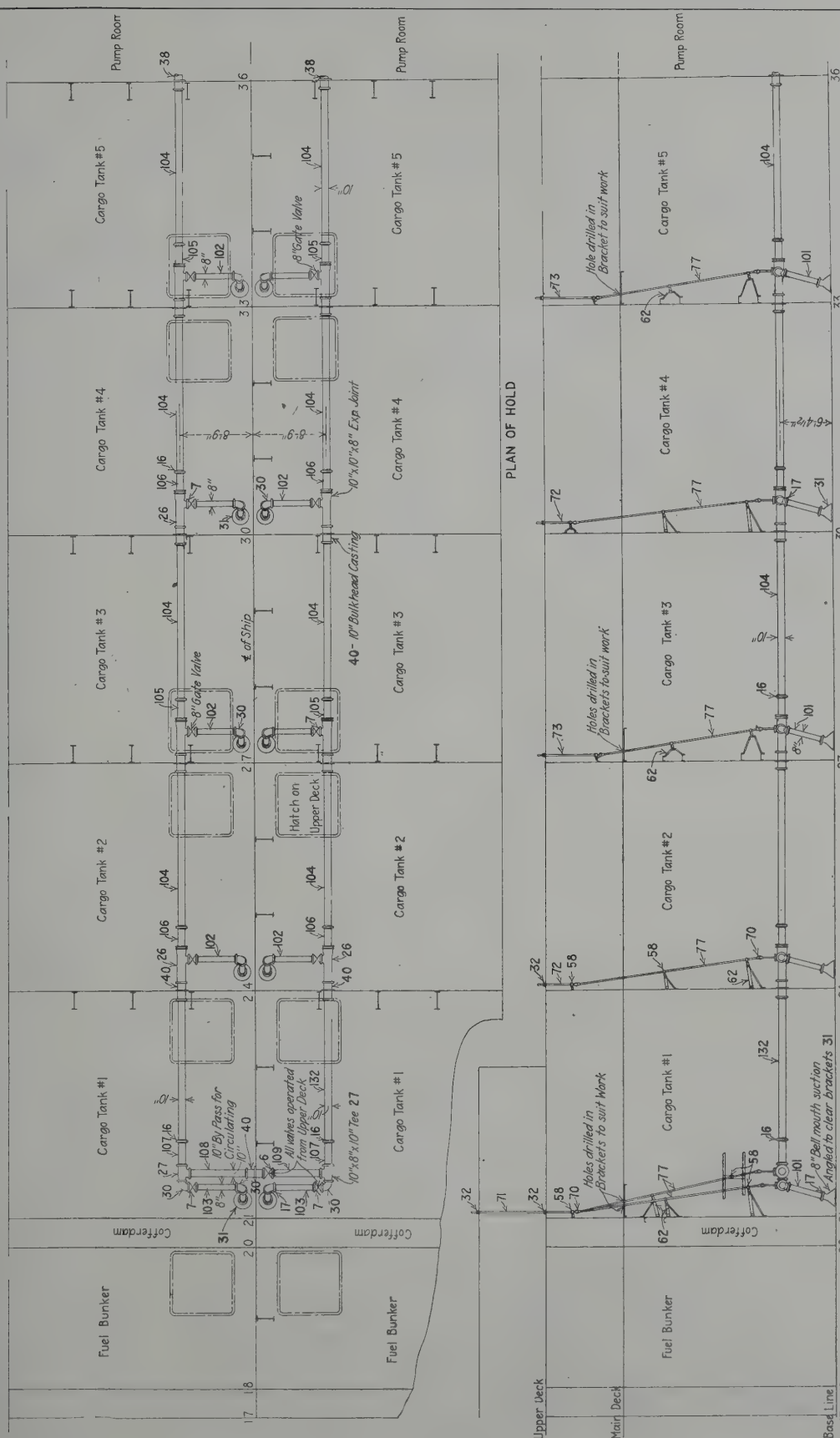
LIST OF MATERIAL FOR ONE SHIP—Continued

Pc. No.	No. Pcs.	Name	Mat'l	Remarks
V40	1	6" Pipe, standard	Steel galv.	20" long—6" Fuel oil line.
V41	1	6" Pipe, standard	Steel galv.	9′ 9" long—6" Fuel oil line.
V42	1	6" Pipe, standard	Steel galv.	6′ 5" long—6" Fuel oil line.
V43	1	6" Pipe, standard	Steel galv.	13′ 6" long—6" Fuel oil line.
V44	1	6" Pipe, standard	Steel galv.	19" long—6" Fuel oil line.
V45	1	3½" Pipe, standard	Steel galv.	6′ 10" long—Air escape.
V46	1	3½" Pipe, standard	Steel galv.	5′ 11" long—Air escape.
V47	1	3½" Pipe, standard	Steel galv.	15′ 10" long—Air escape.
V52	70′	1¼" Pipe, standard	Steel	Lengths to suit work.
V56	1	6"x5¾"x6" Pump		Fuel oil transfer.
V60	12	1¼" Double boss flange ..	C.I.	Heating line.
V61	60	1½" Flange unions, extra heavy	C.I. brass seat	Heating coils.
V62	10	1¼"x1½" Flange unions, extra heavy	C.I. brass seat	Heating coils.
V63	14	1¼" Flange unions, extra heavy	C.I. brass seat	Heating coils.
V107	1	3½" Deck flange	C.I. galv.	Air escape.
V108	1	3½" Special flange	C.I. galv.	Air escape.
V118	19	3½" Standard flange	C.I. galv.	Air escape.
V119	75′	3½" Standard pipe	Steel galv.	Air ecape.
V146	2	3½" Standard screw ell...	C.I. galv.	On air escape line.
V201	1	1¼" Steam coil	Steel galv.	9′ 3" long.
V202	1	1¼" Steam coil	Steel galv.	11′ 6" long.
V203	1	1¼" Steam coil	Steel galv.	11′ 6" long.
V204	1	1¼" Steam coil	Steel galv.	13′ 0" long.
V205	1	1¼" Steam coil	Steel galv.	24′ 0" long.
V206	1	1¼" Steam coil	Steel galv.	24′ 0" long.
V207	1	1½" Steam coil	Steel galv.	18′ 6" long.
V208	1	1½" Steam coil	Steel galv.	19′ 3" long.
V209	1	1¼" Steam coil	Steel galv.	18′ 6" long.
V210	1	1½" Steam coil	Steel galv.	18′ 6" long.
V211	1	1½" Steam coil	Steel galv.	19′ 6" long.
V212	1	1½" Steam coil	Steel galv.	16′ 0" long.
V213	1	1½" Steam coil	Steel galv.	17′ 6" long.
V214	1	1½" Steam coil	Steel galv.	14′ 6" long.
V215	1	1½" Steam coil	Steel galv.	15′ 0" long.
V216	1	1¼" Steam coil	Steel galv.	3′ 0" long.
V217	1	1½" Steam coil	Steel galv.	18′ 6" long—To other hand of Pc. No. V207.
V225	1	1½" Steam coil	Steel galv.	15′ 0" long—To other hand of Pc. No. V215.


Note:-
All Pipes to be lap welded steel Standard weight except small pieces in expansion which are extra heavy.
All castings to be Cast Iron.
All gate Valves to be Cast Iron especially adapted for use with Crude Oil with non rising spindles and Drain Bosses.
Joining to be 1/8" Trunk Board.
All flanges to be of Cast Iron.
System to be tested to 200 Ft Pressure
Operating rods to be 1" Dia Black Iron Rod for Valves in Main Cargo Tanks and 1 Dia for Valves in Summer Tanks.
PLAN OF HOLD
ELEVATION - PORT SIDE
Cofferdam
Cargo Tank #9
Cargo Tank #8
Cargo Tank #7
Cargo Tank #6
Pump Room
Upper Dk
Main Dk
Foscle Dk
Oil Fuel or Water Ballast
Exp Trunk
10" Bypass for Circulating
10" Gate Valve
Hatch on Upper Deck
10"x10"x8" Casting
10"x10"x8" Expansion Joint
40-10" Bulkhead Casting
All Valves Operated from Upper Dk
Hole Drilled in Bracket to suit Work
Holes Drilled in Brackets to Suit Work
8" Bell Mouth Suction Angled to Clear Brackets
1-8 5/8" Dia Hole
2-3 1/2" Dia Holes
1 1/8" Dia Hole to suit Work
2-1 1/8" Dia Holes to suit Work
Drill 1-1 1/8" Dia Hole to suit Work
2-4 1/4" Holes

10,000-TON D. W. STANDARD TANKER
Sun Shipbuilding Co., Chester, Pa.

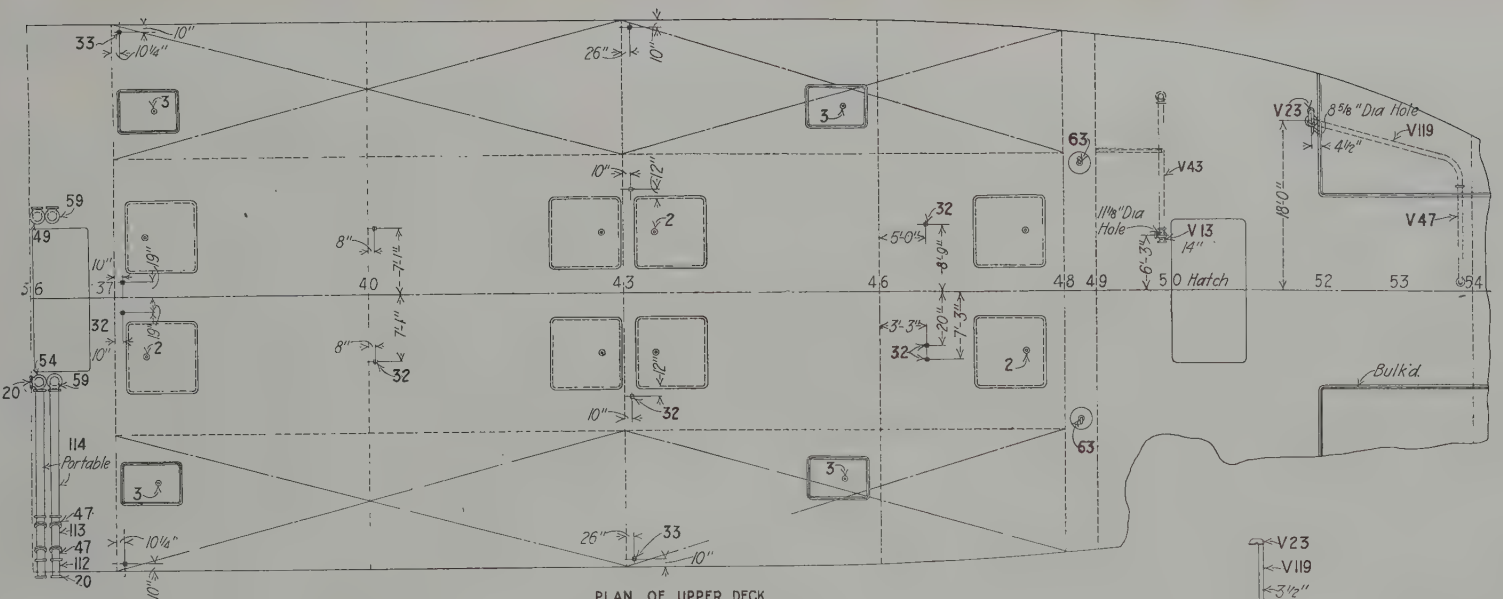
See Pages 614 and 615

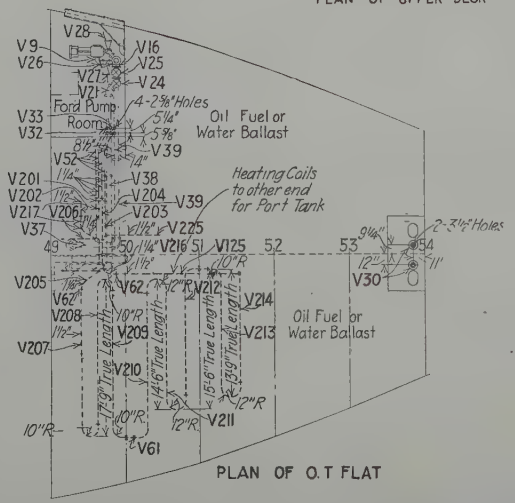


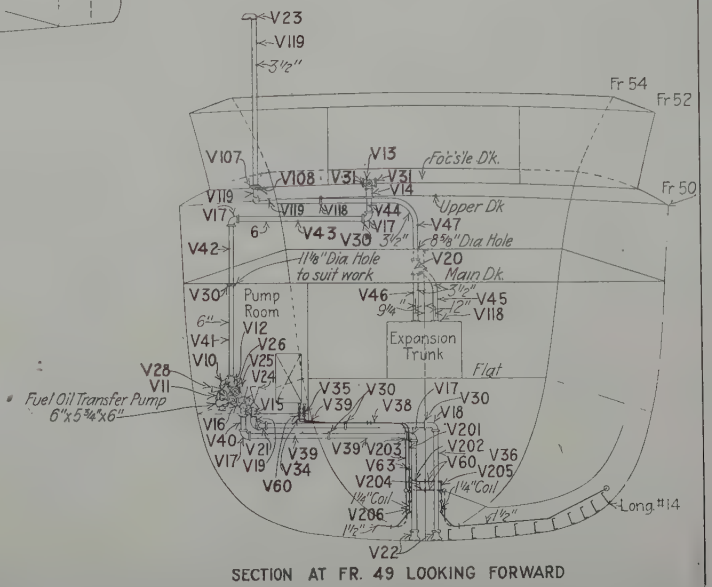
10,000-TON D. W. STANDARD TANKER

Sun Shipbuilding Co., Chester, Pa.

See Pages 614 and 615

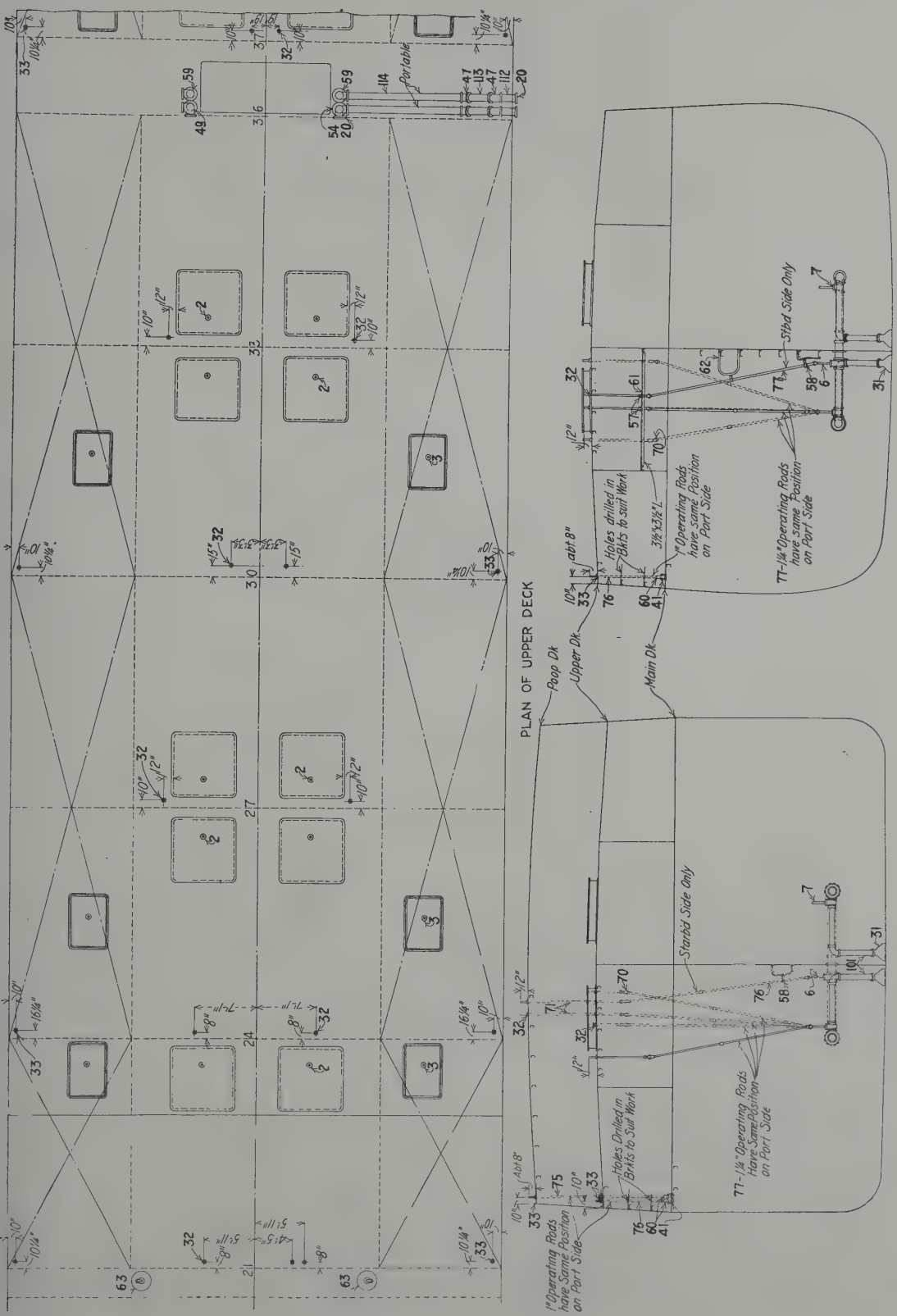






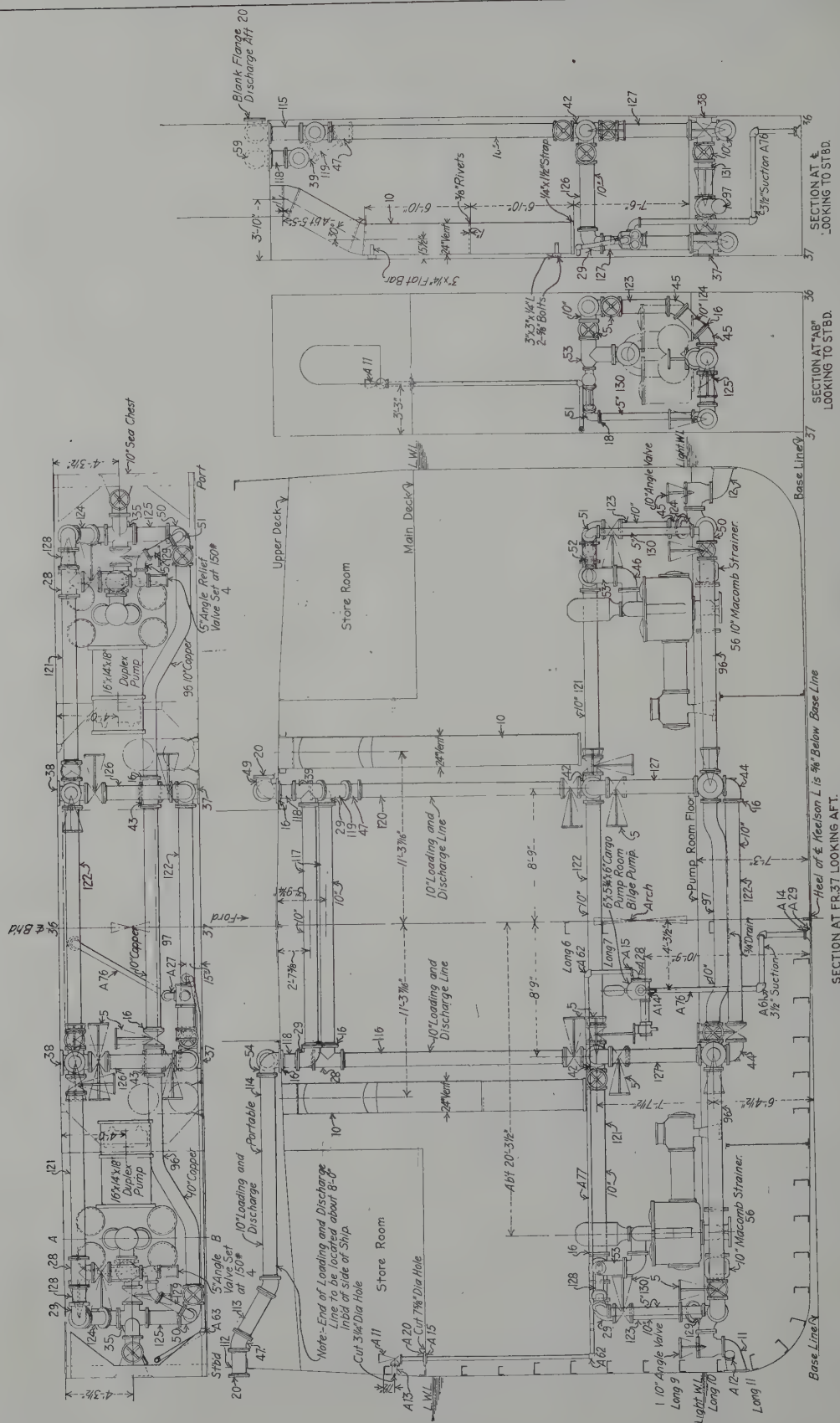
10,000-TON D. W. STANDARD TANKER
Sun Shipbuilding Co., Chester, Pa.

See Pages 614 and 615


PLAN OF UPPER DECK
SECTION AT FR NO 34, LOOKING AFT
SECTION AT FR NO 48, LOOKING AFT
Poop Dk
Upper Dk
Main Dk
Portable
Stbd Side Only
Starbd Side Only
Holes drilled in Brkts to suit Work
1" Operating Rods have same Position on Port Side
77-1/4" Operating Rods have same Position on Port Side

10,000-TON D. W. STANDARD TANKER
Sun Shipbuilding Co., Chester, Pa.

See Pages 614 and 615


Blank Flange Discharge Aft
SECTION AT ℄ LOOKING TO STBD.
SECTION AT "AB" LOOKING TO STBD.
3"x3"x¼" L's 2-⅞" Bolts
3"x¼" Flat Bar
Upper Deck
Main Deck
Store Room
Base Line
Light W.L.
10" Angle Valve
10" Macomb Strainer.
Pump Room Floor
Heel of ℄ Nelson L is ¾" Below Base Line
SECTION AT FR.37 LOOKING AFT.
10,000-TON D. W. STANDARD TANKER
Sun Shipbuilding Co., Chester, Pa.
See Pages 614 and 615
10" Sea Chest
5" Angle Relief Valve Set at 150#
16"x14"x18" Duplex Pump
10" Copper
Port
Ford
Stbd
10" Loading and Discharge
Portable
5" Angle Valve Set at 150#
Note:-End of Loading and Discharge Line to be located about 8'-0" Inbd of side of Ship
Cut 3¼" Dia Hole
Cut 7⅝" Dia Hole
Store Room
10" Loading and Discharge Line
24" Vent
8'-9"
11'-3⅜"
8'-4½"
7'-7½"
6'-10"
6'-0"
4'-3½"
8"x5"x8" Cargo Pump Room Bilge Pump
Arch
Drain
Suction
Long 6
Long 7
Long 9
Long 10
Long 11
1 10" Angle Valve

7,500-TON D. W. CONCRETE TANKER

For Arrangement Plans See Plate XLVI
Opposite Page 624 and Pages 624 and 625

LIST OF MATERIAL FOR ONE SHIP

Pc. No.	No. Pcs.	Name	Material	Working Pressure	Test Pressure	Service	Remarks
V1	34	5" Pressure and vacuum relief valve.	Brass	5 lbs.	5 lbs.	On oil hatches	
V2	4	5" Relief valve, angle type.....	Cast iron body brass mounted.	100 lbs.	200 lbs.	Oil pump discharge	Brass stem, valve seat, valve and gland and outside spring, flanged 10" dia., drill for 8¾" bolts on 8½" P. C.
V3	39	10" Gate valve, stationary stem....	C. I. body brass mounted	125 lbs.	200 lbs.	Oil line	13¾" Face to face double disc. brass seats and stem, brass fitted discs. flanged 16" dia. drilled, 12—⅞" bolts on 14¼" P. C.
V4	26	10" Gate valve, stationary stem....	C. I. body brass mounted	125 lbs.	200 lbs.	In oil tanks	Same as V3, but stem 18" longer than std., flanged 16" dia. drilled, 12—⅞" bolt on 14¼" P. C.
V5	2	10" Angle valve.....	C. I. body brass mounted	125 lbs.	200 lbs.	Sea valves	Brass stem. valve and valve seat 10" centerline to face flanged 16" dia. Inlet not drilled. Outlet drilled, 12—⅞" bolts on 14¼" P. C.
V6	**2**	**10" Angle valve**.....	C. I. body brass mounted	125 lbs.	200 lbs.	Inboard of sea valve	Brass stem, valve and valve seat, 10" centerline to face. Flanged 16" dia. Both ends drilled, 12—⅞" bolts on 14¼" P. C.
V7	8	¾" Steam cock, with lever handle..	Brass	125 lbs.	150 lbs.	Drains	Screwed ends, one end male, other female.
V8	12	4" Gate valve, stationary stem.....	C. I. body brass mounted	125 lbs.	200 lbs	In summer oil tanks	Flanged 9" dia. Drilled for 8—⅝" bolts on 7½" P. C.
V9	30	8" Gate valve, stationary stem.....	C. I. body brass mounted	125 lbs.	200 lbs.	Oil line	Flanged 13½" dia. Drilled for 8—¾" bolts on 11¾" P. C.
P3	5	10" Pipe, standard, 4' 6" long.....	Steel	.....	.....	Where shown	Flanged, faced and drilled. Threaded flanges 16" dia.; drilled 12—⅞" bolts on 14¼" P. C.
P4	13	10" Pipe, standard, 10' 0" long....	Steel	.....	.....	Where shown	Flanged, faced and drilled. Threaded flanges 16" dia.; drilled 12—⅞" bolts on 14¼" P. C.
P5	18	10" Pipe, standard, 12' 0" long....	Steel	.....	.....	Where shown	Flanged, faced and drilled. Threaded flanges 16" dia.; drilled 12—⅞" bolts on 14¼" P. C.
P6	1	10" Pipe, standard, 11' 2" long....	Steel	.....	.....	Where shown	Flanged, faced and drilled. Threaded flanges 16" dia.; drilled 12—⅞" bolts on 14¼" P. C.
P7	1	10" Pipe, standard, 13' 0" long.....	Steel	.....	.....	Where shown	Flanged, faced and drilled. Threaded flanges 16" dia.; drilled 12—⅞" bolts on 14¼" P. C.
P8	1	10" Pipe, standard, 7' 0" long.....	Steel	.....	.....	Where shown	Flanged, faced and drilled. Threaded flanges 16" dia.; drilled 12—⅞" bolts on 14¼" P. C.
P9	2	10" Pipe, standard, 5' 6" long.....	Steel	.....	.....	Where shown	Flanged, faced and drilled. Threaded flanges 16" dia.; drilled 12—⅞" bolts on 14¼" P. C.
P10	5	10" Pipe, standard, 14' 0" long....	Steel	.....	.....	Where shown	Flanged, faced and drilled. Threaded flanges 16" dia.; drilled 12—⅞" bolts on 14¼" P. C.
P11	1	10" Pipe, standard, bend to suit work 9' 6" long.	Steel	.....	.....	Where shown	Flanged, faced and drilled. Threaded flanges 16" dia.; drilled 12—⅞" bolts on 14¼" P. C.
P12	2	10" Pipe, standard, 9' 0" long.....	Steel	.....	.....	Where shown	Flanged, faced and drilled. Threaded flanges 16" dia.; drilled 12—⅞" bolts on 14¼" P. C.
P14	6	10" Pipe, standard, 15' 6" long....	Steel	.....	.....	Where shown	Flanged, faced and drilled. Threaded flanges 16" dia.; drilled 12—⅞" bolts on 14¼" P. C.
P15	2	10" Pipe, standard, 13' 0" long....	Steel	.....	.....	Where shown	Flanged, faced and drilled. Threaded flanges 16" dia.; drilled 12—⅞" bolts on 14¼" P. C.
P16	4	10" Pipe, standard, 11' 8" long....	Steel	.....	.....	Where shown	Flanged, faced and drilled. Threaded flanges 16" dia.; drilled 12—⅞" bolts on 14¼" P. C.
P17	10	10" Pipe, standard, 6' 9" long.....	Steel	.....	.....	Where shown	Flanged, faced and drilled. Threaded flanges 16" dia.; drilled 12—⅞" bolts on 14¼" P. C.
P18	16	10" Pipe, standard, 12' 0" long....	Steel	.....	.....	Where shown	Flanged, faced and drilled. Threaded flanges 16" dia.; drilled 12—⅞" bolts on 14¼" P. C.
P19	2	10" Pipe, standard, 7' 3" long.....	Steel	.....	.....	Where shown	Flanged, faced and drilled. Threaded flanges 16" dia.; drilled 12—⅞" bolts on 14¼" P. C.
P20	4	5" Pipe, standard, 12' 6" long.....	Steel	.....	.....	Cut to suit at relief valve disch.	Flanged faced and drilled; flanges 10" dia; drilled 8—¾" bolts on 8½" P. C.
P21	12	4" Pipe, standard, 12' 0" long.....	Steel	.....	.....	Where shown	
P22	12	4" Pipe, standard, 12' 2" long.....	Steel	.....	.....	Where shown	
P23	2	4" Pipe, standard, 8' 0" long.....	Steel	.....	.....	Where shown	
P23	1	10" Pipe, standard, bend to suit work 12' 0" long.	Steel	.....	.....	Where shown	Flanged, faced and drilled. Threaded flanges 16" dia.; drilled 12—⅞" bolts on 14¼" P. C.

(Continued on next page)

7,500-TON D. W. CONCRETE TANKER

For Arrangement Plans See Plate XLVI
Opposite Page 624 and Pages 624 and 625

LIST OF MATERIAL FOR ONE SHIP—Continued

Pc. No.	No. Pcs.	Name	Material	Working Pressure	Test Pressure	Service	Remarks
P24	12	10" Pipe, standard, 1' 6" long.....	Steel	.....	.....	Port and starboard tanks aft	Flanged, faced and drilled. Threaded flanges 16" dia.; drilled 12—⅞" bolts on 14¼" P. C.
P25	12	10" Pipe, standard, 2' 6" long.....	Steel	.....	.....	Port and starboard tanks forward	Flanged, faced and drilled. Threaded flanges 16" dia.; drilled 12—⅞" bolts on 14¼" P. C.
F1	4	6" Dial pressure gauge, graduated 1 to 250 lbs.	Brass	.....	.....	On discharge at gauge board	Complete with siphon and stop cock.
F2	4	6" Dial vacuum gauge.....	Brass	.....	.....	On suction at gauge board	Complete with siphon and stop cock.
F3	2	Gauge board.....	Yellow pine.....	.....	.....		
F4	40	¼" Elbows, screwed.....	C. I.....	.....	.....	For gauge lines	
F5	34	Stuffing boxes.....	Brass	.....	.....	Operating gear at decks	
F6	28	Universal joint for 1¼" rod.....	Steel jaws, brass blocks	.....	.....	Valve operating gear	
F7	54	Coupling, for 1¼" rod.....	Steel	.....	.....	Valve operating gear	
F8	34	Collar, for 1¼" rod.....	Steel	.....	.....	Valve operating gear	
F9	35	1¼" Dia. rods, 32' 0" long.....	Steel	.....	.....		
F10	68	1¼" Pipe locknuts.....	Brass	.....	.....	Valve operating gear	
F11	500	Gaskets for 10" pipe.....	⅛" Trunk-board.	.....	.....	Flange joints	16" O. D. 10" I. D. ⅛" thick. Soaked in linseed oil. 12—1" bolt holes on 14¼" P. C.
F12	50	Gaskets for 8" pipe.....	⅛" Trunk-board.	.....	.....	Flange joints	13½" O. D. 8" I. D. ⅛" thick. Soaked in linseed oil. 8—⅞" bolt holes on 11¾" P. C.
F13	20	Gaskets for 6" pipe.....	⅛" Trunk-board.	.....	.....	Flange joints	11" O. D. 6" I. D. ⅛" thick. Soaked in linseed oil. 8—⅞" bolt holes on 9½" P. C.
F14	24	Gaskets for 5" pipe.....	⅛" Trunk-board.	.....	.....	Flange joints	10" O. D. 5" I. D. ⅛" thick. Soaked in linseed oil. 8—⅞" bolt holes on 8½" P. C.
F15	700	¾" Bolts hex. head and nut, 3¼" long.	Steel	.....	.....	For 8", 6" and 5" pipe	Hex. heads and nuts.
F16	5800	⅞" Bolts hex. head and nut, 3½" long.	Steel	.....	.....	For 10" pipe	Hex. heads and nuts.
F17	4	Strainer box.....	C. I.....	.....	.....	Pump suction	1 Spare strainer per box.
F18	18	10" Bulkhead connection.....	C. I.....	.....	.....	Where shown	
F20	16	10" Stuffing box.....	C. I.....	.....	.....	In holds where shown	Box cast iron; gland brass; pipe ex. strong steel; flange C. I.
F21	12	10" Bellmouth, long.....	C. I.....	.....	.....	Wing tank suction	
F22	12	10" Bellmouth, short.....	C. I.....	.....	.....	Center suction	
F23	60	10" Elbow, 90°, standard.....	C. I.....	125 lbs.	.....	Where shown	11" Centerline to face, flanges 16" dia. × 1 3/16" thick. Drilled 12—⅞" bolts on 14¼" P. C.
F23A	3	10" Long rad. elbow 90°, standard.	C. I.....	125 lbs.	.....	Where shown	16½" Centerline to face, flanges 16" dia. x 1 3/16" thick. Drilled 12—⅞" bolts on 14¼" P. C.
F24	4	10" Elbow, 90°, standard.....	C. I.....	125 lbs.	.....	Where shown	16½" Centerline to face, flanges 16" dia. × 1 3/16" thick. Face not drilled.
F25	4	10" Elbow, 90°.....	C. I.....	125 lbs.	.....	Where shown	Drilled 12—⅞" bolts on 14¼" P. C.
F26	3	10" Elbow, 90° with 5" side outlet.	C. I.....	125 lbs.	.....	Where shown	
F27	4	10" Elbow, 45°, standard.....	C. I.....	125 lbs.	.....	Where shown	6¼" Centerline to face, flanges 16" dia. × 1 3/16" thick. Drilled 12—⅞" bolts on 14¼" P. C.
F28	15	10" x 8" Y special.....	C. I.....	125 lbs.	.....	Where shown	
F29	15	8" x 6" Reducer, standard.....	C. I.....	125 lbs.	.....	Where shown	
F30	4	10" x 8" Reducer, standard.....	C. I.....	125 lbs.	.....	Spares	12" Face to face; 10" flange 16" dia. × 1 3/16" thick. Drilled 12—⅞" bolts on 14¼" P. C.; 8" flange 13½" dia. × 1½" thick. Drilled 8—¾" bolts on 11¾" P. C.
F31	16	8" x 6" Reducer, standard.....	C. I.....	125 lbs.	.....	Spares	11" Face to face; 8" flange 13¼" dia. × 1⅛" thick. Drilled 8—¾" bolts on 11¾" P. C; 6" flange, 11" dia. × 1" thick, drilled 8—¾" bolts on 9½" P. C.
F32	8	10" x 8" Breeches piece.....	C. I.....	125 lbs.	.....	Spares	
F33	4	8" Tee, standard.....	C. I.....	125 lbs.	.....	Deck filling connections	9" Centerline to face, flanges 13½" dia. × 1⅛" thick. Drilled 8—¾" bolts on 11¾" P. C.
F34	24	10" Tee, standard.....	C. I.....	125 lbs.	.....	Where shown	11" Centerline to face, flanges 16" dia. × 1 3/16" thick. Drilled 12—⅞" bolts on 14¼" P. C.
F35	1	10" Tee, standard.....	C. I.....	125 lbs.	.....	Where shown	11" Centerline to face, flanges 16" dia. × 1 3/16" thick. Face not drilled.
F36	16	10" Tee, with 10" side outlet, standard.	C. I.....	125 lbs.	.....	Where shown	11" Centerline to face, flanges 16" dia. × 1 3/16" thick, drilled 12—⅞" bolts on 14¼" P. C.; 6 with ends not drilled.

(Continued on Next Page)

7,500-TON D. W. CONCRETE TANKER

For Arrangement Plans See Plate XLVI
Opposite Page 624 and Pages 624 and 625

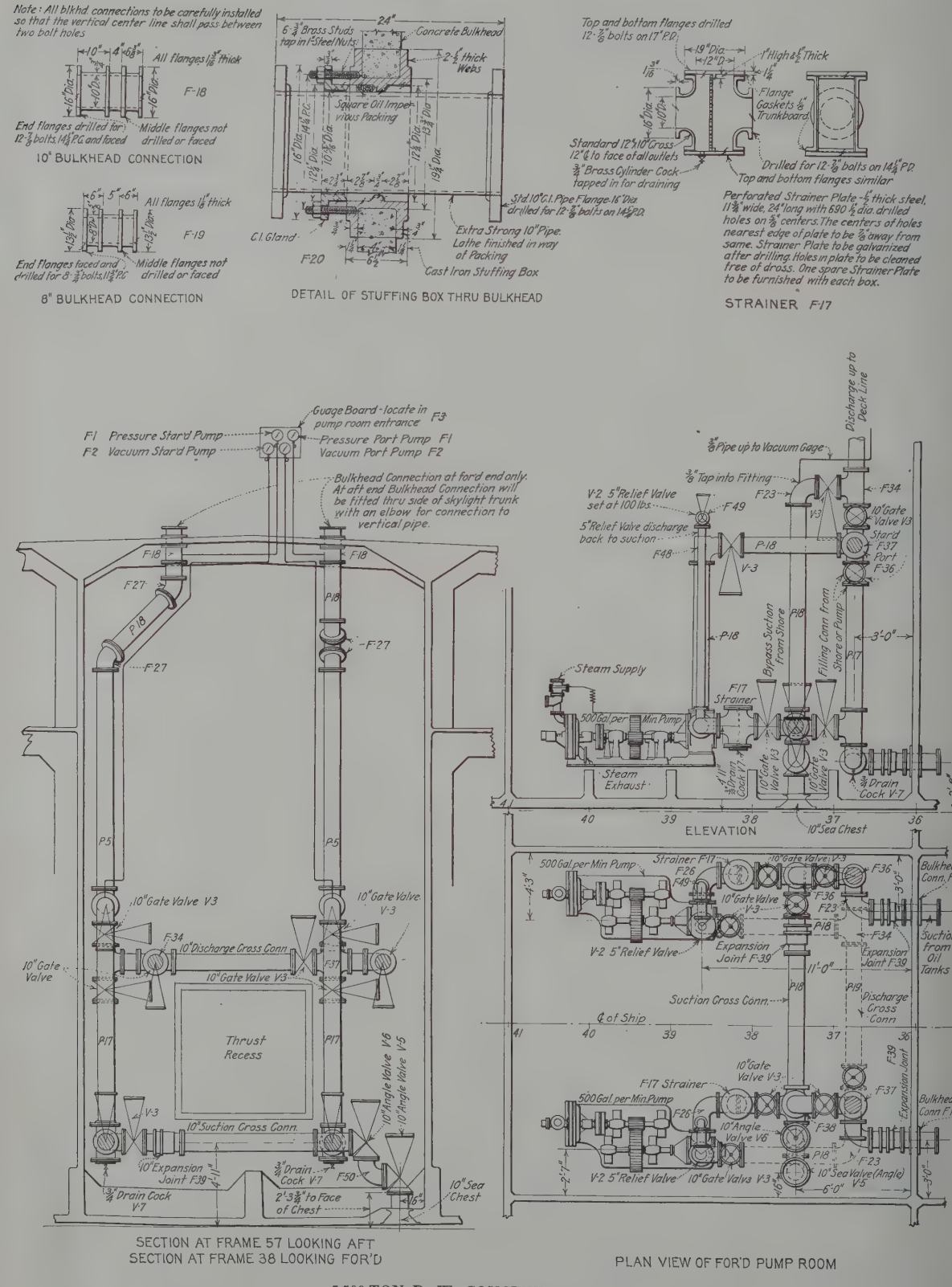
LIST OF MATERIAL FOR ONE SHIP—Continued

Pc. No.	No. Pcs.	Name	Material	Working Pressure	Test Pressure	Service	Remarks
F37	5	10" Cross standard	C. I.	125 lbs.	.....	Where shown	11" Centerline to face; flanges 16" dia. × 1 3/16" thick, drilled 12—7/8" bolts on 14¼" P. C.
F38	2	10" Cross with 10" side outlet, standard.	C. I.	125 lbs.	.....	Where shown	11" Centerline to face; flanges 16" dia. × 1 3/16" thick. Drilled 12—7/8" bolts on 14¼" P. C.
F39	14	10" Expansion joint	C. I., brass mounted	125 lbs.	.....	Where shown	C. I. body, brass fitted gland; sliding section extra strong steel pipe, brass studs, packing oil impervious. To contract to 17½" and expand to 25½" with all bolts in place; flanges 16" dia. drilled 12—7/8" bolts on 14¼" P. C.
F40	34	10" Ullage plate	.....	125 lbs.	.....	Oil hatches	
F41	1	10" Special elbow with 5" side outlet.	C. I.	125 lbs.	.....	At pump	
F42	100	¾" Bolts and nuts, 18" long	Steel	.....	.....	Operating rod supports	For operating gear supports.
F43	250	¼" Steel cotter pins	Steel	.....	.....	Operating gear	At couplings and universal joints.
F44	130 ft.	4½" x ⅜" supports for operating gear.	Flat steel	.....	.....		
F45	1	10" Expansion joint	C. I., brass mounted	.....	.....		Generally similar to F-39, but with anchor bolts to prevent slide drawing out. Minimum length, 24".
F46	4	8" Elbow, standard	C. I.	125 lbs.	.....	Spares	9" Centerline to face, flanges 13½" ; dia. 1⅛" thick, drilled 8—¾" bolts on 11¾" P. C.
F47	2	10" Elbow with 2" heel outlet	C. I.	125 lbs.	.....	Steam blow-outs in end tanks	11" Centerline to face, 10" flanges 16" dia., 1 3/16" thick, drilled 12—7/8" bolts on 14¼" P. C.; 2" flange 6" dia. × 5/8" thick, drilled 4—5/8" bolts on 4¾" P. C.
F48	4	10" x 5" x 10" Tee, standard	C. I.	125 lbs.	.....	Pump disch.	11" Centerline to face 10" flanges 16" dia. 1 3/16" thick. Drilled 12—7/8" bolts on 14¼" P. C.; 5" flange 10" dia. 1⅛" thick. Drilled 8—¾" bolts on 8½" P. C.
F49	4	5" Elbow, standard	C. I.	125 lbs.	.....	Relief valve discharge	7½" Centerline to face, flanges 10" dia., 1⅛" thick, drilled 8—¾" bolts on 8½" P. C.
F50	2	10" Elbow, standard	C. I.	125 lbs.	.....	At sea valves	Flanges 16" dia., finished rough, not faced or drilled, but cast so as to finish 11" centerline.
F51	62	Label plate .050" thick	Brass	.....	.....	On valve wheels	
F52	16	5" Pipe flanges, threaded	C. I.	.....	.....		16" dia. 1 3/16" thick, threaded, drilled 12—7/8" bolts on 14¼" P. C.
F53	206	10" Pipe flanges, threaded	C. I.	.....	.....		10" dia. 15/16" thick, threaded, drilled 8—¾" bolts on 8½" P. C.
F54	200 ft.	8" Oil hose flexible	Galv. steel	.....	.....	Portable	In 10' lengths, flanged 13½" dia., drilled 8—¾" bolts on 11¾" P. C.
F55	12	10" x 4" x 10" Tee, standard	C. I.	.....	.....	Where shown	
F56	4	3" x 3" x ⅜" Angle, 4' 9" long	Steel	.....	.....	8" deck filling connection	
F57	16	½" Anchor bolts and nuts with washers.	Steel	.....	.....	8" deck filling connection	
F58	12	4" Bellmouth	Steel	.....	.....	Summer tank suction	
F59	12	4" Bulkhead stuffing box	C. I.	.....	.....	Summer tank suction	
F60	12	¾" Steel rod, 8' 0" long	Steel	.....	.....	Valve operating gear	
F61	12	¾" Deck stuffing box	Brass	.....	.....	Valve operating gear	
F62	4	4" Standard ells	C. I.	.....	.....	Summer tank suction	
F63	24	¾" Coupling	Steel	.....	.....	Valve operating gear	
F64	64	4" Standard flange	C. I.	.....	.....	Summer tank suction	Drilled for 8⅝" bolts on 7½" P. C.
F65	525	⅝" Bolts hex. head and nuts, 2¾" long.	Steel	.....	.....	Summer tank suction	
F66	4	¾" U-bolts	Steel	.....	.....	8" deck filling connection	

GENERAL NOTES

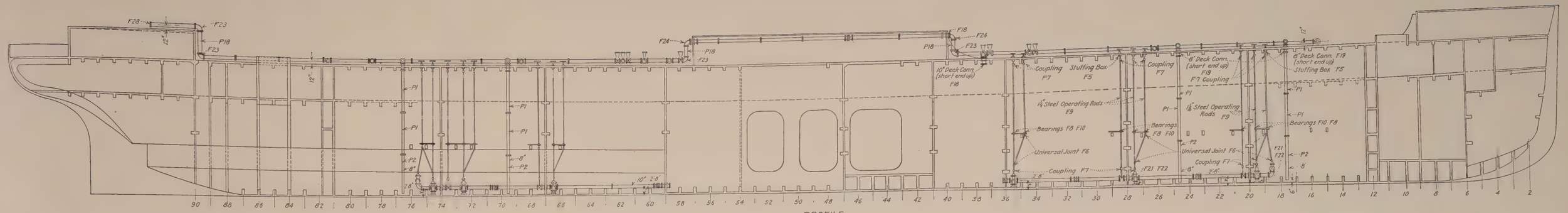
1. Piping in holds should, if possible, be fitted up in place complete before structure is poured, to avoid possibility of errors in alignment.
2. All outlets on weather deck to be fitted with blank flanges.
3. All piping, standard steel pipe, black.
4. All bolts and nuts steel, black.
5. All fittings, cast iron.
6. All gate valves, cast iron bodies, brass mounted, stationary stems.
7. All flanges, cast iron, screwed on. Flanges and drilling American standard, spot faced only where necessary to obtain oil tightness.
8. Flange gaskets ⅛" trunkboard, soaked in linseed oil.
9. Operating rods, 1¼" dia. steel, with steel couplings.
10. Universal joints with brass blocks to be fitted where necessary.
11. Bearings brass bushed.
12. All necessary stools, hangers, straps and brass name-plates to be fitted complete.
13. Suction and discharge piping to be tested to 150 lbs. per sq. in. hydraulic pressure, and to be absolutely tight for 12 hours.

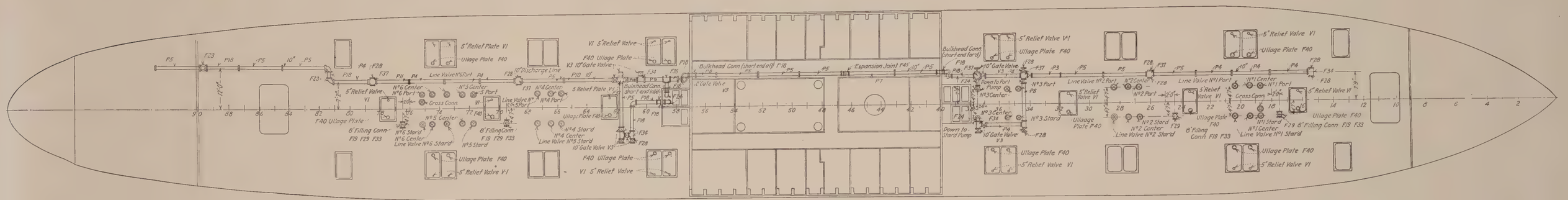
ARRANGEMENT OF OIL PUMPING SYSTEM IN PUMP ROOMS

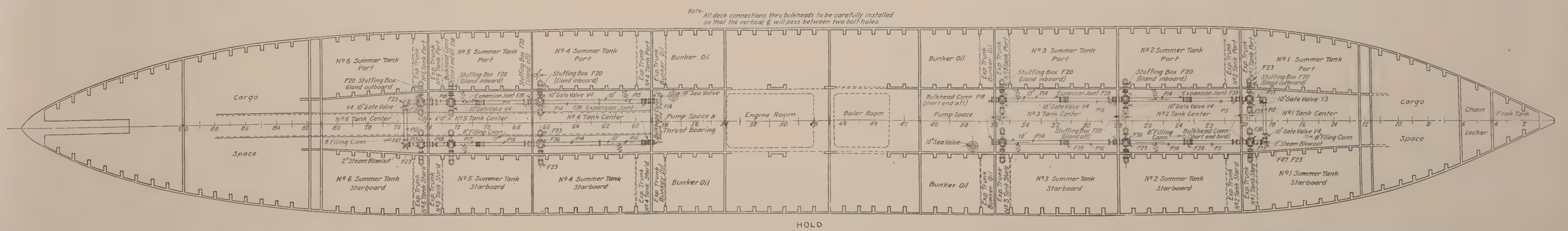

Note: All blkhd connections to be carefully installed so that the vertical center line shall pass between two bolt holes
All flanges 1 1/16" thick
F-18
End flanges drilled for 12-7/8 bolts, 14 1/4" P.C. and faced
Middle flanges not drilled or faced
10" BULKHEAD CONNECTION
All flanges 1 1/8" thick
F-19
End flanges faced and drilled for 8-3/4 bolts, 11 1/2" P.C.
Middle flanges not drilled or faced
8" BULKHEAD CONNECTION
6-3/4" Brass Studs tap in 1" Steel Nuts
Concrete Bulkhead
2-1/2" thick Webs
Square Oil Impervious Packing
C.I. Gland
F-20
Extra Strong 10" Pipe. Lathe finished in way of Packing
Cast Iron Stuffing Box
Std. 10" C.I. Pipe Flange 16" Dia. drilled for 12-7/8 bolts on 14 1/4" P.D.
DETAIL OF STUFFING BOX THRU BULKHEAD
Top and bottom flanges drilled 12-7/8 bolts on 17" P.D.
Standard 12"x10" Cross 12" ℄ to face of all outlets
3/4" Brass Cylinder Cock tapped in for draining
Drilled for 12-7/8 bolts on 14 1/4" P.D.
Top and bottom flanges similar
Flange Gaskets 1/8" Trunkboard
Perforated Strainer Plate, 1/4" thick steel, 11 3/8" wide, 24" long with 690 1/2" dia. drilled holes on 5/8" centers. The centers of holes nearest edge of plate to be 1/8" away from same. Strainer Plate to be galvanized after drilling. Holes in plate to be cleaned free of dross. One spare Strainer Plate to be furnished with each box.
STRAINER F-17
Guage Board - locate in pump room entrance F3
F1 Pressure Stand'd Pump
F2 Vacuum Stand'd Pump
Pressure Port Pump F1
Vacuum Port Pump F2
Bulkhead Connection at for'd end only. At aft end Bulkhead Connection will be fitted thru side of skylight trunk with an elbow for connection to vertical pipe.
Discharge up to Deck Line
3/8" Pipe up to Vacuum Gage
3/8" Tap into Fitting
V-2 5" Relief Valve set at 100 lbs.
5" Relief Valve discharge back to suction
10" Gate Valve V-3
Stand'd F-37
Port F-36
Bypass Suction from Shore
Filling Conn from Shore or Pump
Steam Supply
F17 Strainer
500 Gal. per Min. Pump
Steam Exhaust
3/4" Drain Cock V-7
ELEVATION
10" Sea Chest
Strainer F-17
10" Gate Valve V-3
Bulkhead Conn. F18
Suction from Oil Tanks
Expansion Joint F-39
V-2 5" Relief Valve
Suction Cross Conn.
Discharge Cross Conn
℄ of Ship
Thrust Recess
10" Gate Valve
10" Discharge Cross Conn.
10" Angle Valve V6
10" Angle Valve V5
10" Suction Cross Conn.
10" Expansion Joint F-39
3/4" Drain Cock V-7
2'-3 3/4" to Face of Chest
10" Sea Valve (Angle) V-5
SECTION AT FRAME 57 LOOKING AFT
SECTION AT FRAME 38 LOOKING FOR'D
PLAN VIEW OF FOR'D PUMP ROOM

7,500-TON D. W. CONCRETE TANKER

See Pages 621, 622 and 623



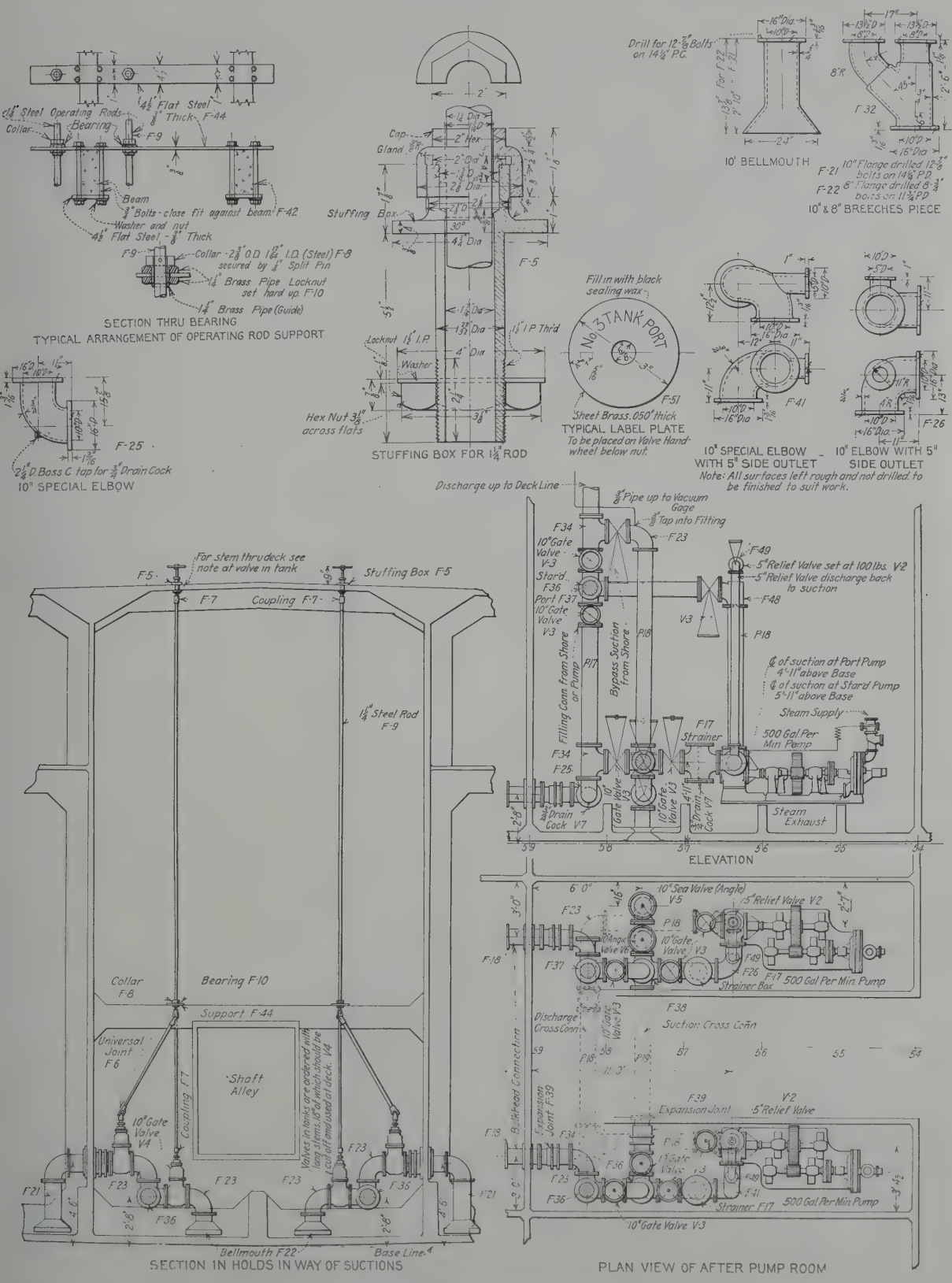



Note- All deck connections thru bulkheads to be carefully installed so that the vertical ℄ will pass between two bolt holes
HOLD

ARRANGEMENT OF OIL PUMPING SYSTEM
7,500-TON D. W. CONCRETE TANKER

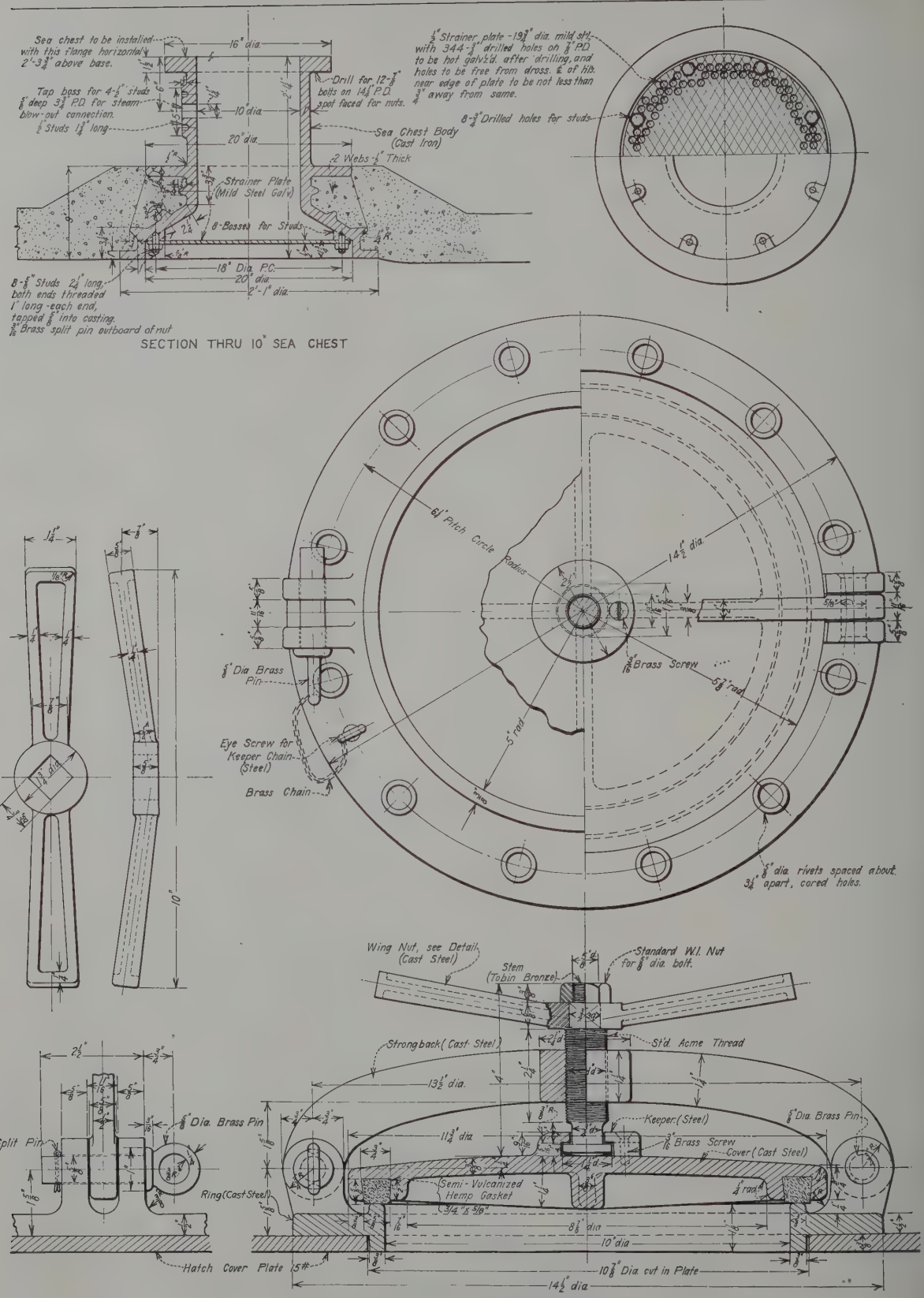
PLATE XLVI

ARRANGEMENT OF OIL PUMPING SYSTEM IN PUMP ROOMS


SECTION THRU BEARING
TYPICAL ARRANGEMENT OF OPERATING ROD SUPPORT
STUFFING BOX FOR 1¼" ROD
TYPICAL LABEL PLATE
10" BELLMOUTH
10" & 8" BREECHES PIECE
10" SPECIAL ELBOW
10" SPECIAL ELBOW WITH 5" SIDE OUTLET
10" ELBOW WITH 5" SIDE OUTLET
Note: All surfaces left rough and not drilled to be finished to suit work.
ELEVATION
PLAN VIEW OF AFTER PUMP ROOM
SECTION IN HOLDS IN WAY OF SUCTIONS

7,500-TON D. W. CONCRETE TANKER

See Pages 621, 622 and 623


Sea chest to be installed with this flange horizontal 2'-3¾" above base.
16" dia.
Tap boss for 4-½" studs ⅝" deep 3¾" P.D. for steam blow-out connection.
8 Studs 1¼" long
10" dia.
Drill for 12-⅞" bolts on 14¼" P.D. spot faced for nuts.
20" dia.
Sea Chest Body (Cast Iron)
2 Webs-½" Thick
Strainer Plate (Mild Steel Galv'd)
8-Bosses for Studs
18" Dia. P.C.
20" dia.
2'-1" dia.
8-⅞" Studs 2¼" long both ends threaded 1" long each end, tapped ⅝" into casting.
⅜" Brass split pin outboard of nut
SECTION THRU 10" SEA CHEST
½" Strainer plate - 19⅜" dia. mild st'l. with 344-⅜" drilled holes on ¾" P.D. to be hot galv'd. after drilling, and holes to be free from dross. ¢ of hls. near edge of plate to be not less than ¾" away from same.
8-¾" Drilled holes for studs
6¼" Pitch Circle Radius
14½" dia.
⅜" Brass Screw
5⅞" rad
5" rad
⅝" Dia Brass Pin
Eye Screw for Keeper Chain (Steel)
Brass Chain
⅝" dia. rivets spaced about 3¼" apart, cored holes.
10'
Wing Nut, see Detail (Cast Steel)
Stem (Tobin Bronze)
Standard W.I. Nut for ⅝" dia. bolt.
Strongback (Cast Steel)
St'd. Acme Thread
13½" dia.
Keeper (Steel)
⅝" Dia. Brass Pin
11¾" dia.
⅜" Brass Screw
Cover (Cast Steel)
Split Pin
Ring (Cast Steel)
Semi-Vulcanized Hemp Gasket
¼ rad
8⅝" dia
10" dia
Hatch Cover Plate 15#
10⅜" Dia. cut in Plate
14½" dia

SEA CHEST AND ULLAGE PLATE
7,500-TON D. W. CONCRETE TANKER

9,000-TON D. W. FREIGHTER

For Arrangement Plans See Plates XLVII and XLVIII
Opposite Page 630

LIST OF VALVES FOR ONE SHIP

Pc.No.	No.Pcs.	Name.	Mat'l.	Remarks.
J 42	1	7" Globe stop valve flanged.	C.I...	Exh. to aux. cond.
J 43	1	7" Angle stop valve flanged.	C.I...	Exh. to atmosph.
J 44	1	6" Angle stop valve flanged.	C.I...	Exh. to main cond.
J 45	1	7" Back press. valve flanged.	C.I...	Exh. to aux. cond.
J 46	1	6" Back press. valve flanged.	C.I...	Exh. to main cond.
J 47	1	5" Globe stop valve flanged.	C.I...	Exh. to feed water heater.
J 48	2	5" Angle stop valve flanged.	C.I...	Exh. to L. P. turb. exh. from main circ. pump.
J 49	1	4" Globe stop valve flanged..	C.I...	Exh. from evap. to main cond.
J 50	1	4" Globe stop valve flanged..	Ferro-steel.	Aux. steam, ex. h'vy.
J 51	1	4" Reducing valve flanged..	Ferro-steel.	Aux. steam, 200 lbs. to 100 lbs.
J 52	1	3" Globe stop valve flanged..	Ferro-steel	St. to main feed pump, feed wat. heat., air ejs., etc., extra h'vy.
J 53	1	2½" Globe stop valve flanged	Ferro-steel	St. to inj., generators, fuel oil pumps and heaters, ex. h'vy.
J 54	2	2½" Globe stop valve flanged	C.I...	Exh. from generators.
J 55	6	2½" Angle stop valve flanged	C.I...	Exh. from 2 blowers, 2 main feed pumps, 1 ballast pump, 1 F. & B. pump.
J 56	6	2" Globe stop valve scr'd...	Brass.	St. to 2 blowers, injector, 1 evap., 1 ballast, 1 f. & b. pump, ex. h'y.
J 57	3	2" Globe stop valve scr'd...	Brass.	Exh. from 1 aux. air and circ. pump, 2 cond. pumps.
J 58	5	1½" Globe stop valve scr'd.	Brass.	St. to 5 main feed pumps, 1 ballast manifold, 1 aft heat., coils ex. heavy.
J 59	2	1½" Angle stop valve scr'd.	Brass.	St. to 3 main feed pumps, ex. h'vy.
J 60	1	1½" Chronometer valve scr'd.	Brass.	St. to 3 Main feed pumps. ex. h'v'y.
J 61	3	1½" Globe stop valve scr'd.	Brass.	Exh. from 1 fuel oil trans. pump, 1 ash hoist, 1 ice machine.
J 62	2	1¼" Globe stop valve scr'd.	Brass.	Exh. from 1 san. pump, 1 aux. oil pump.
J 63	2	1¼" Globe stop valve scr'd.	Brass.	St. to 1 aux. air and circ. pump, 1 fuel oil trans. pump, ex. h'vy.
J 64	1	1¼" Angle stop valve scr'd.	Brass.	Exh. from eng. room bilge pump.
J 65	11	1" Globe stop valve scr'd...	Brass.	St. to 1 feed wat. heat., 2 fuel oil heaters, 2 cond. pumps, 1 ice mach., 1 ash hoist, 1 main cond., 1 san. pump, 1 engr. bilge pump, 1 aux. oil pump, ex. heavy.
J 66	1	1" Angle stop valve scr'd..	Brass.	Exh. from evap. feed pump.
J 67	2	1" Globe stop valve scr'd...	Brass.	Exh. from fuel oil pumps.
J 68	7	¾" Globe stop valve scr'd..	Brass.	St. to 1 evap. feed pump, 6 fuel oil pumps, extra heavy.
J 69	1	¾" Globe stop valve scr'd..	Brass.	Exh. from fresh water pump.
J 70	2	¾" Governor valve scr'd...	Brass.	St. to fuel oil pumps.
J 71	2	½" Globe stop valve scr'd..	Brass.	St. to fresh water pump, 1 drain from st. line to f. & f. tank, ex. h'vy.
J 72	1	½" Relief valve scr'd.....	Brass.	Aux. steam, set at 105 lbs. per sq. in.
J347	2	1" Cross stop valve scr'd...	Brass.	St. to aux. oil pump, by-pass.
J 5	1	1¼" Globe valve scr'd.....	Brass.	St. to main circ. sea chest.

LIST OF VALVES FOR ONE SHIP—Continued

Pc.No.	No.Pcs.	Name.	Mat'l.	Remarks.
J 21	1	¾" Globe valve scr'd.....	Brass.	St. to ballast sea chest.
J350	1	Steam press. gage: 6" dial...	I. case brass ring.	To register 200 lbs. per sq. in.
K316	1	4" Globe stop valve fl'g'd...	Ferro-steel.	Steam to deck mach., ex. h'vy.
K317	1	4" Reducing valve flanged..	Ferro-steel.	Steam to deck mach.
K318	1	½" Relief valve scr'd.....	Brass.	Steam to deck mach., set at 105 lbs. per sq. in.
K486	1	Steam press gage: 6" dial..	I. case brass ring.	To register 200 lbs. per sq. in.
L127	1	1½" Globe stop valve scr'd.	Brass.	Steam to heating system, ex. h'vy.
L128	1	1½" Angle stop valve scr'd.	Brass.	Steam to heating system, ex. h'vy.
L129	1	1½" Reducing valve scr'd...	Brass.	Steam to heating system, 100 lbs. to 30 lbs.
L130	1	1¼" Globe stop valve scr'd.	Brass.	Steam to heating system, extra heavy.
L131	1	1¼" Angle stop valve scr'd..	Brass.	Steam to heating system.
L132	1	½" Relief valve scr'd.....	Brass.	Steam to heating system, set at 35 lbs. per sq. in.
L149	1	Steam press. gage: 5" dial scr'd.	I. case brass ring.	To register 100 lbs. per sq. in.

LIST OF CAST FITTINGS FOR ONE SHIP

J126	1	6" Std. Ell, extra heavy...	C.I...	Aux. steam.
J127	1	4" Std. Ell-Bosses, ¼ and ½" P. T., extra heavy.....	C.I...	Aux. steam.
J128	1	3"x1½"x2½" Tee, ex. h'vy..	C.I...	St. to blowers, ash hoist, Ford. heating coils.
J129	1	3" Std. Ell-Boss 1½" P. T., extra heavy	C.I...	St. to steer. eng., aft heat. coils.
J130	1	2½" St. Ell-Boss, 1¼" P. T., extra heavy	C.I...	St. to main circ. pump, cond. pumps, air ejectors.
J131	1	3" Std. Ell-Boss 1" P. T., extra heavy	C.I...	St. to aux. oil pump, steer. eng., aft heat coils.
J132	2	2½" Std. Ell-Boss, 1" P. T., extra heavy	C.I...	St. to blowers, ash hoist, feed wat. heat, air ejs., cond. pumps, main circ. pump.
J133	1	3" Std. Ell, extra heavy....	C.I...	St. to san. and f. w. pumps, ice mach., aux. oil pump, steer eng., aft heat coils.
J134	1	6"x4"x4"x4" Cross, ex. h'vy.	C.I...	Aux. steam.
J135	1	3½"x2½"x3"x2½" Cross, extra heavy	C.I...	Aux. steam.
J136	1	2½"x1¼"x2"x1¼" Cross, extra heavy	C.I...	St. to aux. air and circ. pump, ballast pump, fuel oil trans. pump.
J137	1	2½"x2"x1½"x1" Cross, extra heavy	C.I...	St. to f. & b. pump, ballast manifold sea chest, bilge pump.
J138	1	3"x2½"x4" Tee-Boss, ½" P. T., extra heavy.....	C.I...	Aux. steam.
J139	1	3½"x3"x2" Tee, extra heavy	C.I...	Aux. steam.
J282	1	3½"x3½"x4" Tee, ex. h'vy.	C.I...	Aux. steam.
J140	1	3"x2½"x1½" Tee, ex. h'vy.	C.I...	St. to main feed pump, feed wat. heat., air ejs., cond. pumps, main circ. pump.
J141	1	3"x3"x1½" Tee, ex. heavy.	C.I...	St. to san. and f. w. pumps, ice mach., steer. eng., aux. oil pump, aft heat. coils.

(Continued on Next Page)

9,000-TON D. W. FREIGHTER

For Arrangement Plans See Plates XLVII and XLVIII
Opposite Page 630

LIST OF CAST FITTINGS FOR ONE SHIP—Continued

Pc.No.	No.Pcs.	Name.	Mat'l.	Remarks.
J142	1	2½"x2"x2" Tee, ex. heavy.	C.I...	St. to blowers.
J143	1	2½"x1"x2" Tee, ex. heavy.	C.I...	St. to main circ. pump, cond. pumps.
J144	1	2"x2"x2½" Tee, ex. heavy.	C.I...	St. to ejectors, generators, fuel oil pumps and heaters.
J145	2	7" Std. Ell.....	C.I...	Exh. to aux. cond. and exh. to atmosphere.
J146	1	6" Std. Ell.....	C.I...	Exh. to main cond.
J147	1	5" Std. Ell.....	C.I...	Exh. from main circ. pump.
J148	1	5" Std. Ell-Boss, 2" P. T..	C.I...	Exh. from main circ. pump, cond. pumps.
J149	1	6" Std. Ell-Boss, 1¼" P. T.	C.I...	Exh. from ford. dk. mach., ash hoist, blowers, fuel oil pumps.
J150	1	5" Long Rad. Ell.....	C.I...	Exh. from main circ. pump, cond. pump.
J151	3	4" Std. Ell.....	C.I...	Exh. from evap. to main cond.
J152	1	3½" Std. Ell.....	C.I...	Exh. from san. and f. w. pump, ice mach., steer. eng., aux. oil pump.
J153	1	3" Std. Ell-Boss, 1¼" P. T.	C.I...	Exh. from steer. eng., aux. oil pump.
J154	1	3" Std. Ell.....	C.I...	Exh. from steer. eng.
J281	1	2½" Std. Ell-Boss, 1¼" P. T.	C.I...	Exh. from fire and bilge pump, eng. room bilge pump.
J155	1	7"x6"x4" Tee-Boss, 1½" P. T.	C.I...	To aux. cond.
J156	1	6"x6"x7" Tee	C.I...	Exh. to atmosph.
J157	2	6"x6"x6" Tees	C.I...	Aux. exh. line.
J158	1	6"x5"x6" Tee-Boss, 1" P. T.	C.I...	Exh. to main cond.
J159	1	6"x5"x6" Tee	C.I...	Exh. to feed water heat.
J160	1	6"x5"x5" Tee	C.I...	Exh. from main circ. pump, cond. pumps, generators.
J161	1	6"x5"x3" Tee	C.I...	Exh. from ford. dk. mach., ash hoist, blowers.
J162	1	5"x2½"x5" Tee	C.I...	Exh. to feed water heater.
J283	1	5"x2½"x5" Tee-Boss, ¾" P. T.	C.I...	Exh. to l. p. turbine.
J163	1	4½"x3½"x5" Tee	C.I...	Exh. from aft dk. mach., steer. eng., ice mach., etc.
J164	1	4"x2½"x2½" Tee-Boss, 2" P.T.	C.I...	Exh. from aux. air and circ. pump, ballast pump, fire and bilge pump, eng. room bilge pump.
J165	1	3½"x3"x2" Tee	C.I...	Exh. from san. & f. w. pumps, ice mach., steer. eng., aux. oil pump.
J166	1	3"x2½"x2½" Tee	C.I...	Exh. from blowers.
J167	2	2½"x2½"x2½" Tee	C.I...	Exh. from main feed pumps. generators.
J168	1	Special casting	C.I...	Escape to atmosphere from boilers.
J169	1	Special casting	Comp.	St. to whistle.
J170	1	Special casting	Comp.	St. to whistle.
K319	1	4½" Long rad. Ell-Bosses, ¼" and ½" P. T.....	C.I...	St. to deck mach.
K320	1	4" Long rad. Ell.....	C.I...	St. to deck mach., ford.
K321	1	4" Std. Ell.....	C.I...	St. to deck mach., ford.
K322	1	3½" Std. Ell.....	C.I...	St. to deck mach., aft.
K323	1	3½"x4"x4½" Tee	C.I...	St. to deck mach.
K324	1	4½" Std. Ell.....	C.I...	Exh. from deck mach., aft.

LIST OF SCREWED FITTINGS FOR ONE SHIP

Pc.No.	No.Pcs.	Name.	Mat'l.	Remarks.
J 75	18	2" Ell 90° screwed, ex. h'vy.	C.I...	St. to main circ. pump 3, evap. 3, blowers 5, ballast pump 3, fire and bilge pump 2, generators 2.
J 76	20	1½" Ell 90° scr'd., ex. h'vy.	C.I...	St. to main feed pumps 3, fuel oil pumps and heaters 6, ballast manifold 5, heating coils, ford. and aft. 6.
J 77	15	1¼" Ell 90° scr'd., ex. h'vy.	C.I...	St. to air ejectors 4, fuel oil transfer pump 5, sea chest 4, aux. air and circulating pumps 2.
J 78	36	1" Ell 90° scr'd., ex. h'vy...	C.I...	St. to feed water heater 2, ice machine 5, main cond. 4, bilge pump 3, ash hoist 3, fuel oil heat. 2, san. pump 1, cond. pump 5, aux. oil pump 11.
J 79	15	¾" Ell 90° scr'd., ex. h'vy.	C.I...	St. to fuel oil pumps 6, sea chest 2, evap. feed pump 2, generators 5.
J 80	1	¾" Ell 45° scr'd., ex. h'vy.	C.I...	St. to sea chest.
J 81	3	½" Ell 90° scr'd., ex. h'vy.	C.I...	Drain from st. line to feed and filter tank.
J 83	1	2"x2"x¾" Tee scr'd., ex. h'vy	C.I...	St. to generators, fuel oil pumps and heaters.
J124	1	2"x1½"x¾" Tee scr'd., extra heavy	C.I...	St. to generators, fuel oil pumps and heaters.
J 84	1	2"x1½"x2" Tee screwed, extra heavy	C.I...	St. to heating sys., ejector evap., etc.
J125	2	2"x½"x2" Tee screwed, extra heavy	C.I...	St. to evaporator, ejectors.
J 85	4	1½"x1½"x1½" Tee screwed, extra heavy	C.I...	St. to main feed pumps 3, ford. heat coils 1.
J 86	1	1½"x¾"x1½" Tee screwed, extra heavy	C.I...	St. to ballast manifold, sea chest.
J 87	1	1½"x1½"x1" Tee screwed, extra heavy	C.I...	St. to heating sys., main cond.
J 88	1	1¼"x1"x1½" Tee screwed, extra heavy	C.I...	St. to san. and fresh water pump, ice machine.
J 89	1	1½"x1"x1¼" Tee screwed, extra heavy	C.I...	St. to fuel oil pumps and heaters.
J 90	1	1¼"x1¼"x1¼" Tee screwed, extra heavy	C.I...	St. to air ejectors.
J 91	1	1¼"x1"x1" Tee screwed, extra heavy	C.I...	St. to fuel oil heaters.
J 92	1	1¼"x1"x½" Tee screwed, extra heavy	C.I...	St. to sanitary and fresh water pump.
J 93	1	1"x1"x1" Tee screwed, extra heavy	C.I...	St. to condensate pumps.
J 94	3	¾"x¾"x¾" Tee screwed, extra heavy	C.I...	St. to fuel oil pumps.
J 95	1	2"x1¼"x2"x¾" Cross, screwed, extra heavy.	C.I...	St. to evap., evap. feed pump, sea chest.
J 96	1	1"x¾"x¾"x¾" Cross, screwed, extra heavy.	C.I...	St. to fuel oil pumps.

(Continued on next page)

9,000-TON D. W. FREIGHTER

For Arrangement Plans See Plates XLVII and XLVIII—Opposite Page 630

LIST OF SCREWED FITTINGS FOR ONE SHIP—Cont'd.

Pc.	No.	No. Pcs.	Name.	Mat'l.	Remarks.
J	97	120 ft.	2" Pipe, extra heavy.....	Lap welded steel	St. to main circ. pump, injector, evap., blowers, ballast pump, f. & b. pump, ford. heat coils, generators, fuel oil pumps and heaters.
J	98	108 ft.	1½" Pipe, extra heavy...	Lap welded steel	Main feed pumps, ballast manifold, aft heat. coils, fuel oil pumps and heaters.
J	99	54 ft.	1¼" Pipe, extra heavy...	Lap welded steel	St. to air ejectors, fuel oil heaters, fuel oil trans. pump, aux. air and circ. pump, san. and f. w. pumps, main sea chest.
J	100	164 ft.	1" Pipe, extra heavy.....	Lap welded steel	St. to feed wat. heat, cond. pumps, ash hoist, ice mach., san. pump, aux. oil pump, fuel oil heats. and pumps, eng. r. bilge pump.
J	101	48 ft.	¾" Pipe, extra heavy....	Lap welded steel	St. to fuel oil pumps, evap. feed pump, sea chest, generators.
J	102	12 ft.	½" Pipe, extra heavy....	Lap welded steel	St. to fresh water pump, drain from st. line to f. and f. tank.
J	104	4	1½" Union, extra heavy....	M.I..	St. to main feed pumps 1, ballast man. 1, Ford. heat. coils 2.
J	105	2	1¼" Union, extra heavy....	M.I..	St. to aux. air and circ. pump 1, sea chest 1.
J	106	6	1" Union, extra heavy.....	M.I..	St. to aux. oil pumps 3, fresh wat. heat. 1, main cond. 1, ice mach. 1.
J	107	5	¾" Union, extra heavy.....	M.I..	St. to generators 2, fuel oil pumps 2, sea chest 1.
J	108	2	2½" Std. Ell 90°, screwed.	C.I...	Exh. from generators.
J	109	8	2" Std. Ell 90°, screwed...	C.I...	Exh. from cond. pumps 4, aux. air and circ. pump 4.
J	110	12	1½" Std. Ell 90°, screwed..	C.I...	Exh. from ice mach. 5, ash hoist 3, fuel oil trans. pump 4.
J	111	11	1¼" Std. Ell 90°, screwed..	C.I...	Exh. from san. pump 3, aux. oil pumps 3, fuel oil pumps 3, eng. r. bilge pumps 2.
J	112	7	1" Std. Ell 90°, screwed...	C.I...	Exh. from evap. feed pumps 6, fuel oil pump 1.
J	113	2	¾" Std. Ell 90°, screwed..	C.I...	Exh. from fresh water pump.
J	114	1	2"x2"x2" Tee, screwed.....	C.I...	Exh. from cond. pumps.
J	115	1	1½"x1½"x2" Tee, screwed..	C.I...	Exh. from ice mach., san. and f. w. pumps.
J	116	1	1½"x1¼"x¾" Tee, screwed.	C.I...	Exh. from fresh water and san. pumps.
J	117	1	1¼"x1"x1" Tee, screwed....	C.I...	Exh. from fuel oil pumps.
J	118	30 ft.	2" Std. pipe.....	W.I..	Exh. from cond. pumps, aux. air and circ. pump.
J	119	54 ft.	1½" Std. pipe.....	W.I..	Exh. from ice mach., ash hoist, fuel oil trans. pump.

LIST OF SCREWED FITTINGS FOR ONE SHIP—Cont'd.

Pc.	No.	No. Pcs.	Name.	Mat'l.	Remarks.
J	120	72 ft.	1¼" Std. pipe.....	W.I..	Exh. from fuel oil pumps, aux. oil pump, san. pump, eng. r. bilge pump.
J	121	44 ft.	1" Std. pipe.....	W.I..	Exh. from evap. feed pump, fuel oil pumps.
J	122	3 ft.	¾" Std. pipe.....	W.I..	Exh. from fresh water pump.
J	123	1	2" Union	M.I..	Exh. from aux. air and circ. pump.
J	349	1	1½" Union	M.I..	Exh. from ice mach.
J	351	1 ft. 0"	½" Std. pipe (iron pipe size)	Brass.	St. to Main sea chest.
J	352	1 ft. 0"	¼" Std. pipe (iron pipe size)	Brass.	For St. gage Pc. No. J350.
L	133	1	1½"x1½"x1½"x½" Cross screwed	C.I...	St. to heat. system.
L	134	1	1½"x1¼"x1¼" Tee scr'd...	C.I...	St. to heat. system.
L	135	1	1¼"x1"x1" Tee screwed....	C.I...	St. to heat. system.
L	136	1	1½" Std. Ell 90°, screwed, extra heavy	C.I...	St. to heat. system.
L	137	2	1½" Std. Ell 45°, screwed.	C.I...	St. to heat. system.
L	138	5	1¼" Std. Ell 90°, screwed.	C.I...	St. to heat. system.
L	139	2	1¼" Std. Ell 45°, screwed.	C.I...	St. to heat. system.
L	140	1	1" Std. Ell 90°, screwed...	C.I...	St. to heat. system.
L	141	1	1½" Union	M.I..	St. to heat. system.
L	142	2	1¼" Union	M.I..	St. to heat. system.
L	143	20 ft.	1½" Std. pipe, black.....	Lap welded steel.	St. to heat. system.
L	144	72 ft.	1¼" Std. pipe, black....	Lap welded steel.	St. to heat. system.
L	145	8 ft.	1" Std. pipe, black.....	Lap welded steel.	St. to heat. system.
L	150	1	1½"x1¼"x1¼"x¼" Cross screwed	C.I...	St. to heat. system.
L	151	1 ft. 0"	¼" Std. pipe (iron pipe size)	Brass.	St. to heat. system, gage Pc. No. L149.
L	153	5 ft. 0"	1½" Pipe, ex. heavy.	Lap welded steel.	
K	342	1ft. 0"	¼" Std. pipe (iron pipe size)	Brass.	For St. gage Pc. No. K341.

LIST OF PIPES FOR ONE SHIP

Pc.	No.	Name.	Mat'l.	Remarks.
J	201	1 6" Pipe, extra heavy.....	Lap welded steel.	Aux. steam.
J	202	1 4" Pipe Std.....	Lap welded steel.	Aux. steam.
J	203	1 3½" Pipe Std.....	Lap welded steel.	St. to ballast pump, blowers, etc.
J	204	1 3½" Pipe Std.....	Lap welded steel.	St. to ballast pump, blowers, etc.
J	205	1 3½" Pipe Std.....	Lap welded steel.	St. to heating sys., evap., etc.
J	206	1 3" Pipe Std.....	Lap welded steel.	St. to blowers, ash hoist, Ford. heat. coils.
J	207	1 3" Pipe Std.....	Lap welded steel.	St. to blowers, ash hoist, Ford. heat. coils.
J	208	1 3" Pipe Std.....	Lap welded steel.	St. to blowers, ash hoist, Ford. heat. coils.
J	209	1 3" Pipe Std.....	Lap welded steel.	St. to san. & f. w. pumps, steer. eng., aux. oil pump, aft heat. coils.
J	210	1 3" Pipe Std.....	Lap welded steel.	St. to san. & f. w. pumps, steer. eng., aux. oil pump, aft heat. coils.
J	211	1 3" Pipe Std.....	Lap welded steel.	St. to san. & f. w. pumps, steer. eng., aux. oil pump, aft heat. coils.

(Continued on Next Page)

9,000-TON D. W. FREIGHTER

For Arrangement Plans See Plates XLVII and XLVIII
Opposite Page 630

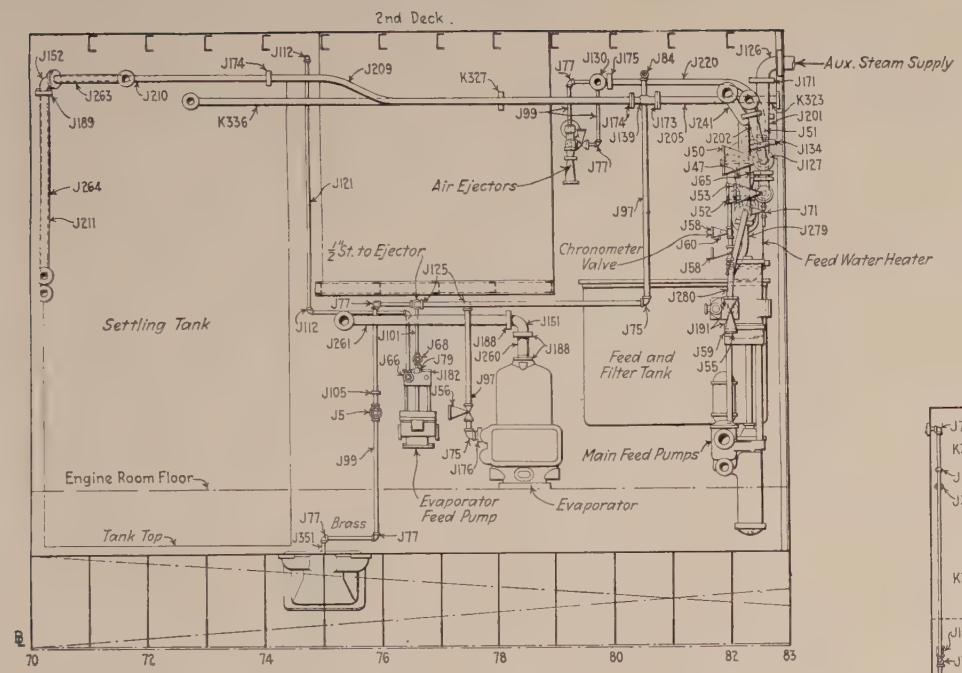
LIST OF PIPES FOR ONE SHIP—Continued

Pc.No.	No.Pcs.	Name.	Mat'l.	Remarks.
J212	1	3" Pipe Std.....	Lap welded steel.	St. to steer. eng., aft heat. coils, aux. oil pump.
J213	1	3" Pipe Std.....	Lap welded steel.	St. to steer. eng., aft heat. coils, aux. oil pump.
J214	1	2½" Pipe Std.....	Lap welded steel.	St. to Ballast pump, aux. air and circ. pump, fuel oil trans. pump.
J215	1	2½" Pipe Std.....	Lap welded steel.	St. to Ballast pump, aux. air and circ. pump, fuel oil trans. pump.
J216	1	2½" Pipe Std.....	Lap welded steel.	St. to f. & b. pump, eng. r. bilge pump ballast man., sea chest.
J217	1	2½" Pipe Std.....	Lap welded steel.	St. to blowers, ash hoist.
J218	1	2½" Pipe Std.....	Lap welded steel.	St. to blowers, ash hoist.
J219	1	2½" Pipe, extra heavy.....	Lap welded steel.	St. to feed wat. heat., air ejs., cond. pumps, main circ. pump.
J220	1	2½" Pipe, extra heavy.....	Lap welded steel.	St. to air ejs., cond. pumps, main circ. pump.
J221	1	2½" Pipe, extra heavy.....	Lap welded steel.	St. to cond. pumps, main circ. pump.
J222	1	2½" Pipe, extra heavy.....	Lap welded steel.	St. to cond. pumps, main circ. pump.
J223	1	2½" Pipe, extra heavy.....	Lap welded steel.	St. to injector, generators, fuel oil pumps and heaters.
J224	1	2" Pipe	Copper No. 9.	St. to whistle.
J225	1	2" Pipe	Copper No. 9.	St. to whistle.
J226	1	2" Pipe	Copper No. 9.	St. to whistle.
J227	1	2" Pipe	Copper No. 9.	St. to whistle.
J228	1	2" Pipe	Copper No. 9.	St. to whistle.
J229	1	2" Pipe	Copper No. 10.	St. to whistle.
J230	1	2" Pipe	Copper No. 10.	St. to whistle.
J231	1	8" Pipe Std.....	Lap welded steel.	Exh. to atmosphere.
J232	1	8" Pipe Std.....	Lap welded steel.	Exh. to atmosphere.
J233	1	7" Pipe Std.....	Lap welded steel.	Exh. to atmosphere.
J234	1	7" Pipe Std.....	Lap welded steel.	Exh. to atmosphere.
J235	1	7" Pipe Std.....	Lap welded steel.	Exh. to aux. cond.
J236	1	6" Pipe Std.....	Lap welded steel.	Aux. exh. line.
J237	1	6" Pipe Std.....	Lap welded steel.	Aux. exh. line.
J238	1	6" Pipe Std.....	Lap welded steel.	Aux. exh. line.
J239	1	6" Pipe Std.....	Lap welded steel.	Aux. exh. line.
J240	1	6" Pipe Std.....	Lap welded steel.	Aux. exh. line.
J241	1	5" Pipe Std.....	Lap welded steel.	Exh. to feed water heater.
J242	1	5" Pipe Std.....	Lap welded steel.	Exh. from aft deck mach., steer. eng., etc.

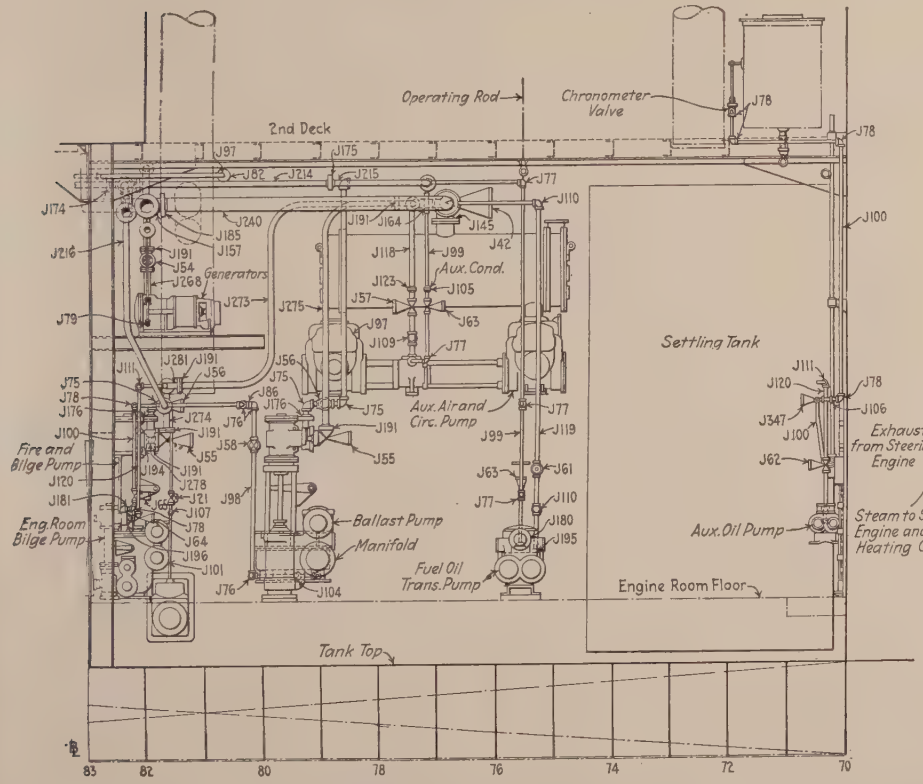
LIST OF PIPES FOR ONE SHIP—Continued

Pc.No.	No.Pcs.	Name.	Mat'l.	Remarks.
J243	1	5" Pipe Std.....	Lap welded steel.	Exh. from main circ. pump.
J244	1	5" Pipe Std.....	Lap welded steel.	Exh. from main circ. pump.
J245	1	5" Pipe Std.....	Lap welded steel.	Exh. from main circ. pump, cond. pump.
J246	1	5" Pipe Std.....	Lap welded steel.	Exh. from Ford. dk. mach., ash hoist.
J284	1	5" Pipe Std.....	Lap welded steel.	Exh. from Ford. dk. mach., ash hoist.
J247	1	6" Pipe Std.....	Lap welded steel.	Exh. from Ford. dk. mach., ash hoist, blowers.
J248	1	6" Pipe Std.....	Lap welded steel.	Exh. from Ford. dk. mach., ash hoist, blowers, fuel oil pumps.
J249	1	6" Pipe Std.....	Lap welded steel.	Exh. from Ford. dk. mach., ash hoist, blowers, fuel oil pumps.
J250	1	6" Pipe Std.....	Lap welded steel.	Exh. from Ford. dk. mach., ash hoist, blowers, fuel oil pumps.
J251	1	5" Pipe Std.....	Lap welded steel.	Exh. to L. P. turbine.
J252	1	5" Pipe Std.....	Lap welded steel.	Exh. to L. P. turbine.
J253	1	4½" Pipe Std.....	Lap welded steel.	Escape from port boiler to atmosphere.
J254	1	4½" Pipe Std.....	Lap welded steel.	Escape from port boiler to atmosphere.
J255	1	4½" Pipe Std.....	Lap welded steel.	Escape from center boiler to atmosphere.
J256	1	4½" Pipe Std.....	Lap welded steel.	Escape from center boiler to atmosphere.
J257	1	4½" Pipe Std.....	Lap welded steel.	Escape from st'b'd. boiler to atmosphere.
J258	1	4½" Pipe Std.....	Lap welded steel.	Escape from st'b'd. boiler to atmosphere.
J259	1	4½" Pipe Std.....	Lap welded steel.	Escape from st'b'd. boiler to atmosphere.
J260	1	4" Pipe Std.....	Lap welded steel.	Exh. from evap. to main cond.
J261	1	4" Pipe Std.....	Lap welded steel.	Exh. from evap. to main cond.
J262	1	4" Pipe Std.....	Lap welded steel.	Exh. from evap. to main cond.
J263	1	3½" Pipe Std.....	Lap welded steel.	Exh. from ice mach., san. & f. w. pumps, steer. eng., aux. oil pump.
J264	1	3½" Pipe Std.....	Lap welded steel.	Exh. from ice mach., san. & f w. pumps, steer. eng., aux. oil pump.
J265	1	3" Pipe Std.....	Lap welded steel.	Exh. from steer. eng., aux. oil pump.
J266	1	3" Pipe Std.....	Lap welded steel.	Exh. from steer. eng., aux. oil pump.
J267	1	3" Pipe Std.....	Lap welded steel.	Exh. from blowers.
J268	2	2½" Pipe Std.....	Lap welded steel.	Exh. from generators.
J269	1	2½" Pipe Std.....	Lap welded steel.	Exh. from generators.
J270	1	2½" Pipe Std.....	Lap welded steel.	Exh. from generators.

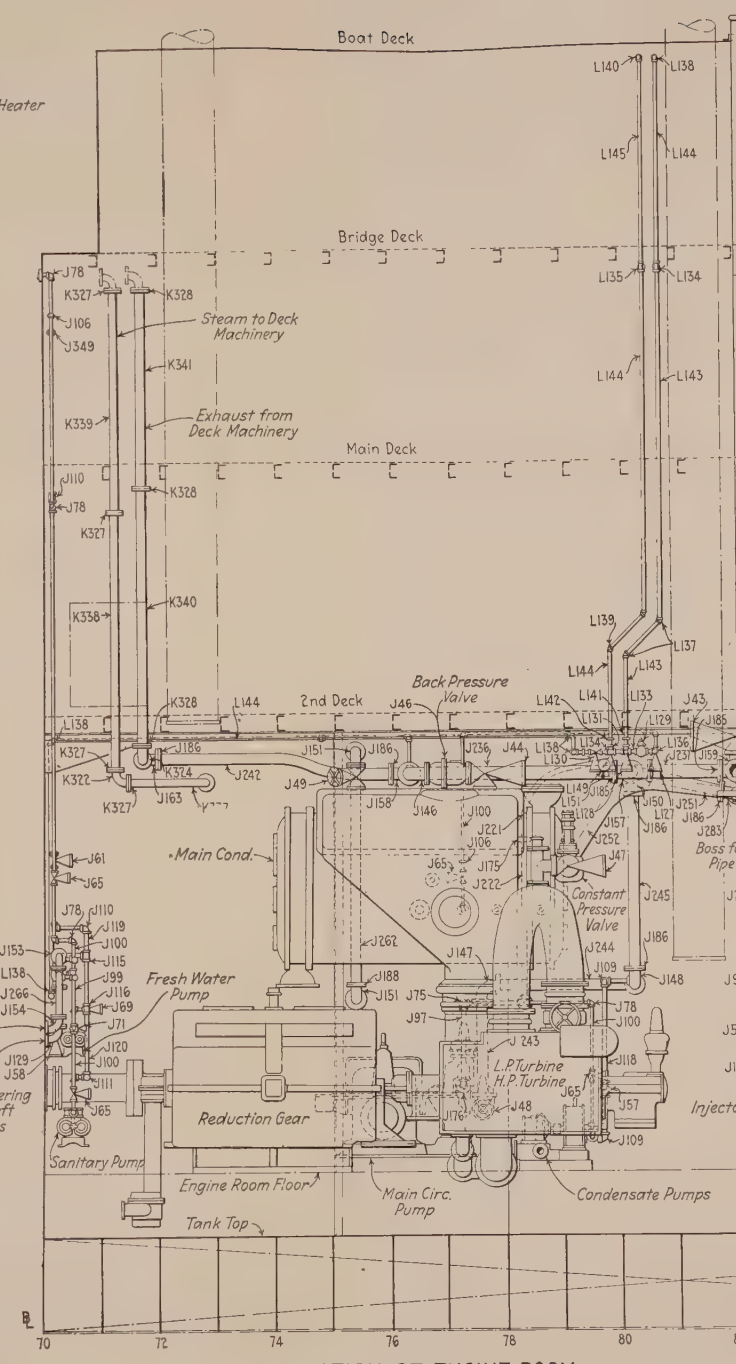
(Continued on Next Page)



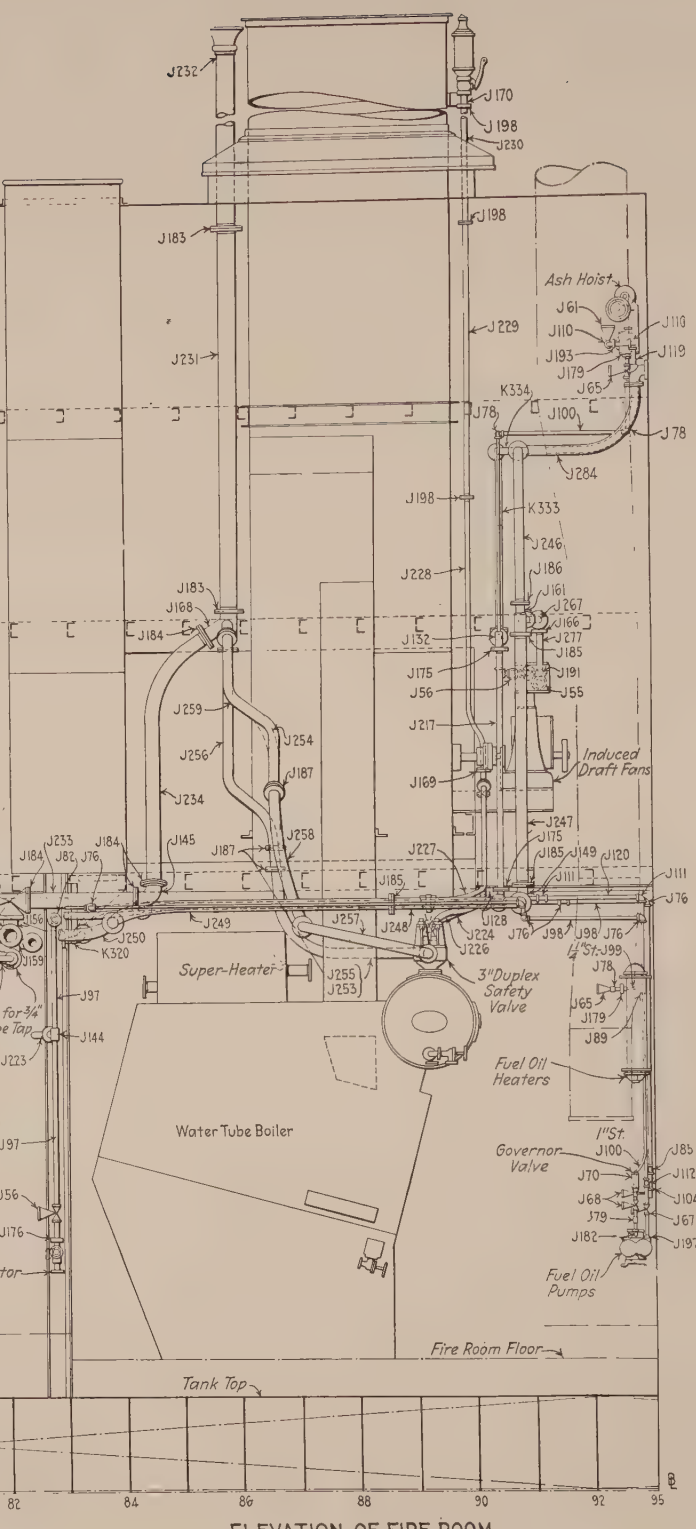
ELEVATION OF ENGINE ROOM
Portside. Looking Outboard



ELEVATION OF ENGINE ROOM
Stb'd Side, Looking Outboard



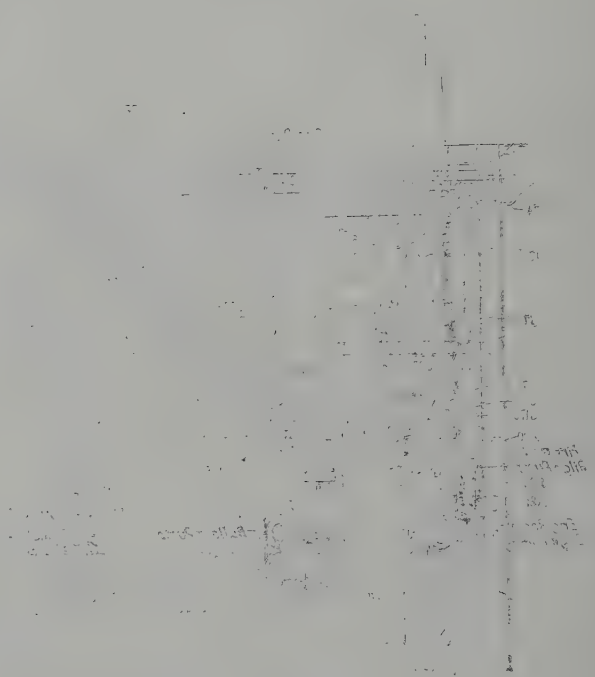
ELEVATION OF ENGINE ROOM
℄ Looking to Port

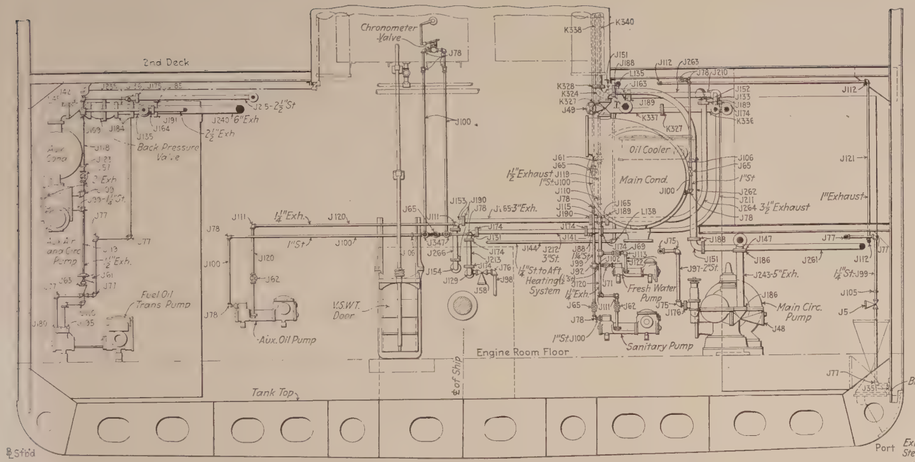


ELEVATION OF FIRE ROOM
Stb'd Side Looking Inb'd

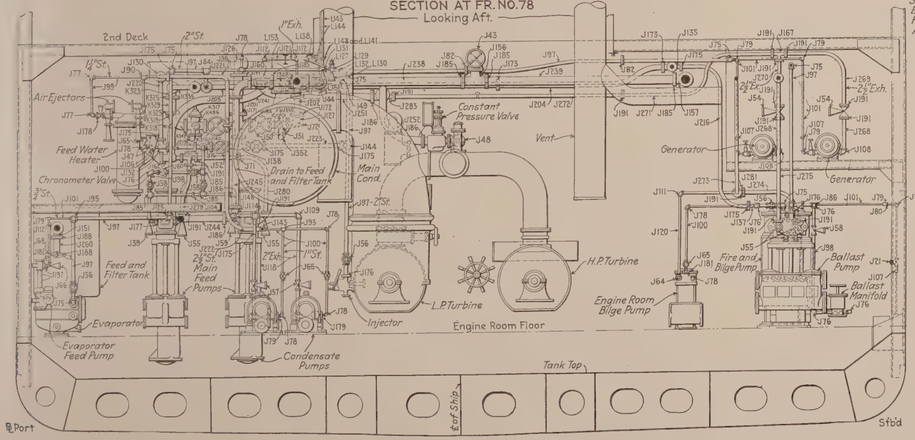
ARRANGEMENT OF AUXILIARY STEAM AND EXHAUST PIPING, TURBINE INSTALLATION
9,000-TON D. W. FREIGHTER

PLATE XLVII





SECTION AT FR. NO. 78
Looking Aft.



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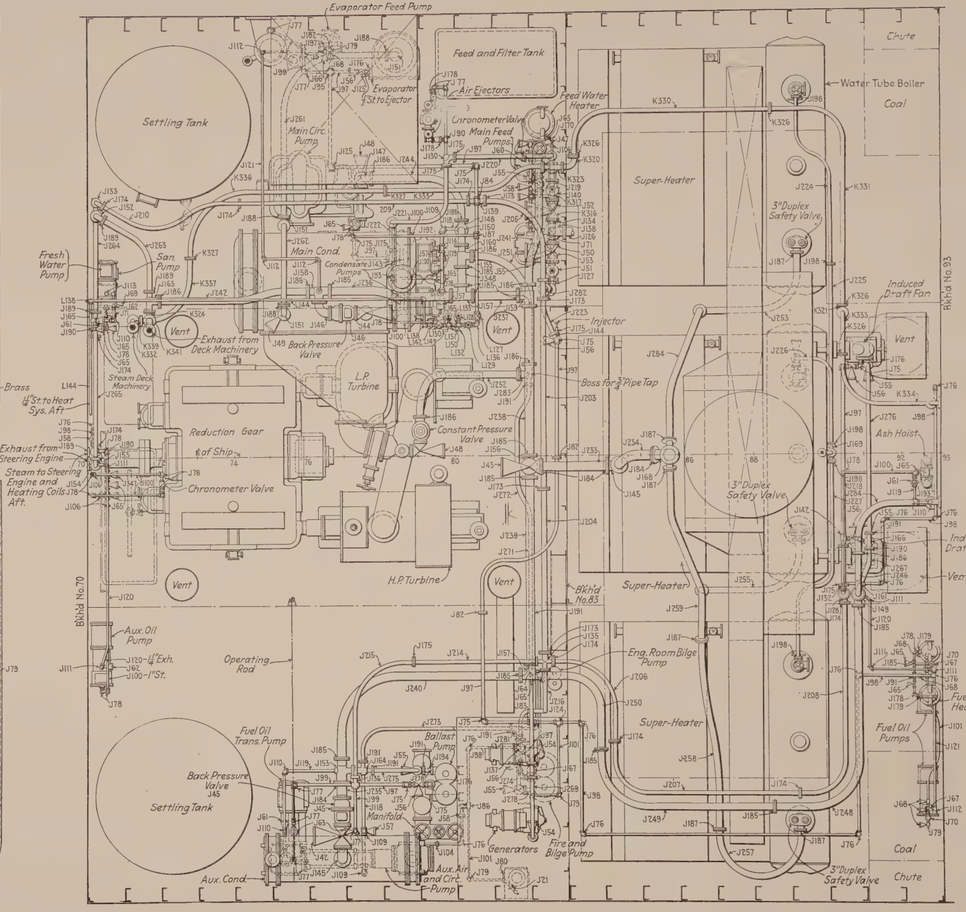
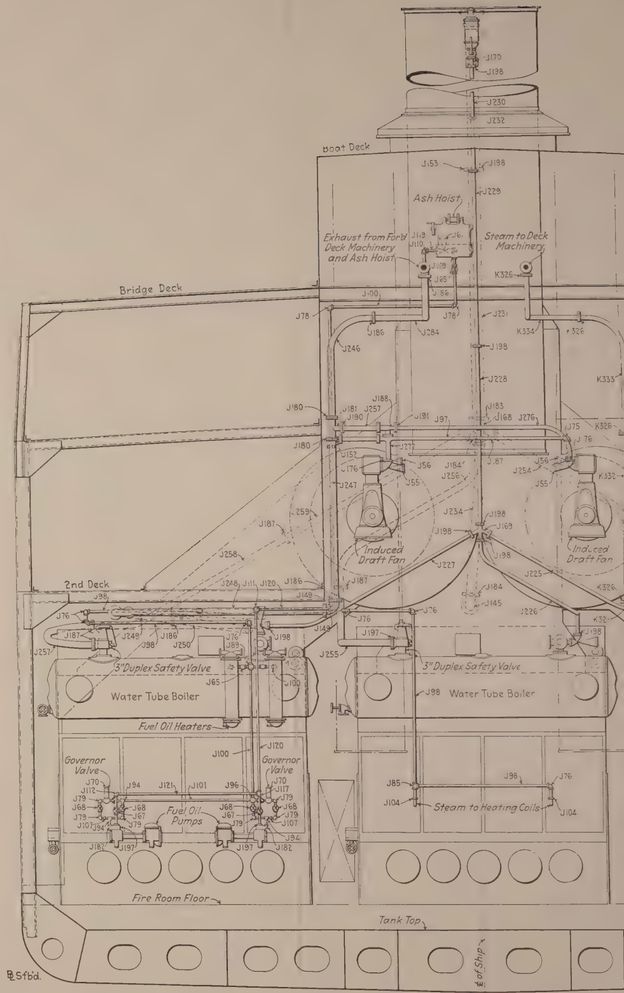
Looking Ford



PLAN



SECTION AT FR. NO. 93
Looking Aft

ARRANGEMENT OF AUXILIARY STEAM AND EXHAUST PIPING, TURBINE INSTALLATION
9,000-TON D. W. FREIGHTER

9,000-TON D. W. FREIGHTER

For Arrangement Plans See Plates XLVII and XLVIII
Opposite Page 630

LIST OF PIPES FOR ONE SHIP—Continued

Pc.No.	No.Pcs.	Name.	Mat'l.	Remarks.
J271	1	2½" Pipe Std.....	Lap welded steel.	Exh. from generators.
J272	1	2½" Pipe Std.....	Lap welded steel.	Exh. from generators.
J273	1	2½" Pipe Std.....	Lap welded steel.	Exh. from fire and bilge pump, eng. room bilge pump.
J274	1	2½" Pipe Std.....	Lap welded steel.	Exh. from fire and bilge pump.
J275	1	2½" Pipe Std.....	Lap welded steel.	Exh. from ballast pump.
J276	1	2½" Pipe Std.....	Lap welded steel.	Exh. from blowers.
J277	1	2½" Pipe Std.....	Lap welded steel.	Exh. from blowers.
J278	2	2½" Pipe Std., distance piece	Lap welded steel.	Exh. from fire and bilge pump, ballast pump.
J279	1	2½" Pipe Std.....	Lap welded steel.	Exh. from main feed pumps.
J280	1	2½" Pipe Std.....	Lap welded steel.	Exh. from main feed pumps.
J348	1	6" Pipe Std.....	Lap welded steel.	Exh. from main circ. pump, cond. pump, generators.
K329	1	4½" Pipe Std.....	Lap welded steel.	Steam to deck mach.
K330	1	4" Pipe Std.....	Lap welded steel.	Steam to deck mach. Ford.
K331	1	4" Pipe Std.....	Lap welded steel.	Steam to deck mach. Ford.
K332	1	4" Pipe Std.....	Lap welded steel.	Steam to deck mach. Ford.
K333	1	4" Pipe Std.....	Lap welded steel.	Steam to deck mach. Ford.
K334	1	4" Pipe Std.....	Lap welded steel.	Steam to deck mach. Ford.
K335	1	3½" Pipe Std.....	Lap welded steel.	Steam to deck mach. aft.
K336	1	3½" Pipe Std.....	Lap welded steel.	Steam to deck mach. aft.
K337	1	3½" Pipe Std.....	Lap welded steel.	Steam to deck mach. aft.
K338	1	3½" Pipe Std.....	Lap welded steel.	Steam to deck mach. aft.
K339	1	3½" Pipe Std.....	Lap welded steel.	Steam to deck mach. aft.
K340	1	4½" Pipe Std.....	Lap welded steel.	Exh. from deck mach. aft.
K341	1	4½" Pipe Std.....	Lap welded steel.	Exh. from deck mach. aft.

LIST OF FLANGES FOR ONE SHIP

Pc.No.	No.Pcs.	Name.	Mat'l.	Remarks.
J171	2	6" Std. flange.....	Forged steel.	For pipes, J201.
J172	2	4" Std. flange.....	Forged steel.	For pipes, J202.
J173	6	3½" Std. flange.....	Forged steel.	For pipes, J203, J204, J205.
J174	16	3" Std. flange.....	Forged steel.	For pipes, J206, J207, J208, J209, J210, J211, J212, J213.
J175	20	2½" Std. flange.....	Forged steel.	For pipes, J214, J215, J216, J217, J218, J219, J220, J221, J222, J223.
J176	7	2" Std. flange scr'd, ex. h'vy	Forged steel.	St. to main circ. pump 1, blowers 2, evap. 1, inj. 1, ballast pump 1, fire and bilge pump 1.

LIST OF FLANGES FOR ONE SHIP—Continued

Pc.No.	No.Pcs.	Name.	Mat'l.	Remarks.
J177	2	1½" Std. flange scr'd, ex. heavy	Forged steel.	St. to main feed pumps.
J178	2	1¼" Std. flange scr'd, ex. heavy	Forged steel.	St. to air ejectors.
J179	5	1" Std. flange scr'd, ex. h'vy	Forged steel.	St. to cond. pumps 2, fuel oil heaters 2, ash hoist 1.
J180	1	1¼" Spec. flange scr'd, ex. heavy	Forged steel.	St. to fuel oil transfer pump (furnished with pump).
J181	1	1" Spec. flange scr'd, ex. h'vy	Forged steel.	St. to engine room bilge pump (furnished with pump).
J182	3	¾" Spec. flange scr'd, ex. h'vy	Forged steel.	St. to 2" fuel oil pumps, 1" evap. feed pump (furnished with pump).
J198	14	2" Std. flange.....	Braz. metal.	For pipes, J224, J225, J226, J227, J228, J229, J230.
J183	3	8" Std. flange scr'd.....	C.I...	For pipes, J231, J232.
J184	6	7" Std. flange scr'd.....	C.I...	For pipes, J233, J234, J235.
J185	20	6" Std. flange scr'd.....	C.I...	For pipes, J236, J237, J238, J239, J240, J247, J248, J249, J250, J348.
J186	18	5" Std. flange scr'd.....	C.I...	For pipes, J241, J242, J243, J244, J245, J246, J284, J251, J252.
J187	14	4½" Std. flange scr'd.....	C.I...	For pipes, J253, J254, J255, J256, J257, J258, J259.
J188	6	4" Std. flange scr'd.....	C.I...	For pipes, J260, J261, J262.
J189	4	3½" Std. flange scr'd.....	C.I...	For pipes, J263, J264.
J190	6	3" Std. flange scr'd.....	C.I...	For pipes, J265, J266, J267.
J191	26	2½" Std. flange scr'd.....	C.I...	For pipes, J268, J269, J270, J271, J272, J273, J274, J275, J276, J277, J278, J279, J280.
J192	2	2" Std. flange scr'd.....	C.I...	Exh. from cond. pumps.
J193	1	1½" Std. flange scr'd.....	C.I...	Exh. from ash hoist.
J194	2	2½" Spec. flange scr'd.....	C.I...	Exh. from ballast pump, fire and bilge pump (furnished with pump).
J195	1	1½" Spec. flange scr'd.....	C.I...	Exh. from fuel oil trans. pump (furnished with pump).
J196	1	1¼" Spec. flange scr'd.....	C.I...	Exh. from eng. room bilge pump (furnished with pump).
J197	3	1" Spec. flange scr'd.....	C.I...	Exh. from 2 fuel oil pumps, 1 evap. feed pump (furnished with pumps).
J 82	4	2" Std. flange scr'd.....	Ferro-steel.	St. to gen's., fuel oil, pumps and heaters.
K325	2	4½" Std. flange.....	Forged steel.	For pipe, K329.
K326	10	4" Std. flange.....	Forged steel.	For pipes, K330, K331, K332, K333, K334.
K327	10	3½" Std. flange.....	Forged steel.	For pipes, K335, K336, K337, K338, K339.
K328	4	4½" Std. flange scr'd.....	C.I...	For pipes, K340, K341.

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For Arrangement Plans See Plates XLIX and L Opposite Page 634

LIST OF MATERIAL FOR ONE SHIP

Pc. No.	No. Pcs.	Name	Mat'l	Remarks
K1	1	3½" Globe stop valve extra heavy flg'd.	Ferro-steel.	St'm. to winches.
K2	1	2½" Globe stop valve extra heavy flg'd.	Ferro-steel.	St'm. to wind-lass.
K3	2	2½" Angle stop valve extra heavy flg'd.	Ferro-steel.	St'm. to wind-lass, st'm. to steer. eng.
K4	10	2" Globe stop valve extra heavy flg'd.	Brass.	St'm. winches.
K5	1	4½" Globe stop valve St'd. flg'd	C.I.	Exh. from winches.
K6	1	3" Angle stop valve St'd. flg'd.	C.I.	Exh. from wind-lass.
K7	7	2½" Globe stop valve St'd. flg'd.	C.I.	Exh. 6 from winches, exh. 1 from capstan.
K8	4	2½" Angle stop valve St'd. flg'd.	C.I.	Exh. from winches.
K9	8	½" Globe stop valve St'd. scr'd.	Brass.	Drain.
K10	1	3" Globe stop valve St'd. flg'd.	C.I.	Exh. from steering engine.
K11	5	2" Globe stop valve extra heavy scr'd.	Brass.	St'm. to capstan and fire ext.
K12	1	2" Angle stop valve extra heavy scr'd.	Brass.	St'm. to capstan.
K13	4	¾" Globe stop valve St'd. scr'd.	Brass.	Drain steer. eng.
K14	1	¾" Angle stop valve St'd. scr'd.	Brass.	Drain steer. eng.
K15	1	¾" Swing check valve St'd. scr'd.	Brass.	Drain steer. eng.
K16	17	1½" Angle stop valve extra heavy scr'd.	Brass.	St'm. to fire ext.
K17	4	¾" Angle stop valve extra heavy scr'd.	Brass.	St'm. to fire ext.
K18	1	4" Globe stop valve extra heavy flg'd.	Ferro-steel.	St'm. to winches.
K19	1	5" Globe stop valve St'd. flg'd.	C.I.	Exh. from winches.
K101	7	4½" Ell flg'd. St'd.....	C.I. galv.	Exh. from winches.
K102	2	4½" Ell flg'd., with boss tap for ½" pipe th'd. St'd.	C.I. galv.	Exh. from winches.
K103	6	3½" Ell flg'd. extra heavy..	C.I. galv.	St'm. to winches.
K104	2	3½" Ell flg'd., with boss tap for ½" pipe th'd. extra heavy	C.I. galv.	St'm. to winches.
K105	11	3" Ell flg'd. St'd.....	C.I. galv.	Exh. 8 from winches & wind., 3 from steer. eng. (not galv.).
K106	8	2½" Ell flg'd. St'd.....	C.I. galv.	Exh. 6 from winches, 2 from capstan (not galv.).
K107	8	2½" Ell flg'd. extra heavy...	C.I. galv.	St'm. 6 windlass, 2 steer. eng. (not galv.).
K108	7	2" Ell flg'd. extra heavy.....	C.I. galv.	St'm. to winches.
K109	1	2½" Ell flg'd., with boss tap for ½" pipe th'd., extra heavy.	C.I. galv.	St'm. to windlass.
K110	1	3½" x 3" x 2" Tee flg'd., extra heavy.	C.I. galv.	St'm. to winches.
K111	2	3 x 2½" x 2" Tee flg'd., extra heavy.	C. I. galv.	St'm. to winches.
K112	1	2" x 2" x 2" Tee flg'd., extra heavy.	C. I. galv.	St'm. to winches.
K113	1	4" x 2" x 4" Tee flg'd., extra heavy.	C. I. galv.	St'm. to winches.
K114	2	3½" x 3½" x 2" Tee flg'd., extra heavy.	C. I. galv.	St'm. to winches.
K115	2	2½" x 2" x 2" Tee flg'd., extra heavy.	C. I. galv.	St'm. to winches.
K116	1	4" x 2" x 3½" Tee flg'd., extra heavy.	C.I. galv.	St'm. to winches.
K117	1	4½" x 4" x 2½" Tee flg'd. St'd.	C.I. galv.	Exh. from winches.
K118	1	4" x 3" x 2½" Tee flg'd. St'd.	C.I. galv.	Exh. from winches.
K119	1	4" Ell flg'd., extra heavy....	C.I. galv	St'm. to winches.
K120	1	3" x 3" x 2½" Tee flg'd. St'd.	C.I. galv	Exh. from winches.
K121	2	3" x 2½" x 2½" Tee flg'd. St'd.	C.I. galv.	Exh. from winches.
K122	1	3½" Bulkhead flange.....	Steel galv.	St'm. to winches.

LIST OF MATERIAL FOR ONE SHIP—Continued

Pc. No.	No. Pcs.	Name	Mat'l	Remarks
K123	27	3½" Flange, extra heavy....	Steel galv.	St'm. to winches.
K124	54	2½" Flange, extra heavy....	Steel 28 galv	St'm. 28 to winches and wind., 26 to steer. eng. (not galv.).
K125	18	2" Flanges scr'd., extra heavy	C.I. Galv	St'm. to 12 for winches. 4 st'm. fire ext., 2 for capstan.
K126	1	4½" Bulkhead Flange scr'd. Std.	C.I. galv.	Exh. from winches.
K127	29	4½" Flange scr'd. St'd.....	C.I galv.	Exh. from winches.
K128	55	3" Flange scr'd. St'd.....	C.I. 30 galv.	Exh. 30 for winches and wind., 25 for steer. eng. (not galv.).
K129	19	2½" Flange scr'd. St'd.....	C.I. galv.	Exh. 12 for winches. 7 for capstan.
K130	12	2½" Flange St'd.....	C.I	Exh. winches and capstan.
K131	8	2½" x 8½" Flange St'd.....	C.I.	Exh. winches and capstan.
K132	10	2" Flange, extra heavy.....	Brazing metal.	St'm. to winches and capstan.
K133	8	2" x 8¼" Flange, extra heavy	Brazing metal.	St'm. to winches and capstan.
K134	1	2½" Distance piece, extra heavy.	C.I.	St'm to windlass.
K135	1	3" x 3" x 3" Tee, with bulk-head flange St'd.	C.I.	Exh. from steer. eng.
K136	1	3" Ell flg'd., with boss tap for ½" pipe th'd. St'd.	C.I.	Exh. from steer. eng.
K137	1	3" x 2½" x 3" Tee flg'd. St'd.	C.I.	Exh. from steer. eng.
K138	1	2½" x 2½" x 2½" Single sweep tee flg'd., extra heavy.	C.I.	St'm. to steer eng.
K139	1	2½" x 2½" x 2½" Tee flg'd., extra heavy.	C.I.	St'm. to steer eng.
K140	8	2" Ell scr'd., extra heavy...	C.I	2 for st'm. to capstan, 6 for steam to fire ext.
K141	3	2½" Ell scr'd. St'd.....	C.I.	Exh. from capstan.
K142	2	2½" Bulkhead flange.....	Steel	St'm. to steer. eng.
K143	1	3" bulkhead flange scr'd. St'd.	C.I.	Exh. from steer. eng.
K144	1	1½" x 7½" Reducing flange scr'd. St'd.	C.I.	Exh. from steer. eng. with 1½" x ¾" bushing.
K145	1	1½" x 7½" Reducing flange scr'd., extra heavy.	C.I.	St'm. to steer. eng. with 1½" x ¾" bushing.
K146	1	2" x 7½" Reducing flange, extra heavy.	Steel.	St'm. to capstan.
K147	1	2½" x 2½" x 2" Tee flg'd., extra heavy.	C.I.	St'm. to for'd. winches.
K148	1	4" Distance piece, extra heavy.	C.I.	St'm. to for'd. winches.
K149	1	2½" Deck casting St'd.....	C.I.	Exh. from capstan.
K150	1	2" Deck casting, extra heavy.	C.I.	St'm. to capstan.
K151	1	¾" Open float st'm. trap (125-lb. pressure).	C.I.	Drain steer. eng. exh.
K152	21	¾" Ell scr'd. St'd.....	C.I.	6 for steer. eng. drain, 15 for fire ext.
K153	7	¾" x ¾" x ¾" Tee scr'd. St'd.	C.I.	5 for steer. eng. drain 2 for fire ext.
K154	3	¾" 45° Ell St'd.....	C.I. galv.	Drain from steer. eng.
K155	9	¾" Union	Mall. iron galv.	5 for steer. eng. drain, 4 for fire ext.
K156	1	¾" Double boss flange St'd..	C.I. galv.	Drain from steer. eng.
K157	2	2" Manifold 6-1½" branches.	C.I.	St'm. fire ext.
K158	1	2" Manifold 5-1½" branches.	C.I.	St'm. fire ext.
K159	1	2" Manifold 4-1½" branches.	C.I.	St'm. fire ext.
	4	2" Plugs	C.I.	1 for each manifold.

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For Arrangement Plans See Plates XLIX and L Opposite Page 634

LIST OF MATERIAL FOR ONE SHIP—Continued

Pc. No.	No. Pcs.	Name	Mat'l	Remarks
	4	¾" x 1½" Bushing	C.I.	2 for K158. 2 for K159.
K160	70	1½" Ell scr'd	C.I.	Fire ext.
K161	31	1½" x 1½" x 1½" Tee scr'd.	C.I.	Fire ext.
K162	17	1½" Union	Mall. iron.	Fire ext.
K163	28	Deck stuffing box	...	For 1½" pipes. Fire ext.
K164	9	Deck stuffing box	...	For ¾" pipes. Fire ext.
K165	2	¾" x 5" Reducing flange St'd.	C.I.	Settl. tank for fire ext. with 1½" x ¾" bushing.
K166	4	4" Flange, extra heavy galv.	Steel.	St'm. to winches.
K168	1	5" Ell with boss tap for 1½" pipe flg'd. St'd. galv.	C.I.	Exh. from winches.
K169	4	5" Flange scr'd. St'd. galv.	C.I.	Exh. from winches.
K170	1	5" x 2½" x 3" Tee flg'd. St'd. galv.	C.I.	Exh. from winches.
K171	1	5" x 2½" x 4½" Tee flg'd. St'd. galv.	C.I.	Exh. from winches.
K172	2	2½" Distance piece, flg'd. St'd. galv.	C.I.	Exh. from winches.
K173	1	4½" x 3½" x 3" Tee flg'd. St'd. galv.	C.I.	Exh. from winches.
K174	1	3½" x 3" x 2½" Tee flg'd. St'd. galv.	C.I.	Exh. from winches.
K175	1	3½" x 3" x 2½" Tee flg'd, extra heavy St'd. galv.	C.I.	St'm. to winches.
K176	1	2" Flange galv.	C.I.	St'm. to capstan.
K177	1	2½" Flange galv.	C.I.	Exh. from capstan.
K178	1	¾" Open float st'm. trap, high press.	...	Drain from steer. eng. st'm.
K201	1	3½" Lap welded pipe	Steel	St'm. to aft winches.
K202	1	3½" Lap welded pipe	Galv. steel.	St'm. to aft winches.
K203	1	3½" Lap welded pipe	Galv. steel.	St'm. to aft winches.
K204	1	3½" Lap welded pipe	Galv. steel.	St'm. to aft winches.
K205	1	3½" Lap welded pipe	Galv. steel.	St'm. to aft winches.
K206	2	2½" Lap welded pipe	Galv. steel.	St'm. to aft winches.
K207	1	2" Lap welded pipe	Galv. steel.	St'm. to aft winches.
K208	1	2" Lap welded pipe	Galv. steel.	St'm. to aft winches.
K209	1	2" Lap welded pipe	Galv. steel.	St'm. to aft winches.
K210	1	2" Lap welded pipe	Galv. steel.	St'm. to aft winches.
K211	1	2" Seamless drawn No. 9 B. W. G.	Copper.	St'm. to aft winches.
K212	1	2" Seamless drawn No. 9 B. W. G.	Copper.	St'm. to aft winches.
K213	1	2" Seamless drawn No. 9 B. W. G.	Copper.	St'm. to aft winches.
K214	1	2" Seamless drawn No. 9 B. W. G.	Copper.	St'm. to aft winches.
K215	1	4½" Lap welded pipe	Steel.	Exh. to aft winches.
K216	1	4½" Lap welded pipe	Galv. steel.	Exh. to aft winches.
K217	1	4½" Lap welded pipe	Galv. steel.	Exh. to aft winches.
K218	2	4½" Lap welded pipe	Galv. steel.	Exh. to aft winches.
K219	1	4½" Lap welded pipe	Galv. steel.	Exh. to aft winches.
K220	2	3" Lap welded pipe	Galv. steel.	Exh. to aft winches.
K221	1	2" Lap welded pipe	Galv. steel.	St'm. to winches.
K222	1	2½" Lap welded pipe	Galv. steel.	Exh. from winches.
K223	1	2½" Lap welded pipe	Galv. steel.	Exh. from winches.
K224	1	2½" Lap welded pipe	Galv. steel.	Exh. from winches.
K225	1	2½" Lap welded pipe	Galv. steel.	Exh. from winches.

LIST OF MATERIAL FOR ONE SHIP—Continued

Pc. No.	No. Pcs.	Name	Mat'l	Remarks
K226	1	2½" Seamless drawn No. 13 B. W. G.	Copper.	Exh. from winches.
K227	1	2½" Seamless drawn No. 13 B. W. G.	Copper.	Exh. from winches.
K228	1	2½" Seamless drawn No. 13 B. W. G.	Copper.	Exh. from winches.
K229	1	2½" Seamless drawn No. 13 B. W. G.	Copper.	Exh. from winches.
K230	1	4" Lap welded pipe	Galv. steel.	St'm. to winches. for'd.
K231	1	2" Seamless drawn No. 9 B. W. G.	Copper.	St'm. to winches. for'd.
K232	1	4" Lap welded pipe	Galv. steel.	St'm. to winches. for'd.
K233	1	3½" Lap welded pipe	Galv. steel.	St'm. to winches. for'd.
K234	1	3½" Lap welded pipe	Galv. steel.	St'm. to winches. for'd.
K235	1	3½" Lap welded pipe	Galv. steel.	St'm. to winches. for'd.
K236	1	3½" Lap welded pipe	Galv. steel.	St'm. to winches. for'd.
K237	1	3½" Lap welded pipe	Galv. steel.	St'm. to winches. for'd.
K238	1	3½" Lap welded pipe	Galv. steel.	St'm. to winches. for'd.
K239	2	3½" Lap welded pipe	Galv. steel.	St'm. to winches. for'd.
K240	1	3½" Lap welded pipe	Galv. steel.	St'm. to winches. for'd.
K241	1	2½" Lap Welded pipe	Galv. steel.	Exh. from winches.
K242	1	2½" Lap welded pipe	Galv. steel.	St'm. to winches.
K243	1	2½" Lap welded pipe	Galv. steel.	St'm. to winches.
K244	1	2½" Lap welded pipe	Galv. steel.	St'm. to winches.
K245	1	2" Lap welded pipe	Galv. steel.	St'm. to winches.
L246	1	2" Seamless drawn No. 9 B. W. G.	Copper.	St'm. to winches.
K247	1	2" Seamless drawn No. 9 B. W. G.	Copper.	St'm. to winches.
K248	1	2" Seamless drawn No. 9 B. W. G.	Copper.	St'm. to winches.
K249	1	2" Seamless drawn No. 9 B. W. G.	Copper.	St'm. to winches.
K250	1	2½" Lap welded pipe	Galv. steel.	St'm. to windlass.
K251	1	2½" Lap welded pipe	Galv. steel.	St'm. to windlass.
K252	1	2½" Lap welded pipe	Galv. steel.	St'm. to windlass.
K253	1	2½" Lap welded pipe	Galv. steel.	St'm. to windlass.
K254	1	2½" Lap welded pipe	Galv. steel.	St'm. to windlass.
K255	1	2½" Lap welded pipe	Galv. steel.	St'm. to windlass.
K256	1	2½" Lap welded pipe	Galv. steel.	St'm. to windlass.
K257	1	2½" Lap welded pipe	Galv. steel.	St'm. to windlass.
K258	1	2½" Lap welded pipe	Galv. steel.	St'm. to windlass.
K259	1	2" Lap welded pipe	Galv. steel.	St'm. to winches.
K260	1	5" Lap welded pipe	Galv. steel.	Exh. from winches.
K261	2	2½" Seamless drawn No. 13 B. W. G.	Copper.	Exh. from winches.
K262	1	5" Lap welded pipe	Galv. steel.	Exh. from winches.
K263	1	4½" Lap welded pipe	Galv. steel.	Exh. from winches.
K264	1	4½" Lap welded pipe	Galv. steel.	Exh. from winches.
K265	1	4½" Lap welded pipe	Galv. steel.	Exh. from winches.
K266	1	4½" Lap welded pipe	Galv. steel.	Exh. from winches.
K267	1	4½" Lap welded pipe	Galv. steel.	Exh. from winches.
K268	1	4½" Lap welded pipe	Galv. steel.	Exh. from winches.

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9,000-TON D. W. FREIGHTER

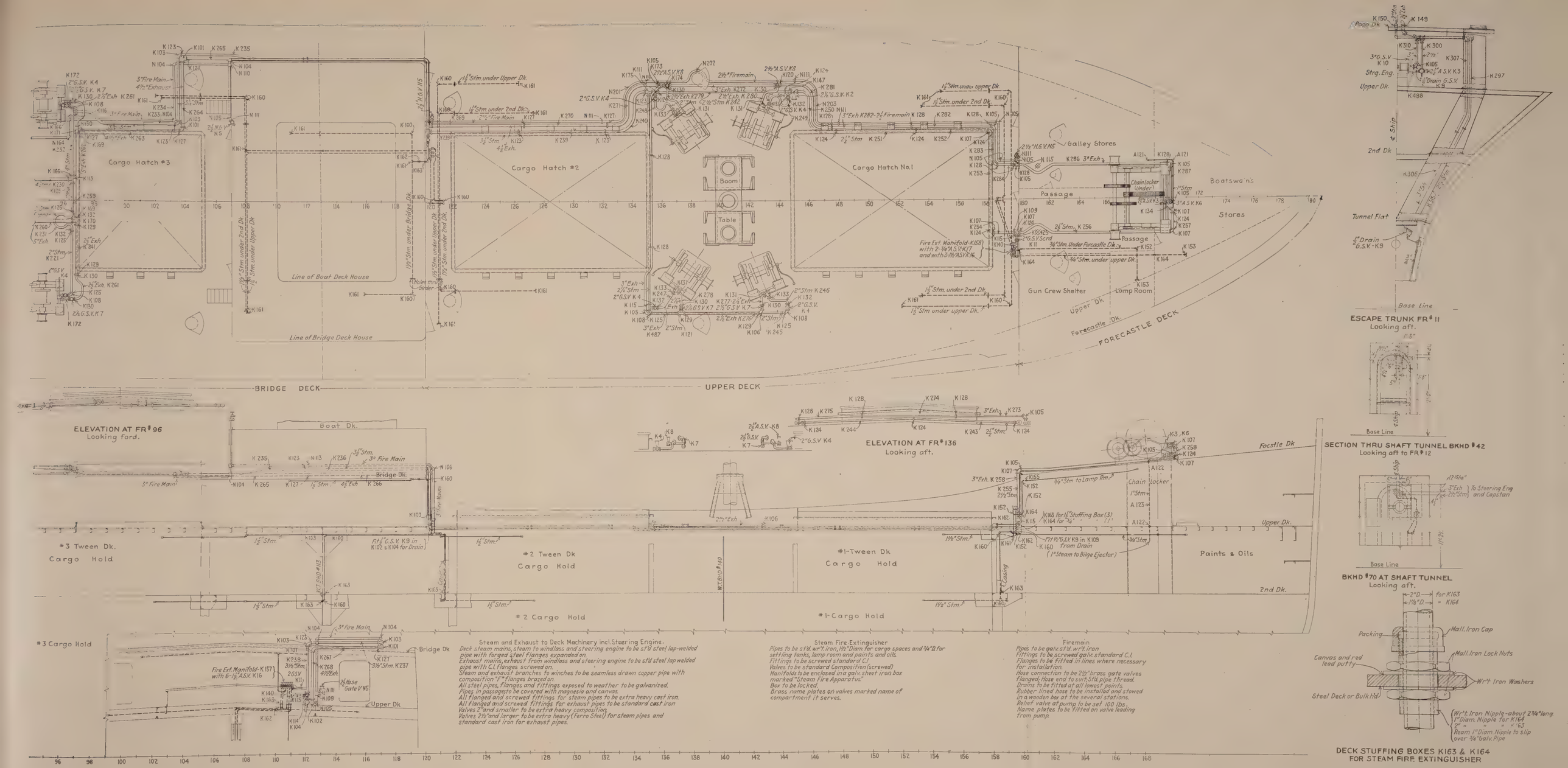
For Arrangement Plans See Plates XLIX and L Opposite Page 634

LIST OF MATERIAL FOR ONE SHIP—Continued

Pc. No.	No. Pcs.	Name	Mat'l	Remarks
K269	1	4½" Lap welded pipe.....	Galv. steel.	Exh. from winches.
K270	1	4½" Lap welded pipe.....	Galv. steel.	Exh. from winches.
K271	1	4½" Lap welded pipe.....	Galv. steel.	Exh. from winches.
K272	1	3" Lap welded pipe.....	Galv. steel.	Exh. from winches.
K273	1	3" Lap welded pipe.....	Galv. steel.	Exh. from winches.
K274	1	3" Lap welded pipe.....	Galv. steel.	Exh. from winches.
K275	1	3" Lap welded pipe.....	Galv. steel.	Exh. from winches.
K276	1	2½" Lap welded pipe.....	Galv. steel.	Exh. from winches.
K277	1	2½" Seamless drawn No. 13 B. W. G.	Copper.	Exh. from winches.
K278	1	2½" Seamless drawn No. 13 B. W. G.	Copper.	Exh. from winches.
K279	1	2½" Seamless drawn No. 13 B. W. G.	Copper.	Exh. from winches.
K280	1	2½" Seamless drawn No. 13 B. W. G.	Copper.	Exh. from winches.
K281	1	3" Lap welded pipe.....	Galv. steel.	Exh. from windlass.
K282	2	3" Lap welded pipe.....	Galv. steel.	Exh. from windlass.
K283	1	3" Lap welded pipe.....	Galv. steel.	Exh. from windlass.
K284	1	3" Lap welded pipe.....	Galv. steel.	Exh. from windlass.
K285	1	3" Lap welded pipe.....	Galv. steel.	Exh. from windlass.
K286	1	3" Lap welded pipe.....	Galv. steel.	Exh. from windlass.
K287	1	3" Lap welded pipe.....	Galv. steel.	Exh. from windlass.
K288	1	2" Pipe	W.I.	St'm. to fire ext. Fr. No. 65.
K289	..	2" Pipes 20 lin. ft.....	...	St'm. to fire ext.
K290	..	1½" Pipes 935 lin. ft.....	W.I.	St'm. to fire ext.
K291	..	¾" Pipes 160 lin. ft.....	W.I.	St'm. to fire ext.
K292	1	2½" Lap welded pipe.....	Steel.	St'm. to steer. eng.
K293	4	2½" Lap welded pipe.....	Steel.	St'm. to steer. eng.
K294	1	2½" Lap welded pipe.....	Steel.	St'm. to steer. eng.
K295	1	2½" Lap welded pipe.....	Steel.	St'm. to steer. eng.
K296	1	2½" Lap welded pipe.....	Steel.	St'm. to steer. eng.
K297	1	2½" Lap welded pipe.....	Steel.	St'm. to steer. eng.
K298	1	2½" Lap welded pipe.....	Steel.	St'm. to steer. eng.
K299	1	2½" Lap welded pipe.....	Steel.	St'm. to steer. eng.
K300	1	2½" Lap welded pipe.....	Steel.	St'm. to steer. eng.
K301	..	2" Lap welded pipe, 20 lin. ft.	Galv. steel.	St'm. to capstan.
K302	5	3" Lap welded pipe.....	Steel.	Exh. from steer. eng.
K303	1	3" Lap welded pipe.....	Steel.	Exh. from steer. eng.
K304	1	3" Lap welded pipe.....	Steel.	Exh. from steer. eng.
K305	1	3" Lap welded pipe.....	Steel.	Exh. from steer. eng.
K306	1	3" Lap welded pipe.....	Steel.	Exh. from steer. eng.
K307	1	3" Lap welded pipe.....	Steel.	Exh. from steer. eng.
K308	1	3" Lap welded pipe.....	Steel.	Exh. from steer. eng.

LIST OF MATERIAL FOR ONE SHIP—Continued

Pc. No.	No. Pcs.	Name	Mat'l	Remarks
K309	1	3" Lap welded pipe.....	Steel.	Exh. from steer. eng.
K310	1	3" Lap welded pipe.....	Steel.	Exh. from steer. eng.
K311	1	2½" Lap welded pipe.....	Steel.	Exh. from capstan.
K312	1	2½" Lap welded pipe.....	Steel.	Exh. from capstan.
K313	..	2½" Lap welded pipe 10 lin. ft.	Galv. steel.	Exh. from capstan.
K314	..	¾" Lap welded pipe 150 lin. ft.	Galv. steel.	Steer. eng. pipe drain.
K315	1	2½" Lap welded pipe.....	Steel.	St'm. to steer. eng.
K487	1	3" Lap welded pipe.....	Galv. steel.	Exh. from winches.
K488	1	2½" Lap welded pipe.....	Steel.	St'm. to steer. eng.
A121	2	1" Ell scr'd.....	Galv. C.I.	
A122	4	1" Locknuts	Galv. mall. iron.	
A123	..	1" Pipes 40 lin. ft.....	Galv. steel.	
N4	2	3" Gate valves.....	C.I.	Bolted bonnet.
N5	7	2½" Hose G. V. flg'd, with cap and chain.	Brass.	Bolted bonnet, st'd. pipe thds.
N6	7	2½" Hose 50 feet length...	Canvass rubber lined.	
N84	7	2½" Hose nozzle.....		
N101	1	3½" Bulkhead flange scr'd..	C.I. galv.	
N102	1	3" x 3" x 3½" Tee scr'd....	Galv. C.I.	
N103	2	3½" Ell scr'd.....	Galv. C.I.	
N104	13	3" Ell scr'd.....	Galv. C.I.	
N105	17	2½" Ell scr'd.....	Galv. C.I.	
N106	1	3" 45° Ell scr'd.....	Galv. C.I.	
N107	2	2½" 45° Ell scr'd.....	Galv. C.I.	
N108	2	3" x 3" x 2½" Tee scr'd....	Galv. C.I.	
N109	2	3" x 2½" x 2½".....	Galv. C.I.	
N110	1	3" x 2½" x 3".....	Galv. C.I.	
N111	19	2½" Flange scr'd.....	Galv. C.I.	
N112	1	3½" Double boss flange scr'd.	Galv. C.I.	
N113	10	3" flange scr'd.....	Galv. C.I.	
N114	3	2½" x 2½" x ½" Tee scr'd.	Galv. C.I.	With ½" plug for drains.
N115	2	2½" x 2½" x 2" Tee.....	Galv. C.I.	
N201	1	2½" Pipe	W.I. galv.	
N202	1	2½" Pipe	W.I. galv.	
N203	1	2½" Pipe	W.I. galv.	
N204	1	2½" Pipe	W.I. galv.	
N205	..	2½" Pipe 250 lin. ft.....	W.I. galv.	
N206	..	3" Pipe 170 lin. ft.....	W.I. galv.	
N207	..	3½" Pipe 20 lin. ft.....	W.I. galv.	



ELEVATION AT FR# 96
Looking ford.

ELEVATION AT FR# 136
Looking aft.

ESCAPE TRUNK FR# 11
Looking aft.

SECTION THRU SHAFT TUNNEL BKHD #42
Looking aft to FR# 12

BKHD #70 AT SHAFT TUNNEL
Looking aft.

DECK STUFFING BOXES K163 & K164
FOR STEAM FIRE EXTINGUISHER

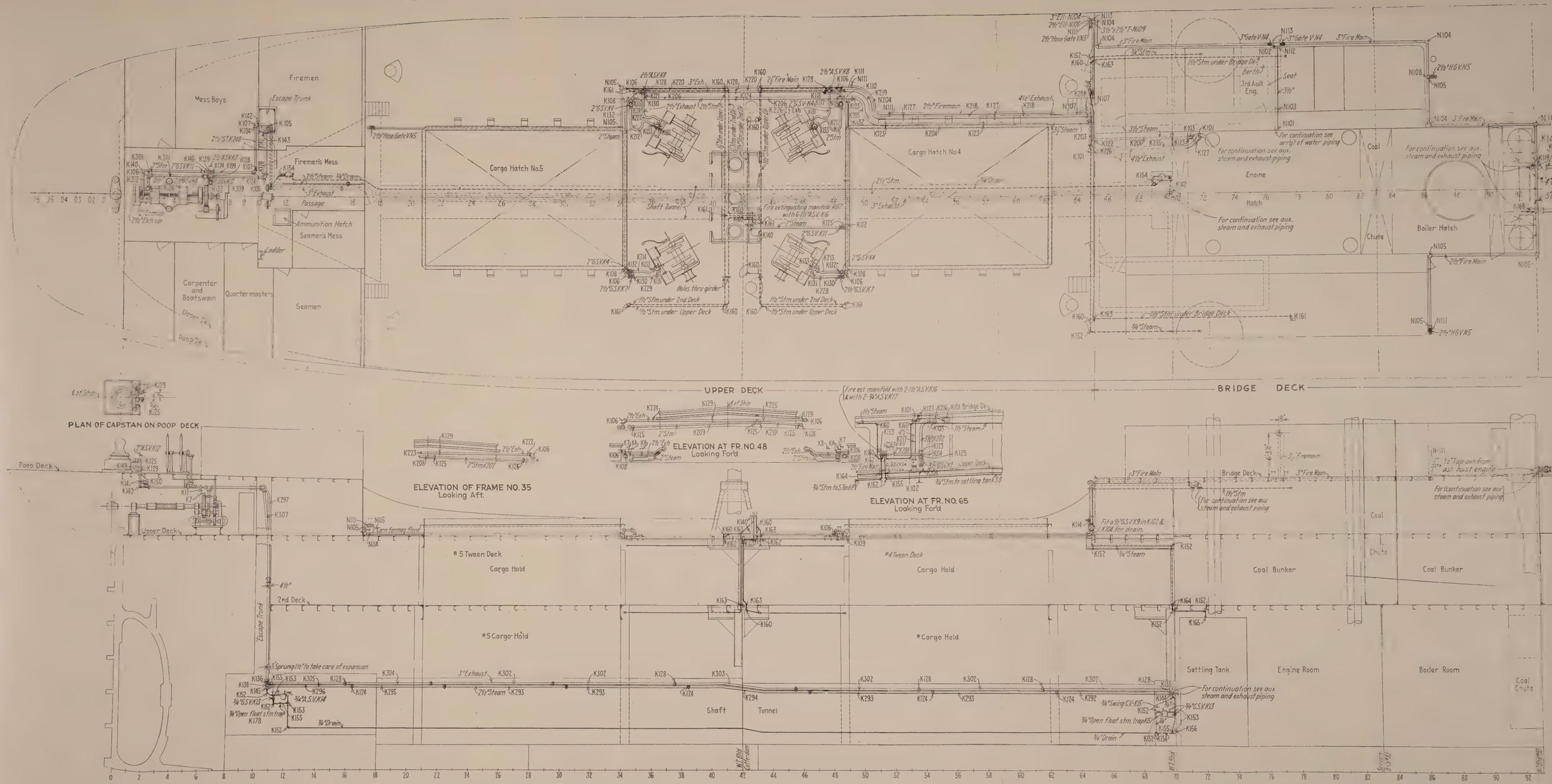
Steam and Exhaust to Deck Machinery incl. Steering Engine.
Deck steam mains, steam to windlass and steering engine to be std steel lap-welded pipe with forged steel flanges expanded on.
Exhaust mains, exhaust from windlass and steering engine to be std steel lap welded pipe with C.I. flanges screwed on.
Steam and exhaust branches to winches to be seamless drawn copper pipe with composition "F" flanges brazed on.
All steel pipes, flanges and fittings exposed to weather to be galvanized.
Pipes in passage to be covered with magnesia and canvas.
All flanged and screwed fittings for steam pipes to be extra heavy cast iron.
All flanged and screwed fittings for exhaust pipes to be standard cast iron
Valves 2" and smaller to be extra heavy composition.
Valves 2½" and larger to be extra heavy (Terro Steel) for steam pipes and standard cast iron for exhaust pipes.

Steam Fire-Extinguisher
Pipes to be std. wr't. iron, 1½" Diam for cargo spaces and ¾" Ø for settling tanks, lamp room and paints and oils.
Fittings to be screwed standard C.I.
Valves to be standard Composition (screwed)
Manifolds to be enclosed in a galv. sheet iron box marked "Steam Fire Apparatus."
Box to be locked.
Brass name plates on valves marked name of compartment it serves.

Firemain
Pipes to be galv. std. wr't. iron
Fittings to be screwed galv. standard C.I.
Flanges to be fitted in lines where necessary for installation.
Hose connection to be 2½" brass gate valves flanged, Hose end to suit 5½ pipe thread.
Drains to be fitted at all lowest points.
Rubber lined hose to be installed and stowed in a wooden box at the several stations.
Relief valve at pump to be set 100 lbs.
Name plates to be fitted on valve leading from pump.

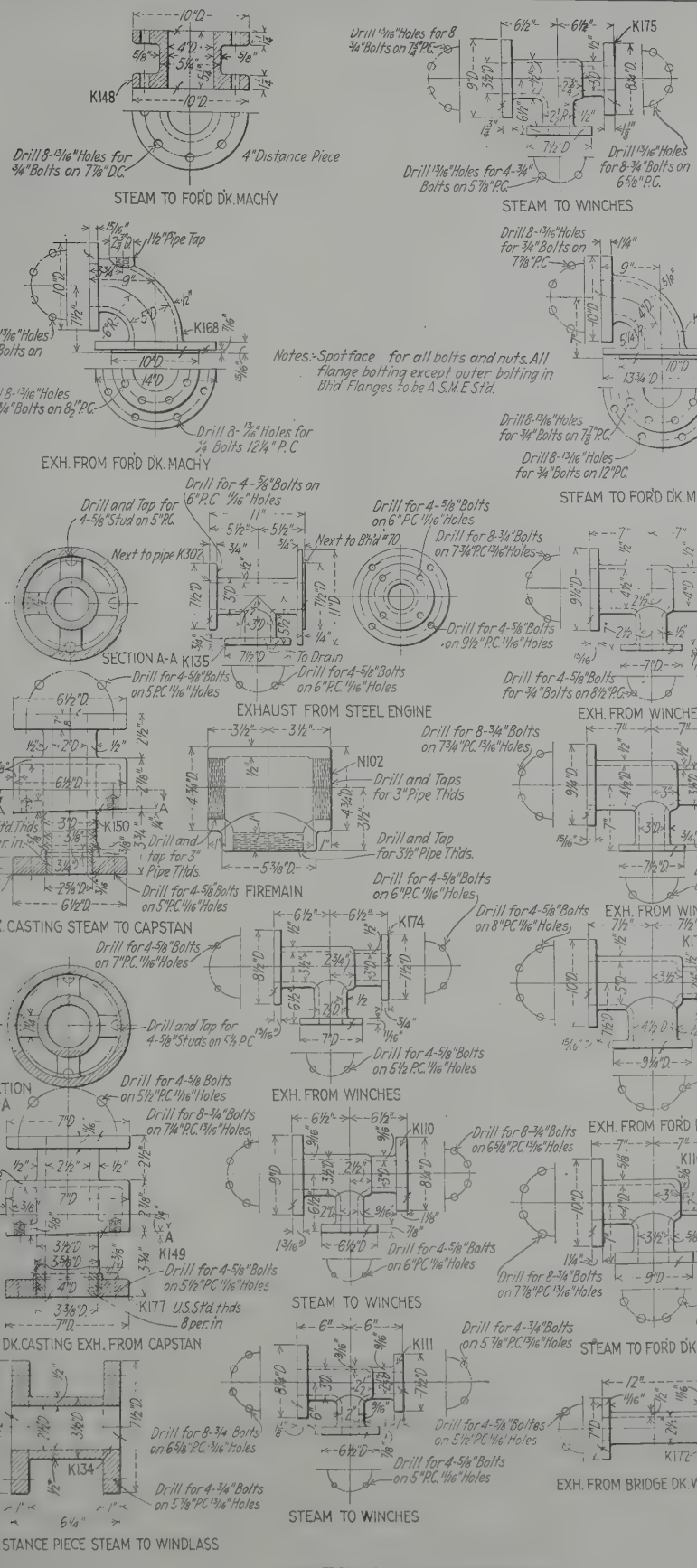
ARRANGEMENT OF DECK MACHINERY, PIPING AND FIREMAINS
9,000-TON D. W. FREIGHTER

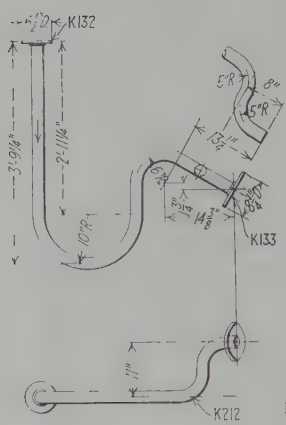
PLATE XLIX



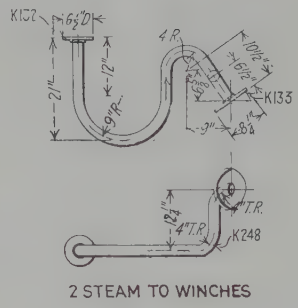
ARRANGEMENT OF DECK MACHINERY, PIPING AND FIREMAINS
9,000-TON D. W. FREIGHTER

PLATE L

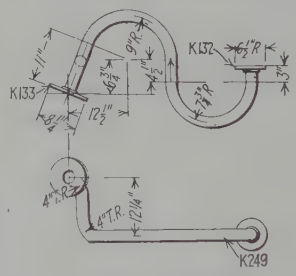

K148
Drill 8-13/16" Holes for 3/4" Bolts on 7 1/8" D.C.
4" Distance Piece
STEAM TO FORD DK. MACHY
Drill 13/16" Holes for 3/4" Bolts on 7 1/8" P.C.
K175
Drill 13/16" Holes for 4-3/4" Bolts on 5 7/8" P.C.
Drill 13/16" Holes for 8-3/4" Bolts on 6 5/8" P.C.
STEAM TO WINCHES
1 1/2" Pipe Tap
K168
Drill 8-13/16" Holes for 3/4" Bolts on 8 1/2" P.C.
Drill 8-13/16" Holes for 3/4" Bolts on 8 1/2" P.C.
Drill 8-13/16" Holes for 1/4" Bolts 12 1/4" P.C.
EXH. FROM FORD DK. MACHY
Notes:- Spot face for all bolts and nuts. All flange bolting except outer bolting in U/tld Flanges to be A.S.M.E Std.
K119
Drill 8-13/16" Holes for 3/4" Bolts on 7 1/8" P.C.
Drill 8-13/16" Holes for 3/4" Bolts on 12" P.C.
STEAM TO FORD DK. MACHY
Drill and Tap for 4-5/8" Stud on 5" P.C.
Drill for 4-5/8" Bolts on 6" P.C. 1 1/16" Holes
Next to pipe K302
Next to B'h'd "70
Drill for 4-5/8" Bolts on 6" P.C. 1 1/16" Holes
SECTION A-A
K135
Drill for 4-5/8" Bolts on 9 1/2" P.C. 1 1/16" Holes
To Drain
Drill for 4-5/8" Bolts on 6" P.C. 1 1/16" Holes
Drill for 4-5/8" Bolts on 5" P.C. 1 1/16" Holes
EXHAUST FROM STEEL ENGINE
Drill for 8-3/4" Bolts on 7 3/4" P.C. 13/16" Holes
Drill for 8-5/8" Bolts on 7 1/2" P.C. 1 1/16" Holes
K117
Drill for 4-5/8" Bolts for 3/4" Bolts on 8 1/2" P.C.
EXH. FROM WINCHES
K150
U.S. Std. Thds 8 per in.
K176
Drill for 4-5/8" Bolts on 5" P.C. 1 1/16" Holes
N102
Drill and Taps for 3" Pipe Thds
Drill and Tap for 3 1/2" Pipe Thds.
Drill and tap for 3" Pipe Thds.
FIREMAIN
Drill for 8-3/4" Bolts on 7 3/4" P.C. 13/16" Holes
Drill for 4-5/8" Bolts on 7" P.C. 1 1/16" Holes
EXH. FROM WINCHES
2" DK. CASTING STEAM TO CAPSTAN
Drill for 4-5/8" Bolts on 6" P.C. 1 1/16" Holes
K173
Drill for 4-5/8" Bolts on 7" P.C. 1 1/16" Holes
Drill for 4-5/8" Bolts on 6" P.C. 1 1/16" Hole
K174
Drill for 4-5/8" Bolts on 8" P.C. 1 1/16" Holes
EXH. FROM WINCHES
Drill for 4-5/8" Bolts on 7" P.C. 1 1/16" Holes
Drill and Tap for 4-5/8" Studs on C/L P.C.
K171
Drill for 4-5/8" Bolts on 5 1/2" P.C. 1 1/16" Holes
Drill for 4-5/8" Bolts on 5 1/2" P.C. 1 1/16" Holes
SECTION A-A
Drill for 4-5/8 Bolts on 5 1/2" P.C. 1 1/16" Holes
Drill for 8-3/4" Bolts on 7 1/4" P.C. 13/16" Holes
Drill for 8-3/4" Bolts on 7 1/4" P.C. 13/16" Holes
EXH. FROM WINCHES
K110
Drill for 8-3/4" Bolts on 6 5/8" P.C. 13/16" Holes
Drill for 4-5/8" Bolts on 6" P.C. 1 1/16" Holes
EXH. FROM FORD DK. MACHY
Drill for 4-5/8" Bolts on 5" P.C. 1 1/16" Holes
K116
Drill for 8-3/4" Bolts on 7 1/8" P.C. 13/16" Holes
Drill for 8-3/4" Bolts on 7 1/4" P.C. 13/16" Holes
K149
Drill for 4-5/8" Bolts on 5 1/2" P.C. 1 1/16" Holes
K177 U.S. Std. thds 8 per in.
STEAM TO WINCHES
2 1/2" DK. CASTING EXH. FROM CAPSTAN
K111
Drill for 4-3/4" Bolts on 5 7/8" P.C. 13/16" Holes
STEAM TO FORD DK MACHY
Drill for 8-3/4 Bolts on 6 5/8" P.C. 3/16" Holes
Drill for 4-5/8" Bolts on 5 1/2" P.C. 1 1/16" Holes
K134
Drill for 4-3/4" Bolts on 5 7/8" P.C. 13/16" Holes
Drill for 4-5/8" Bolts on 5" P.C. 1 1/16" Holes
K172
EXH. FROM BRIDGE DK. WINCHES
STEAM TO WINCHES
2 1/2" DISTANCE PIECE STEAM TO WINDLASS



2" STEAM TO WINCHES



2 STEAM TO WINCHES



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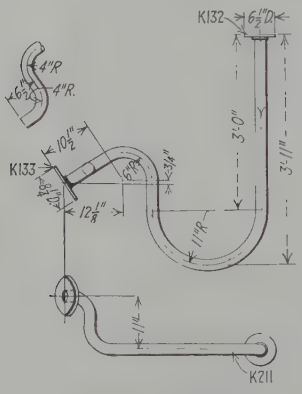

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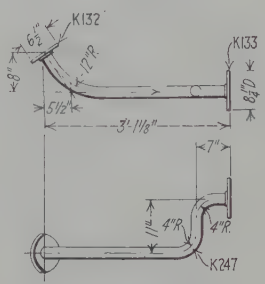

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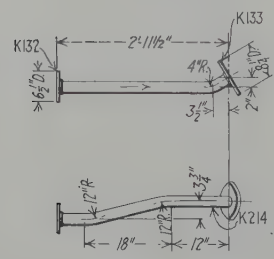

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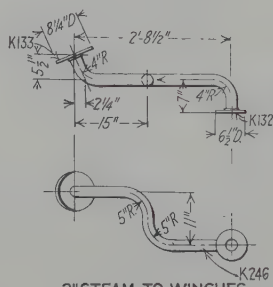

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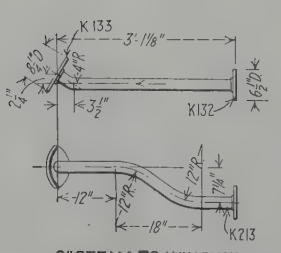

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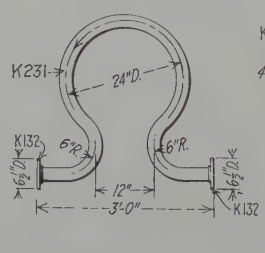

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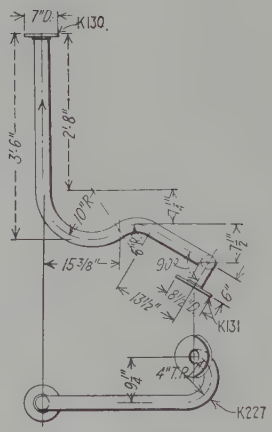
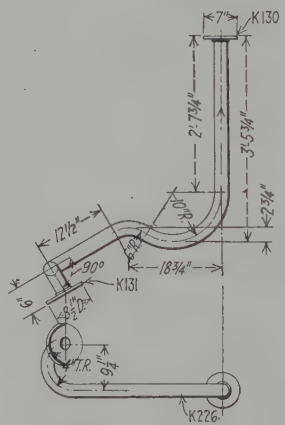


2½" EXH. FROM WINCHES



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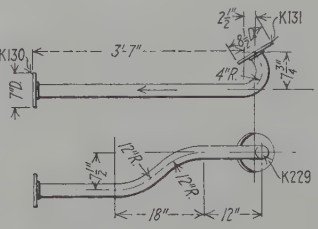

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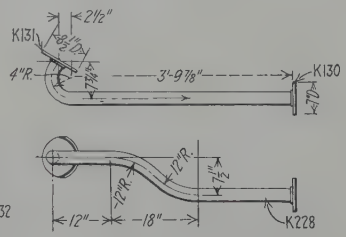

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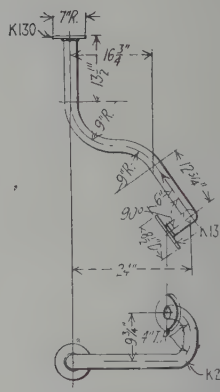

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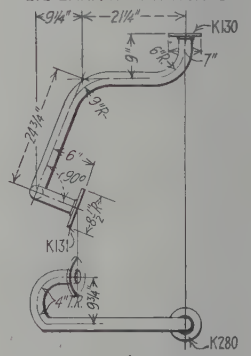

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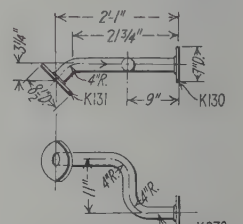

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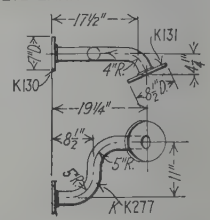

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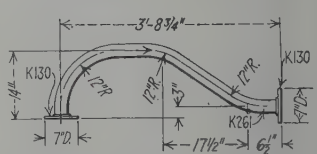
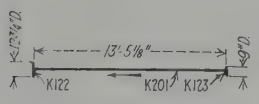
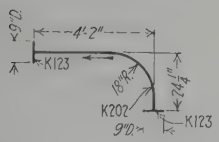


2½" EXH. FROM WINCHES

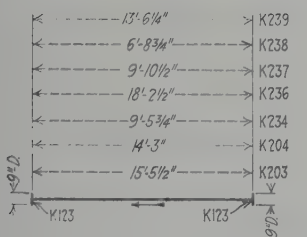
9,000-TON D. W. FREIGHTER



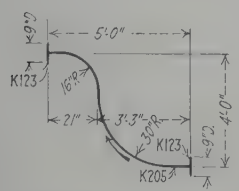
3½" STEAM TO AFT WINCHES



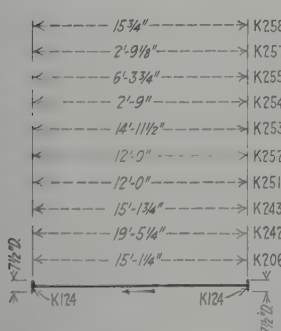
3½" STEAM TO AFT WINCHES



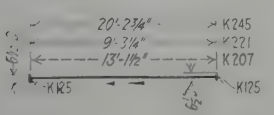
3½" STEAM TO FORD AND AFT WINCHES



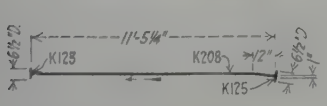
3½" STEAM TO AFT WINCHES



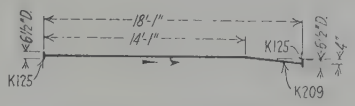
2½" STEAM TO FORD AND AFT WINCHES AND WINDLASS



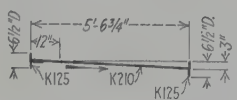
2½" STEAM TO WINCHES



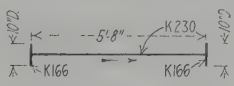
2" STEAM TO AFT WINCHES



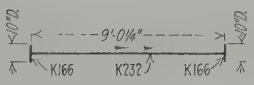
2" STEAM TO AFT WINCHES



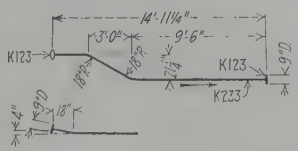
2" STEAM TO AFT. WINCHES



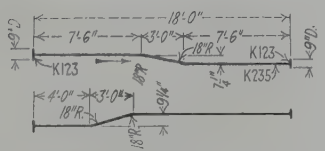
4" STEAM TO FORD DK. MACHY



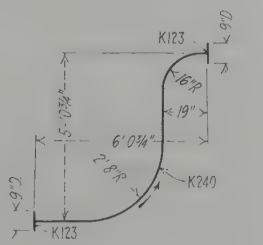
4" STEAM TO FORD DK. MACHY



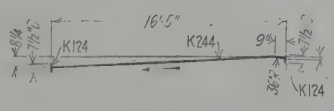
3½" STEAM TO FORD DK. MACHY



3½" STEAM TO FORD DK. MACHY

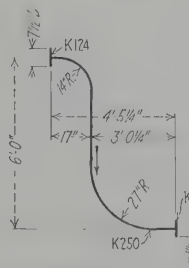


3½" STEAM TO FORD DK. MACHY

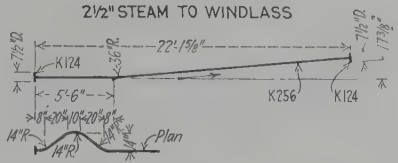


2½" STEAM TO FORD WINCHES

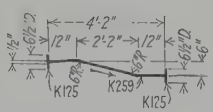
Notes:- Finished dimensions given allowance to be made in length for turning in on flanges and variation in work. All flange bolting except outer bolting on b'th'd. flanges to be A.S.M.E. Standard. Arrow indicates direction of flow.



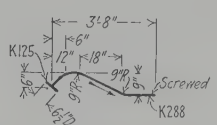
2½" STEAM TO WINDLASS



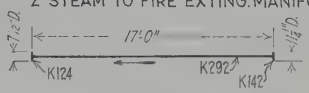
2½ STEAM TO WINDLASS



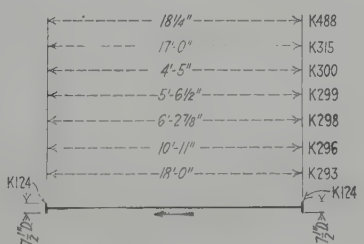
2" STEAM TO BRIDGE WINCHES



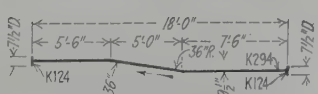
2" STEAM TO FIRE EXTING. MANIFOLD



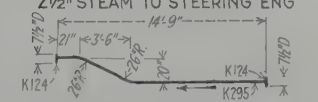
2½" STEAM TO STEERING ENG.



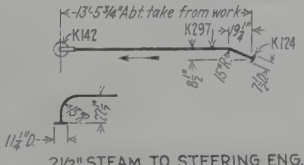
2½" STEAM TO STEERING ENG.



2½" STEAM TO STEERING ENG



2½" STEAM TO STEERING ENG.



2½" STEAM TO STEERING ENG.

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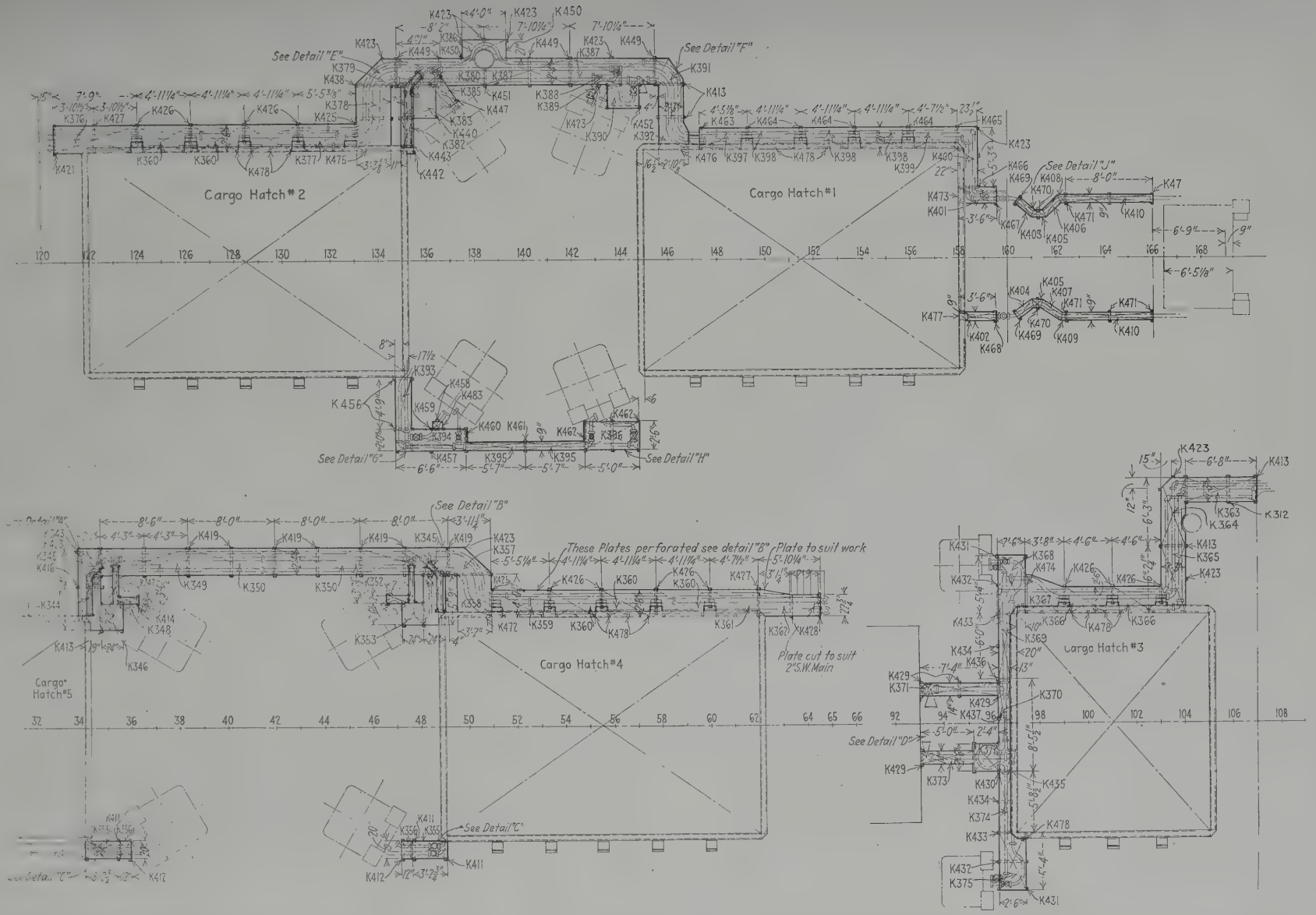
For Arrangement Plans See Pages 639-640-641 and 642

LIST OF MATERIAL FOR PIPE CASING

Pc. No.	No. Pcs.	Name	Mat'l	Remarks
K343	1	¼" Checkered plate	Steel	94" long x 31" wide.
K344	2	¼" Checkered plate	Steel	42" long x 12" wide.
K345	2	¼" Checkered plate	Steel	19½" long x 12" wide.
K346	1	¼" Checkered plate	Steel	24" long x 33" wide.
K347	1	¼" Checkered plate	Steel	42½" long x 12" wide.
K348	1	¼" Checkered plate	Steel	22" long x 14" wide.
K349	1	¼" Checkered plate	Steel	102" long x 35" wide.
K350	3	¼" Checkered plate	Steel	96" long x 35" wide.
K351	1	¼" Checkered plate	Steel	43½" long x 12" wide.
K352	1	¼" Checkered plate	Steel	25" long x 18" wide.
K353	1	¼" Checkered plate	Steel	24" long x 36" wide.
K354	1	¼" Checkered plate	Steel	66" long x 30" wide.
K355	2	¼" Checkered plate	Steel	43¾" long x 26" wide.
K356	2	¼" Checkered plate	Steel	12" long x 26" wide.
K357	1	¼" Checkered plate	Steel	50¼" long x 35" wide.
K358	1	¼" Checkered plate	Steel	48½" long x 44" wide.
K359	1	¼" Checkered plate	Steel	65¼" long x 33" wide.
K360	6	¼" Checkered plate	Steel	59¼" long x 33" wide.
K361	1	¼" Checkered plate	Steel	55½" long x 33" wide.
K362	1	¼" Checkered plate	Steel	70¼" long x 36" wide.
K363	1	¼" Checkered plate	Steel	80" long x 33" wide.
K364	1	¼" Checkered plate	Steel	78" long x 33" wide.
K365	1	¼" Checkered plate	Steel	74¼" long x 33" wide.
K366	2	¼" Checkered plate	Steel	54" long x 33" wide.
K367	1	¼" Checkered plate	Steel	44" long x 46" wide.
K368	1	¼" Checkered plate	Steel	64" long x 40" wide.
K369	1	¼" Checkered plate	Steel	72" long x 16" wide.
K370	1	¼" Checkered plate	Steel	101½" long x 16" wide.
K371	1	¼" Checkered plate	Steel	88" long x 20" wide.
K372	1	¼" Checkered plate	Steel	28" long x 36" wide.
K373	1	¼" Checkered plate	Steel	60" long x 20" wide.
K374	1	¼" Checkered plate	Steel	68½" long x 16" wide.
K375	1	¼" Checkered plate	Steel	64" long x 36" wide.
K376	1	¼" Checkered plate	Steel	93" long x 36" wide.
K377	1	¼" Checkered plate	Steel	65⅜" long x 33" wide.
K378	1	¼" Checkered plate	Steel	71" long x 45⅜" wide.
K379	1	¼" Checkered plate	Steel	49⅝" long x 34" wide.
K380	1	¼" Checkered plate	Steel	98" long x 34" wide.
K381	1	¼" Checkered plate	Steel	19½" long x 14" wide.
K382	1	¼" Checkered plate	Steel	67½" long x 14" wide.
K383	1	¼" Checkered plate	Steel	36" long x 45" wide.
K384	1	¼" Checkered plate	Steel	39" long x 20" wide.
K385	1	¼" Checkered plate	Steel	36" long x 20" wide.
K386	1	¼" Checkered plate	Steel	54" long x 24" wide.
K387	2	¼" Checkered plate	Steel	94¼" long x 34" wide.
K388	1	¼" Checkered plate	Steel	31½" long x 16½" wide.
K389	1	¼" Checkered plate	Steel	18" long x 12" wide.
K390	1	¼" Checkered plate	Steel	26" long x 42" wide.
K391	1	¼" Checkered plate	Steel	34" long x 31" wide.
K392	1	¼" Checkered plate	Steel	71" long x 37⅛" wide.
K393	1	¼" Checkered plate	Steel	57" long x 23½" wide.
K394	1	¼" Checkered plate	Steel	78" long x 30" wide.
K395	2	¼" Checkered plate	Steel	67" long x 15" wide.
K396	1	¼" Checkered plate	Steel	60" long x 36" wide.
K397	1	¼" Checkered plate	Steel	53⅜" long x 24" wide.
K398	3	¼" Checkered plate	Steel	59¼" long x 24" wide.
K399	1	¼" Checkered plate	Steel	55½" long x 24" wide.
K400	1	¼" Checkered plate	Steel	66" long x 26¼" wide.
K401	1	¼" Checkered plate	Steel	42" long x 24" wide.
K402	1	¼" Checkered plate	Steel	42" long x 15" wide.
K403	1	¼" Checkered plate	Steel	24" long x 15" wide.
K404	1	¼" Checkered plate	Steel	24" long x 15" wide.
K405	2	¼" Checkered plate	Steel	13½" long x 15" wide.
K406	1	¼" Checkered plate	Steel	27" long x 15" wide.
K407	1	¼" Checkered plate	Steel	27" long x 15" wide.
K408	1	¼" Checkered plate	Steel	9¼" long x 15" wide.
K409	1	¼" Checkered plate	Steel	9¼" long x 15" wide.
K410	2	¼" Checkered plate	Steel	96" long x 15" wide.
K483	1	¼" Checkered plate	Steel	8" long x 18" wide.
K411	4	Plate supports—flat bar..	W.I.	2½"x⅜"x4' 9" long.
K412	2	Plate supports—flat bar..	W.I.	2½"x⅜"x5' 7" long.
K413	9	Plate supports—flat bar..	W.I.	2½"x⅜"x4' 5" long.
K414	2	Plate supports—flat bar..	W.I.	2½"x⅜"x3' 11" long.

LIST OF MATERIAL FOR PIPE CASING—Continued

Pc. No.	No. Pcs.	Name	Mat'l	Remarks
K415	2	Plate supports—flat bar..	W.I.	2½"x⅜"x19" long.
K416	1	Plate supports—flat bar..	W.I.	2½"x⅜"x4' 3" long.
K417	7	Plate supports—flat bar..	W.I.	2½"x⅜"x2' 3" long.
K418	1	Plate supports—flat bar..	W.I.	2½"x⅜"x2' 2" long.
K419	9	Plate supports—flat bar..	W.I.	2½"x⅜"x4' 7" long.
K420	1	Plate supports—flat bar..	W.I.	2½"x⅜"x4' 2" long.
K421	3	Plate supports—flat bar..	W.I.	2½"x⅜"x4' 8" long.
K422	2	Plate supports—flat bar..	W.I.	2½"x⅜"x4' 4" long.
K423	14	Plate supports—flat bar..	W.I.	2½"x⅜"x13" long.
K424	1	Plate supports—flat bar..	W.I.	2½"x⅜"x5' 4" long.
K425	2	Plate supports—flat bar..	W.I.	2½"x⅜"x2' 7" long.
K426	11	Plate supports—flat bar..	W.I.	2½"x⅜"x2' 10" long.
K427	2	Plate supports—flat bar..	W.I.	2½"x⅜"x3' 10" long.
K428	2	Plate supports—flat bar..	W.I.	2½"x⅜"x4' 1" long.
K429	4	Plate supports—flat bar..	W.I.	2½"x⅜"x4' 7" long.
K430	2	Plate supports—flat bar..	W.I.	2½"x⅜"x5' 11" long.
K431	2	Plate supports—flat bar..	W.I.	2½"x⅜"x6' 10" long.
K432	2	Plate supports—flat bar..	W.I.	2½"x⅜"x5' 10" long.
K433	2	Plate supports—flat bar..	W.I.	2½"x⅜"x2' 8" long.
K434	2	Plate supports—flat bar..	W.I.	2½"x⅜"x2' 11" long.
K435	1	Plate supports—flat bar..	W.I.	2½"x⅜"x15" long.
K436	1	Plate supports—flat bar..	W.I.	2½'x⅜"x3' 0" long.
K437	1	Plate supports—flat bar..	W.I.	2½"x⅜"x3' 1" long.
K438	2	Plate supports—flat bar..	W.I.	2½"x⅜"x5' 6" long.
K439	1	Plate supports—flat bar..	W.I.	2½"x⅜"x5' 5" long.
K440	1	Plate supports—flat bar..	W.I.	2½"x⅜"x4' 3" long.
K441	1	Plate supports—flat bar..	W.I.	2½"x⅜"x3' 4" long.
K442	1	Plate supports—flat bar..	W.I.	2½"x⅜"x2' 6" long.
K443	1	Plate supports—flat bar..	W.I.	2½"x⅜"x2' 0" long.
K444	1	Plate supports—flat bar..	W.I.	2½"x⅜"x2' 3" long.
K445	1	Plate supports—flat bar..	W.I.	2½"x⅜"x2' 5" long.
K446	1	Plate supports—flat bar..	W.I.	2½"x⅜"x2' 6" long.
K447	1	Plate supports—flat bar..	W.I.	2½"x⅜"x4' 5" long.
K448	1	Plate supports—flat bar..	W.I.	2½"x⅜"x3' 0" long.
K449	5	Plate supports—flat bar..	W.I.	2½"x⅜"x4' 6" long.
K450	2	Plate supports—flat bar..	W.I.	2½"x⅜"x3' 3" long.
K451	1	Plate supports—flat bar..	W.I.	2½"x⅜"x3' 7" long.
K452	2	Plate supports—flat bar..	W.I.	2½"x⅜"x5' 2" long.
K453	1	Plate supports—flat bar..	W.I.	2½"x⅜"x11" long.
K454	1	Plate supports—flat bar..	W.I.	2½"x⅜"x2' 9" long.
K455	1	Plate supports—flat bar..	W.I.	2½"x⅜"x3' 11" long.
K456	2	Plate supports—flat bar..	W.I.	2½"x⅜"x4' 11" long.
K457	2	Plate supports—flat bar..	W.I.	2½"x⅜"x20" long.
K458	1	Plate supports—flat bar..	W.I.	2½"x⅜"x23" long.
K459	1	Plate supports—flat bar..	W.I.	2½"x⅜"x4' 5" long.
K460	1	Plate supports—flat bar..	W.I.	2½"x⅜"x5' 5" long.
K461	1	Plate supports—flat bar..	W.I.	2½"x⅜"x4' 2" long.
K462	3	Plate supports—flat bar..	W.I.	2½"x⅜"x5' 11" long.
K463	1	Plate supports—flat bar..	W.I.	2½"x⅜"x3' 1" long.
K464	4	Plate supports—flat bar..	W.I.	2½"x⅜"x2' 3" long.
K465	1	Plate supports—flat bar..	W.I.	2½"x⅜"x3' 1" long.
K466	1	Plate supports—flat bar..	W.I.	2½"x⅜"x3' 2" long.
K467	1	Plate supports—flat bar..	W.I.	2½"x⅜"x3' 8" long.
K468	1	Plate supports—flat bar..	W.I.	2½"x⅜"x2' 11" long.
K469	2	Plate supports—flat bar..	W.I.	2½"x⅜"x3' 4" long.
K470	2	Plate supports—flat bar..	W.I.	2½"x⅜"x3' 0" long.
K471	6	Plate supports—flat bar..	W.I.	2½"x⅜"x2' 7" long.
K472	1	2½"x2½"x¼" Angle bar.	Steel	2' 10" long.
K473	3	2"x2"x¼" Angle bar.....	Steel	16" long.
K474	1	2½"x2½"x¼" Angle bar.	Steel	3' 5" long.
K475	1	2½"x2½"x¼" Angle bar.	Steel	3' 0" long.
K476	1	2½"x2½"x¼" Angle bar.	Steel	2' 6½" long.
K477	1	2"x2"x¼" Angle bar.....	Steel	7" long.
K478	55	2½"x2½"x¼" Angle bar clips	Steel	2½" long.
K479	2	2½"x⅜" Flat bar.....	W.I.	7" long.
K480	1	2½"x⅜" Flat bar.....	W.I.	8" long.
K481	1	2½"x⅜" Flat bar.....	W.I.	6" long.
K482	6	2½"x⅜" Flat bar.....	W.I.	9" long.
K484	475	½" Bolts	Steel	1¾" long.
K485	800	⅜" Flat head countersunk screws	Brass	⅝" long.



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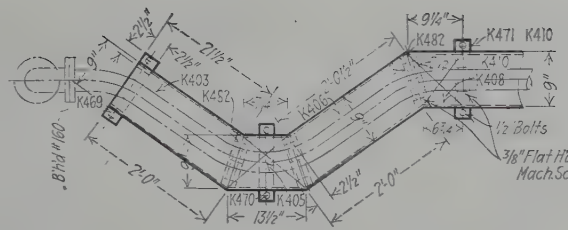

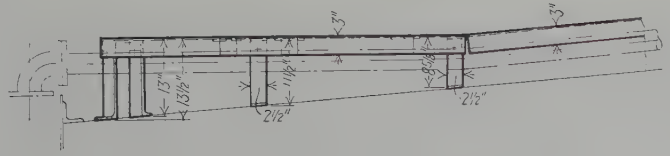

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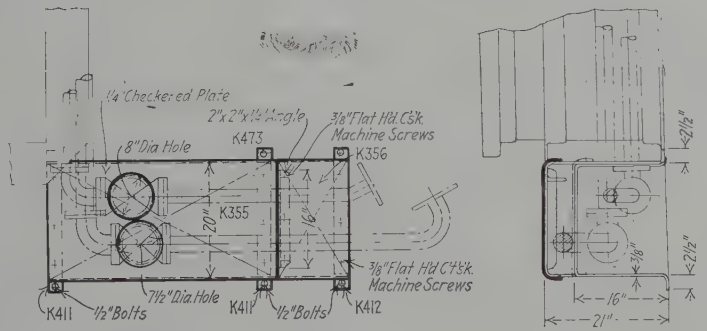

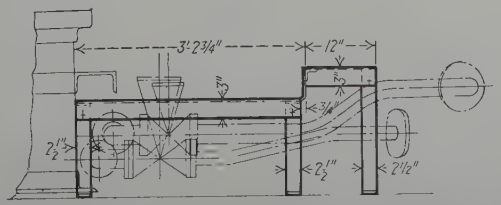

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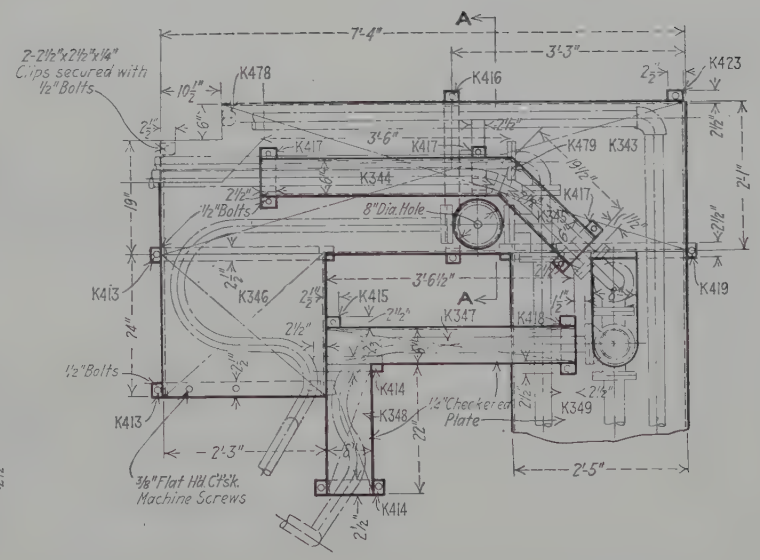
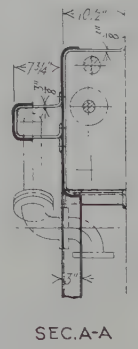
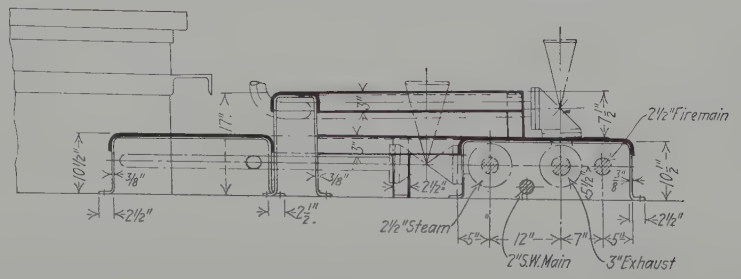
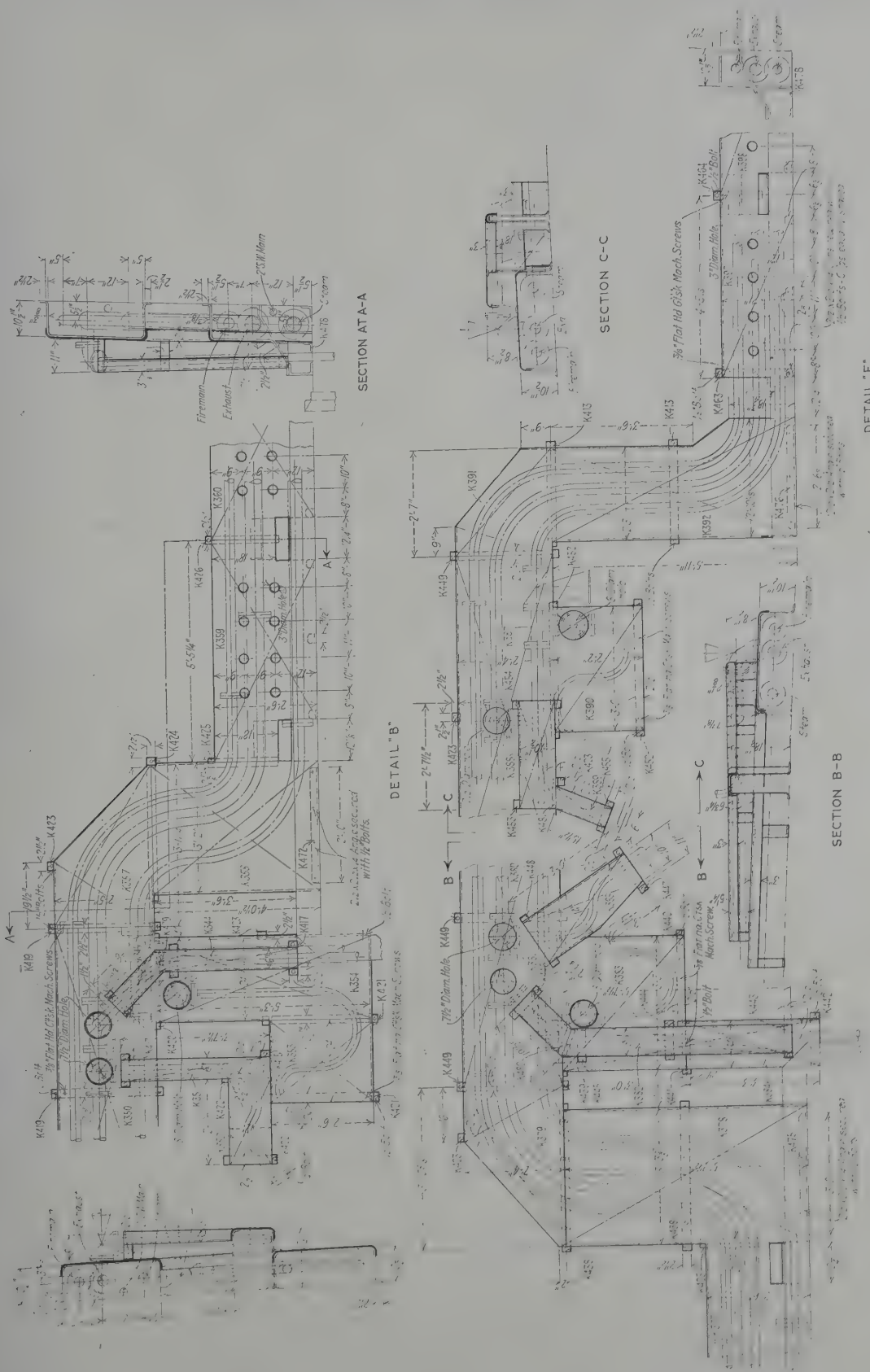






DETAIL "A"

See Page 638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SECTION C-C
DETAIL "B"
DETAIL "F"
SECTION B-B
DETAIL "E"
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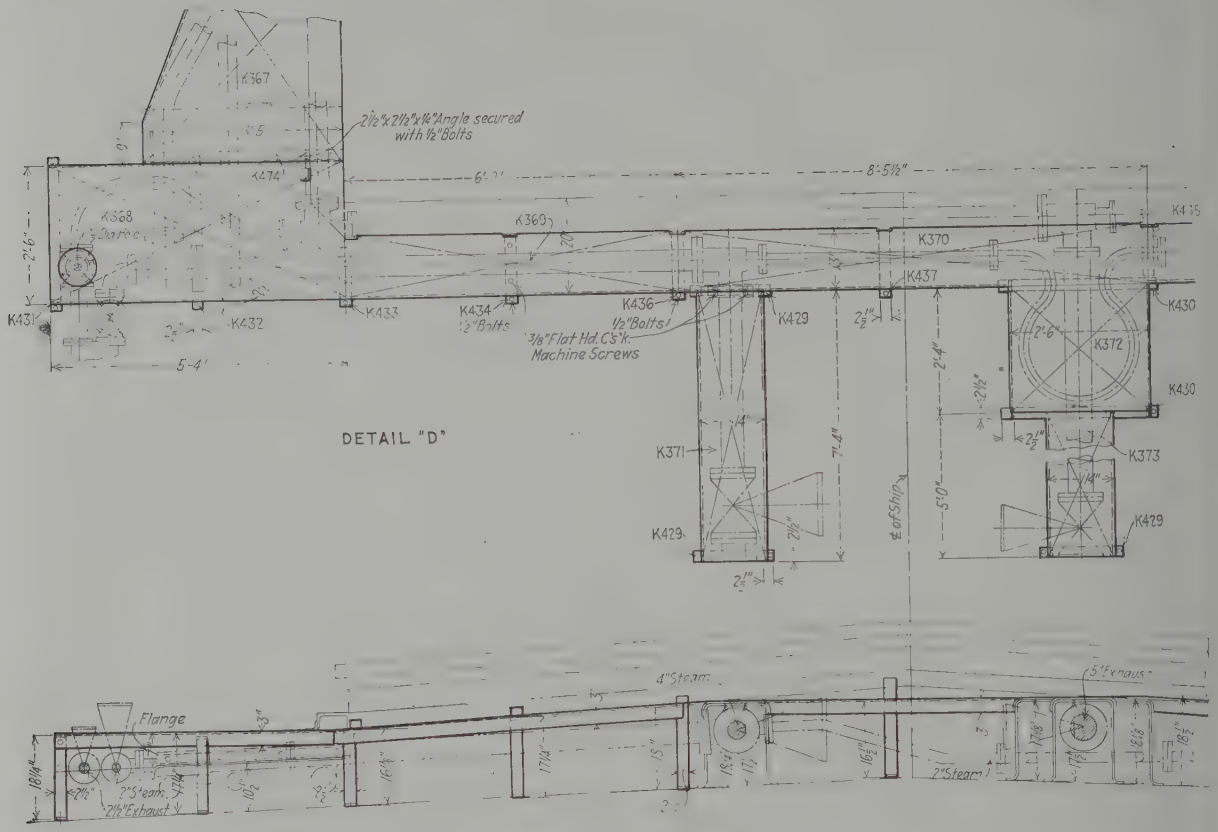
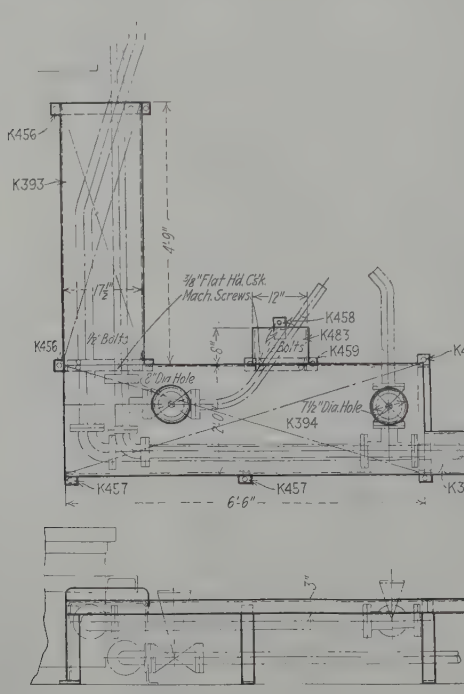
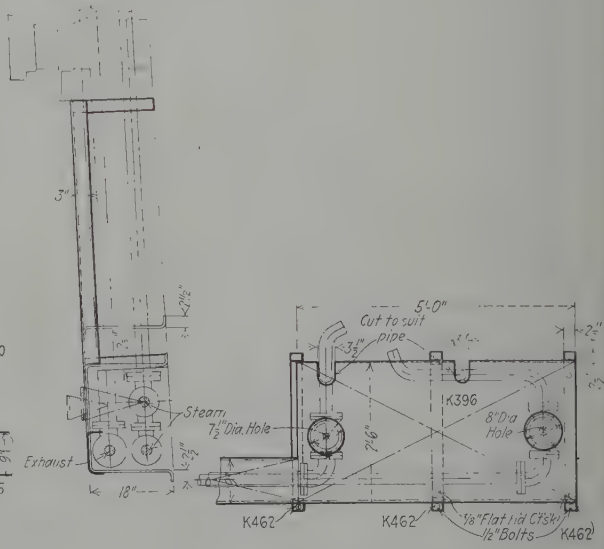
See Page 638







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AUXILIARY FIVE MASTED SCHOONER

For Arrangement Plans See Pages 648-649-650 and 651

LIST OF PIPES FOR ONE SHIP

No.	Mat'l	Dia.	Thickness	Service
1	Steel	3½"	Standard	Steam outlet from port boiler.
2	Steel	3½"	Standard	Steam outlet from starboard boiler.
3	Steel tubing	3½"	.212"	Steam to port main engine.
4	Steel tubing	3½"	.212"	Steam to starboard main engine.
5	Steel tubing	3½"	.212"	Main steam cross-over line, starboard to port boiler.
6	Steel	3½"	Standard	Escape to starboard boiler.
7	Steel	3½"	Standard	Escape to port boiler.
8	Steel	1½"	Standard	Steam to starboard whistle.
9	Steel	1½"	Standard	Steam to port whistle.
10	Steel	2½"	Standard	Auxiliary steam to starboard machinery.
11	Steel	3"	Standard	Auxiliary steam to port machinery.
12	Steel	3"	Standard	Auxiliary steam, cross-over, starboard to port boiler.
13	Steel	3"	Standard	Auxiliary steam cross-over starboard to port boiler.
14	Steel	2½"	Standard	Auxiliary steam to deck machinery forward.
15	Steel	3"	Standard	Auxiliary steam to deck machinery forward.
16	Steel	3"	Standard	Auxiliary steam to auxiliary machinery port side.
17	Steel	3"	Standard	Auxiliary steam to auxiliary machinery, port side.
18	Steel	3"	Standard	Auxiliary steam to auxiliary machinery, port side.
19	Steel	3"	Standard	Auxiliary steam to auxiliary machinery, port side.
20	Steel	3"	Standard	Auxiliary steam to auxiliary machinery, port side.
21	Steel	2"	Standard	Auxiliary steam to generator and air pump.
22	Steel	1"	Standard	Auxiliary steam to air pump.
23	Steel	1"	Standard	Auxiliary steam to air pump.
24	Steel	2"	Standard	Auxiliary steam to deck winch.
25	Steel	1"	Standard	Auxiliary steam to steam heaters, forward.
26	Steel	1¼"	Standard	Auxiliary steam to evaporator.
27	Steel	1¼"	Standard	Auxiliary steam to evaporator.
28	Steel	1¼"	Standard	Auxiliary steam to evaporator.
29	Steel	1¼"	Standard	Auxiliary steam to evaporator.
30	Steel	⅜"	Standard	Auxiliary steam to sea valve strainer, port side.
31	Steel	⅜"	Standard	Auxiliary steam to sea valve strainer, port side.
32	Steel	⅜"	Standard	Auxiliary steam to sea valve strainer, port side.
33	Steel	¾"	Standard	Auxiliary steam to evaporator and sanitary pumps.
34	Steel	½"	Standard	Auxiliary steam to evaporator feed pump,
35	Steel	½"	Standard	Auxiliary steam to evaporator feed pump.
36	Steel	½"	Standard	Auxiliary steam to sanitary pump.
37	Steel	½"	Standard	Auxiliary steam to sanitary pump.
38	Steel	2"	Standard	Auxiliary steam to fire and bilge pump.
39	Steel	1½"	Standard	Auxiliary steam to circulation pump.
40	Steel	1½"	Standard	Auxiliary steam to generator.
41	Steel	1½"	Standard	Auxiliary steam to generator.

LIST OF PIPES FOR ONE SHIP—Continued

No.	Mat'l	Dia.	Thickness	Service
42	Steel	1½"	Standard	Auxiliary steam to generator.
43	Steel	1½"	Standard	Auxiliary steam to steam heat. and smothering line, aft.
44	Steel	1½"	Standard	Auxiliary steam to smothering pipes, aft.
45	Steel	1"	Standard	Auxiliary steam to steam heat., aft.
46	Steel	1½"	Standard	Auxiliary steam to auxiliary machinery, starboard.
47	Steel	⅜"	Standard	Auxiliary steam to fresh water pump.
48	Steel	1¼"	Standard	Auxiliary steam to feed pumps Nos. 1 and 2.
49	Steel	1"	Standard	Auxiliary steam to feed pump No. 2.
50	Steel	1"	Standard	Auxiliary steam to feed pump No. 1.
51	Steel	1"	Standard	Auxiliary steam to feed pump No. 1.
52	Steel	2"	Standard	Auxiliary steam to inspirator.
53	Steel	2"	Standard	Auxiliary steam to inspirator.
54	Steel	2"	Standard	Auxiliary steam to main engines and bleeder.
55	Steel	2"	Standard	Auxiliary steam to main engines and bleeder.
56	Steel	1¼"	Standard	Auxiliary steam to bypass, starboard engine.
57	Steel	1¼"	Standard	Auxiliary steam to bypass, port engine.
58	Steel	2"	Standard	Bleeder to condenser.
59	Copper	8"	.072"	Exhaust port engine to condenser.
60	Copper	8"	.072"	Exhaust, starboard engine to condenser.
61	Black iron	4"	Standard	Auxiliary exhaust to condenser.
62	Black iron	3"	Standard	Auxiliary exhaust to condenser.
63	Black iron	1"	Standard	Auxiliary exhaust to condenser.
64	Black iron	¾"	Standard	Auxiliary exhaust to condenser.
65	Black iron	1½"	Standard	Auxiliary exhaust from circulating pump.
66	Black iron	1½"	Standard	Auxiliary exhaust from circulating pump.
67	Black iron	1½"	Standard	Auxiliary exhaust from circulating pump.
68	Black iron	2½"	Standard	Auxiliary exhaust from fire and bilge pump.
69	Black iron	2½"	Standard	Auxiliary exhaust from fire and bilge pump.
70	Black iron	2½"	Standard	Auxiliary exhaust from fire and bilge pump.
71	Black iron	¾"	Standard	Auxiliary exhaust from sanitary pump.
72	Black iron	¾"	Standard	Auxiliary exhaust from sanitary pump.
73	Black iron	¾"	Standard	Auxiliary exhaust from sanitary pump.
74	Black iron	¾"	Standard	Auxiliary exhaust from evaporator feed pump.
75	Black iron	¾"	Standard	Auxiliary exhaust from evaporator feed pump.
76	Black iron	¾"	Standard	Auxiliary exhaust from evaporator feed pump.
77	Black iron	2"	Standard	Auxiliary exhaust from generator.
78	Black iron	2"	Standard	Auxiliary exhaust from generator.
79	Black iron	2"	Standard	Auxiliary exhaust from generator.

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AUXILIARY FIVE MASTED SCHOONER

For Arrangement Plans See Pages 648-649-650 and 651

LIST OF PIPES FOR ONE SHIP—Continued

No.	Mat'l	Dia.	Thickness	Service
80	Black iron.....	2"	Standard	Auxiliary exhaust from generator.
81	Black iron.....	2"	Standard	Auxiliary exhaust from generator.
82	Black iron.....	5"	Standard	Auxiliary exhaust to condenser.
83	Black iron.....	2½"	Standard	Evaporator vapor line to condenser.
84	Black iron.....	2½"	Standard	Evaporator vapor line to condenser.
85	Black iron.....	2½"	Standard	Evaporator vapor line to condenser.
86	Black iron.....	4"	Standard	Auxiliary exhaust to condenser and heater.
87	Black iron.....	4"	Standard	Auxiliary exhaust to condenser and heater.
88	Black iron.....	4"	Standard	Auxiliary exhaust to condenser and heater.
89	Black iron.....	4"	Standard	Auxiliary exhaust to condenser and heater.
90	Black iron.....	3"	Standard	Auxiliary exhaust from forward machinery.
91	Black iron.....	3"	Standard	Auxiliary exhaust from forward machinery.
92	Black iron.....	3"	Standard	Auxiliary exhaust to air.
93	Black iron.....	3"	Standard	Discharge to condenser from feed heater, back pressure valve.
94	Black iron.....	3"	Standard	Discharge to condenser from feed heater, back pressure valve.
95	Black iron.....	3"	Standard	Discharge to condenser from feed heater, back pressure valve.
96	Black iron.....	3"	Standard	Discharge to condenser from feed heater, back pressure valve.
97	Black iron.....	1¼"	Standard	Auxiliary exhaust from air pump.
98	Black iron.....	1¼"	Standard	Auxiliary exhaust from air pump.
99	Black iron.....	2"	Standard	Auxiliary exhaust from feed pumps Nos. 1 and 2.
100	Black iron.....	1¼"	Standard	Auxiliary exhaust from feed pump No. 1.
101	Black iron.....	1¼"	Standard	Auxiliary exhaust from feed pump No. 1.
102	Black iron.....	1¼"	Standard	Auxiliary exhaust from feed pump No. 2.
103	Black iron.....	1¼"	Standard	Auxiliary exhaust from feed pump No. 2.
104	Black Iron....	½"	Standard	Auxiliary exhaust from fresh water pump.
105	Black Iron....	½"	Standard	Auxiliary exhaust from fresh water pump.
106	Black iron....	½"	Standard	Auxiliary exhaust from fresh water pump.
107	Black Iron....	1¼"	Standard	Trap drain, aft.
108	Black Iron....	1"	Standard	Discharge from trap, aft to hot well.
109	Black Iron....	1"	Standard	Discharge from trap, aft and forward to hot well.
110	Black Iron....	1"	Standard	Discharge from trap, forward to hot well.
111	Black Iron....	1¼"	Standard	Trap drain from forward heaters.
112	Black Iron....	1¼"	Standard	Discharge from feed heater trap to hot well
113	Black Iron....	1¼"	Standard	Discharge from feed heater trap to hot well
114	Black Iron....	1¼"	Standard	Discharge from feed heater trap to hot well.
115	Black Iron....	¾"	Standard	Discharge from evaporator trap to hot well.
116	Black Iron....	¾"	Standard	Discharge from evaporator trap to hot well.

LIST OF PIPES FOR ONE SHIP—Continued

No.	Mat'l	Dia.	Thickness	Service
117	Black Iron....	¾"	Standard	Discharge from evaporator trap to hot well.
118	Black Iron....	¾"	Standard	Discharge from evaporator trap to hot well.
119	Black Iron....	¾"	Standard	Discharge from evaporator trap to hot well.
120	Copper	4"	.125"	Discharge from fire and bilge pump to condenser.
121	Copper	8"	.084"	Main sea suction to circulating pump.
122	Gal. Iron.....	6"	Standard	Bilge injection to circulating pump.
123	Copper	6"	.084"	Discharge from circulating pump to condenser.
124	Copper	6"	.084"	Discharge from condenser overboard.
125	Copper	6"	.084"	Discharge from condenser overboard.
126	Gal. Iron.....	4"	Standard	Discharge from fire and bilge pump to fire line and overboard.
127	Gal. Iron.....	4"	Standard	Discharge from fire and bilge pump overboard.
128	Gal. Iron.....	4"	Standard	Discharge from fire and bilge pump overboard.
129	Gal. Iron.....	2½"	Standard	Discharge from fire and bilge pump to fire line.
130	Gal. Iron.....	2½"	Standard	Discharge from fire and bilge pump to fire line.
131	Gal. Iron.....	2"	Standard	Fire line, forward.
132	Gal. Iron.....	2"	Standard	Fire line, aft.
133	Gal. Iron.....	2"	Standard	Blow-off from evaporator overboard.
134	Gal. Iron.....	2"	Standard	Blow-off from evaporator overboard.
135	Gal. Iron.....	2"	Standard	Blow-off from evaporator overboard.
136	Copper	5"	.084"	Fire and bilge pump suction line.
137	Gal. Iron.....	3"	Standard	Fire and bilge pump suction to bilge manifold.
138	Gal. Iron.....	3"	Standard	Fire and bilge pump suction to bilge manifold.
139	Gal. Iron.....	3"	Standard	Fire and bilge pump suction to after bilge.
140	Gal. Iron.....	3"	Standard	Fire and bilge pump suction to after bilge.
141	Gal. Iron.....	3"	Standard	Fire and bilge pump suction to after bilge.
142	Gal. Iron.....	3"	Standard	Fire and bilge pump suction to engine room bilge.
143	Gal. Iron.....	3"	Standard	Fire and bilge pump suction to engine room bilge.
144	Gal. Iron.....	3"	Standard	Fire and bilge pump suction to engine room bilge.
145	Gal. Iron.....	3"	Standard	Fire and bilge pump suction to forward hold, port.
146	Gal. Iron.....	3"	Standard	Fire and bilge pump suction to forward hold, port.
147	Gal. Iron.....	3"	Standard	Fire and bilge pump suction to forward hold, port.
148	Gal. Iron.....	3"	Standard	Fire and bilge pump suction to forward hold, starboard.
149	Gal. Iron.....	3"	Standard	Fire and bilge pump suction to forward hold, starboard.
150	Gal. Iron.....	3"	Standard	Fire and bilge pump suction to forward hold, starboard.
151	Gal. Iron.....	3"	Standard	Fire and bilge pump suction to forward hold, starboard.
152	Gal. Iron.....	3"	Standard	Fire and bilge pump suction to forward hold, starboard.
153	Gal. Iron.....	3"	Standard	Fire and bilge pump suction to forward hold, starboard.
154	Gal. Iron.....	2½"	Standard	Sanitary pump, sea suction,
155	Gal. Iron.....	2½"	Standard	Sanitary pump, sea suction,

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AUXILIARY FIVE MASTED SCHOONER

For Arrangement Plans See Pages 648-649-650 and 651

LIST OF PIPES FOR ONE SHIP—Continued

No.	Mat'l	Dia.	Thickness	Service
156	Gal. Iron.....	2½"	Standard	Sanitary pump, sea suction,
157	Gal. Iron.....	1½"	Standard	Sanitary pump discharge to gravity tank.
158	Gal. Iron.....	1½"	Standard	Sanitary pump discharge to gravity tank.
159	Gal. Iron.....	1½"	Standard	Sanitary pump discharge to gravity tank.
160	Gal. Iron.....	1½"	Standard	Sanitary pump discharge to gravity tank.
161	Gal. Iron.....	1¼"	Standard	Evaporator feed pump suction.
162	Gal. Iron.....	1¼"	Standard	Evaporator feed pump suction.
163	Gal. Iron.....	¾"	Standard	Evaporator feed pump discharge to evaporator.
164	Gal. Iron.....	¾"	Standard	Evaporator feed pump discharge to evaporator.
165	Copper	5"	.084"	Fire and bilge, sanitary and evaporator pump suction.
166	Copper	6"	.048"	Air pump discharge to hot well.
167	Gal. Iron.....	3"	Standard	Overflow from hot well.
168	Copper	7"	.084"	Air pump suction from condenser.
169	Gal. Iron.....	3"	Standard	Suction from feed pumps to air pump suction.
170	Gal. Iron.....	3"	Standard	Suction from feed pumps to air pump suction.
171	Gal. Iron.....	3"	Standard	Feed pump suction line.
172	Gal. Iron.....	3"	Standard	Feed pump suction from hot well.
173	Gal. Iron.....	3"	Standard	Feed pump suction from hot well.
174	Gal. Iron.....	3"	Standard	Feed Pump No. 1 suction.
175	Gal. Iron.....	3"	Standard	Feed Pump No. 2 suction.
176	Gal. Iron.....	2"	Standard	Main suction from fresh water tanks.
177	Gal. Iron.....	2"	Standard	Main suction from fresh water tanks.
178	Gal. Iron.....	2"	Standard	Main suction from fresh water tanks.
179	Gal. Iron.....	2"	Standard	Main suction from fresh water tanks.
180	Gal. Iron.....	¾"	Standard	Fresh water feed makeup to air pump.
181	Gal. Iron.....	¾"	Standard	Fresh water feed makeup to air pump.
182	Gal. Iron.....	¾"	Standard	Fresh water feed makeup to air pump.
183	Gal. Iron.....	¾"	Standard	Fresh water feed makeup to air pump.
184	Gal. Iron.....	1¼"	Standard	Fresh water pump suction.
185	Gal. Iron.....	1"	Standard	Fresh water pump discharge to gravity tank.
186	Gal. Iron.....	1"	Standard	Fresh water pump discharge to gravity tank.
187	Gal. Iron.....	2"	Standard	Fresh water suction to inspirator.
188	Gal. Iron.....	2"	Standard	Fresh water suction to inspirator.
189	Gal. Iron.....	2"	Standard	Sea suction to inspirator.
190	Gal. Iron.....	2"	Standard	Sea suction to inspirator.
191	Gal. Iron.....	2"	Standard	Sea suction to inspirator.
192	Gal. Iron.....	2"	Standard	Sea suction to inspirator.
193	Gal. Iron.....	1"	Standard	Overflow from inspirator.
194	Steel Tubing..	2"	.176"	Feed Pump No. 1 discharge.
195	Steel Tubing..	2"	.176"	Feed pump No. 2 discharge.
196	Steel Tubing..	2"	.176"	Feed Pump No. 1 and 2 discharge to heater.
197	Steel Tubing..	..	....	By pass on heater (supplied).
198	Steel Tubing..	2"	.176"	Main feed line to boilers.
199	Steel Tubing..	2"	.176"	Main feed line to boilers.
200	Steel Tubing..	2"	.176"	Main feed line to boilers.
201	Steel Tubing..	2"	.176"	Main feed line to boilers.
202	Steel Tubing..	2"	.176"	Main feed line to starboard boiler.
203	Steel Tubing..	2"	.176"	Main feed line to port boiler.
204	Steel	2"	Ex. heavy	Auxiliary feed line from feed pumps to boilers.
205	Steel	2"	Ex. heavy	Auxiliary feed line discharge from inspirator.
206	Steel	2"	Ex. heavy	Auxiliary feed line discharge from inspirator.
207	Steel	1½"	Ex. heavy	Auxiliary feed line to starboard boiler.
208	Steel	1½"	Ex. heavy	Auxiliary feed line to port boiler.
209	Steel	1¼"	Ex. heavy	Auxiliary feed line to port boiler.

LIST OF PIPES FOR ONE SHIP—Continued

No.	Mat'l	Dia.	Thickness	Service
210	Steel	1"	Standard	Feed line relief valve discharge to hot well.
211	Steel	1"	Standard	Feed line relief valve discharge to hot well.
212	Gal. Iron.....	1¼"	Standard	Blow-off from boiler to sea.
213	Gal. Iron.....	1¼"	Standard	Blow-off from boiler to sea.
214	Gal. Iron.....	1"	Standard	Blow-off to starboard boiler.
215	Gal. Iron.....	1"	Standard	Blow-off to port and starboard boilers.
216	Gal. Iron.....	1"	Standard	Blow-off to port boiler.
217	Gal. Iron.....	1"	Standard	Blow-off to port boiler.
218	Gal. Iron.....	1"	Standard	Blow-off to starboard boiler, starboard side.
219	Gal. Iron.....	1"	Standard	Blow-off to starboard boiler, starboard side.
220	Gal. Iron.....	1"	Standard	Blow-off to starboard boiler, port side.
221	Gal. Iron.....	1"	Standard	Blow-off to starboard boiler, port side.
222	Gal. Iron.....	1"	Standard	Blow-off to port boiler, starboard side.
223	Gal. Iron.....	1"	Standard	Blow-off to port boiler, starboard side.
224	Gal. Iron.....	1"	Standard	Blow-off to port boiler, port side.
225	Gal. Iron.....	1"	Standard	Blow-off to port boiler, port side.
226	Steel	⅜"	Standard	Steam to main injection strainer.
227	Steel	⅜"	Standard	Steam to main injection strainer.
228	Steel	⅜"	Standard	Steam to main injection strainer.
229	Steel	1¼"	Standard	Feed water regulator, port boiler.
230	Steel	1¼"	Standard	Feed water regulator, starboard boiler.
231	.....	....	.....	Water column connection, port boiler (supplied).
232	.....	....	.....	Water column connection, port boiler (supplied).
233	.....	....	.....	Water column connection, port boiler (supplied).
234	.....	....	.....	Water column connection, port boiler (supplied).
235	.....	....	.....	Water column connection, port boiler (supplied).
236	.....	....	.....	Water column connection, port boiler (supplied).
237	.....	....	.....	Water column connection, starboard boiler (supplied).
238	.....	....	.....	Water column connection, starboard boiler (supplied).
239	.....	....	.....	Water column connection, starboard boiler (supplied).
240	.....	....	.....	Water column connection, starboard boiler (supplied).
241	.....	....	.....	Water column connection, starboard boiler (supplied).
242	.....	....	.....	Water column connection, starboard boiler (supplied).
243	Brass	1¼"	Iron Pipe Size	Drain from main engines.

NOTES—To Be Furnished.

2—6" chime whistles with lever valve for 1½" steam.

1—5" iron body steam gauge graduated from 0 to 350 lbs. auxiliary steam line.

2—5" iron body steam gauge graduated from 0 to 100 lbs. steam heat line forward and aft.

1—5" iron body steam gauge graduated from 0 to 150 lbs. fire line.

All gauges to be connected with ¼" pipe.

Bureau veritas requirements.

All gauges to have equivalent metric graduation in kg. per sq. cent.

The weight of the main steam piping, safety valve, etc., to be taken by hangers from overhead, or by some other suitable method to be decided upon after the pipes have been run.

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AUXILIARY FIVE MASTED SCHOONER

For Arrangement Plans See Pages 648-649-650 and 651

LIST OF VALVES FOR ONE SHIP

No.	Material	Size	Type	Type Bonnet	Ends	Pressure	Service
V-1	Steel	3½"	Globe	Bolted	Flanged	250	Main stop on star. boiler.
V-2	Steel	3½"	Globe	Bolted	Flanged	250	Main stop on port boiler.
V-3	Steel	3½"	Angle	Bolted	Flanged	250	Safety valve on star. boiler.
V-4	Steel	3½"	Angle	Bolted	Flanged	250	Safety valve on port boiler.
V-5	Steel	3"	Reducing	Bolted	Flanged	250	Auxiliary steam line, port side.
V-6	Steel	3"	Globe	Bolted	Flanged	250	Auxiliary stop to deck mach.
V-7	Composition	2½"	Globe	Bolted	Flanged	250	Auxiliary stop on port boiler.
V-8	Composition	2½"	Globe	Bolted	Flanged	250	Auxiliary stop on star. boiler.
V-9	Composition	2"	Globe	Bolted	Flanged	300	Main feed check, star. boiler.
V-10	Composition	2"	Globe	Bolted	Flanged	300	Main feed check, port boiler.
V-11	Composition	1½"	Globe	Screw	Screw	300	Main feed bypass, star. boiler.
V-12	Composition	1½"	Regulator	Bolted	Flanged	300	Regulator on port boiler.
V-13	Composition	1½"	Globe	Screw	Screw	300	Main feed bypass, star. boiler.
V-14	Composition	1½"	Globe	Screw	Screw	300	Main feed bypass, port boiler.
V-15	Composition	2"	Globe	Screw	Screw	300	Main feed bypass, star. boiler.
V-16	Composition	2"	Globe	Screw	Screw	300	Main feed bypass, port boiler.
V-17	Composition	1½"	Regulator	Bolted	Flanged	300	Regulator on star. boiler.
V-18	Composition	1½"	Globe	Screw	Screw	300	Main feed bypass, port boiler.
V-19	Composition	2"	Globe	Bolted	Flanged	300	Main feed stop, star. boiler.
V-20	Composition	2"	Globe	Bolted	Flanged	300	Main feed stop, port boiler.
V-21	Cast iron, brass fitted	3"	Globe	Bolted	Flanged	50	Atmospheric exhaust.
V-22	Cast iron, brass fitted	3"	Globe	Bolted	Flanged	50	Auxiliary exhaust from deck mach.
V-23	Composition	2"	Globe	Screw	Screw	250	Steam to inspirator.
V-24	Composition	2"	Globe	Screw	Screw	300	Inspirator discharge to boilers.
V-25	Composition	2"	Globe	Screw	Screw	50	F. W. suction to inspirator.
V-26	Composition	2"	Globe	Screw	Screw	50	S. W. suction to inspirator.
V-27	Composition	1½"	Angle	Screw	Screw	300	Auxiliary feed stop to star. boiler.
V-28	Composition	1½"	Globe	Screw	Screw	300	Auxiliary feed check to star. boiler.
V-29	Composition	1½"	Angle	Screw	Screw	300	Auxiliary feed stop to port boiler.
V-30	Composition	1½"	Globe	Screw	Screw	300	Auxiliary feed check to port boiler.
V-31	Composition	2"	Angle	Screw	Flanged	50	Sea suction to inspirator.
V-32	Composition	1¼"	Angle	Screw	Flanged	250	Blow-off to boilers.
V-33	Composition	5"	Angle	Bolted	Flanged	50	Sea suction to pumps.
V-34	Composition	5"	Globe	Bolted	Flanged	50	Suction stop to pumps.
V-35	Composition	1"	Y	Screw	Screw	250	Blow-off port boiler, star. side.
V-36	Composition	1"	Y	Screw	Screw	250	Blow-off port boiler, port side.
V-37	Composition	1"	Y	Screw	Screw	250	Blow-off port boiler, star. side.
V-38	Composition	1"	Y	Screw	Screw	250	Blow-off port boiler, port side.
V-39	Composition	1"	Y	Screw	Screw	250	Blow-off star. boiler, star. side.
V-40	Composition	1"	Y	Screw	Screw	250	Blow-off star. boiler, port side.
V-41	Composition	1"	Y	Screw	Screw	250	Blow-off star. boiler, star. side.
V-42	Composition	1"	Y	Screw	Screw	250	Blow-off star. boiler, port side.
V-43	Composition	1"	Globe	Screw	Screw	250	Water column, star. boiler.
V-44	Composition	1"	Globe	Screw	Screw	250	Water column, star. boiler.
V-45	Composition	1"	Globe	Screw	Screw	250	Water column, port boiler.
V-46	Composition	1"	Globe	Screw	Screw	250	Water column, port boiler.
V-47	Composition	1¼"	Angle	Screw	Screw	250	Feed water regulator, port boiler.
V-48	Composition	1¼"	Angle	Screw	Screw	250	Feed water regulator, star. boiler.
V-49	Composition	1"	Globe	Screw	Screw	250	Water column, port boiler.
V-50	Composition	1"	Globe	Screw	Screw	250	Water column, port boiler.
V-51	Composition	1"	Globe	Screw	Screw	250	Water column, star. boiler.
V-52	Composition	1"	Globe	Screw	Screw	250	Water column, star. boiler.
V-53	Composition	1"	Globe	Screw	Screw	250	Steam to air pump.
V-54	Composition	1¼"	Globe	Screw	Screw	50	Exhaust to air pump.
V-55	Composition	¼"	Globe	Screw	Screw	250	Steam heat. gauge, for'd.
V-56	Composition	2"	Relief	Screw	Screw	250	Main feed line.
V-57	Composition	¾"	Check	Screw	Screw	250	Evaporator trap to hot well.
V-58	Composition	4"	Globe	Bolted	Flanged	150	Bilge pump discharge, overboard.
V-59	Composition	2½"	Globe	Bolted	Flanged	150	To fire line.
V-60	Composition	2"	Globe	Screw	Flanged	150	Hose connection, fire line.
V-61	Cast iron, brass fitted	3"	Globe	Bolted	Flanged	50	Hot well suction.
V-62	Cast iron, brass fitted	3"	Globe	Bolted	Flanged	50	Feed pump suction to condenser.
V-63	Cast iron, brass fitted	5"	Globe	Bolted	Flanged	50	Auxiliary exhaust to condenser.
V-64	Composition	¾"	Globe	Screw	Screw	50	Fresh water make-up.
V-65	Cast iron, brass fitted	4"	Weighted Check	Bolted	Flanged	50	F. & B. pump discharge, overboard.
V-66	Cast iron, brass fitted	6"	Weighted Check	Bolted	Flanged	50	Condenser discharge, overboard.
V-67	Cast iron, brass fitted	4"	Globe	Bolted	Flanged	100	F. & B. pump disc. to condenser.
V-68	Cast iron, brass fitted	6"	Angle	Bolted	Flanged	50	Bilge injection.
V-69	Composition	8"	Angle	Bolted	Flanged	50	Main injection.
V-70	Composition	2"	Check	Screw	Screw	50	Blow-off to evaporator.

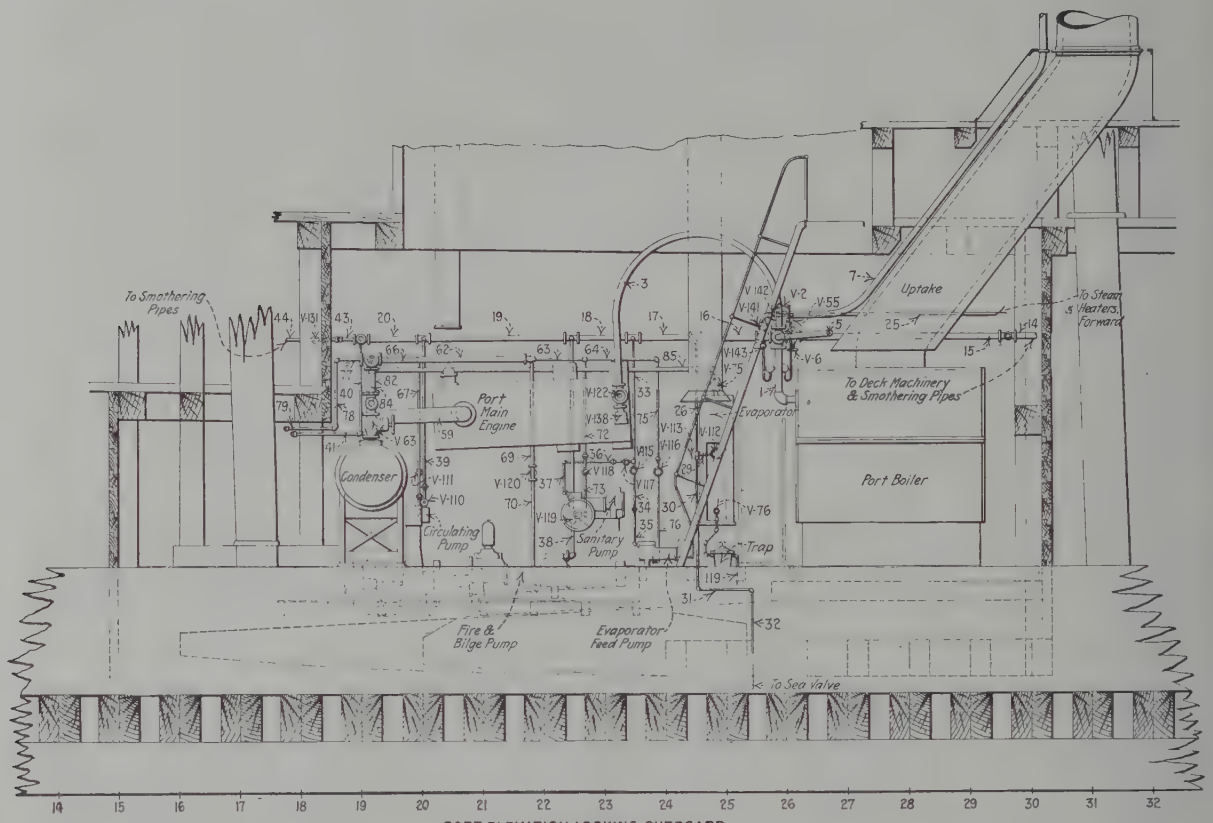
(Continued on next page)

AUXILIARY FIVE MASTED SCHOONER

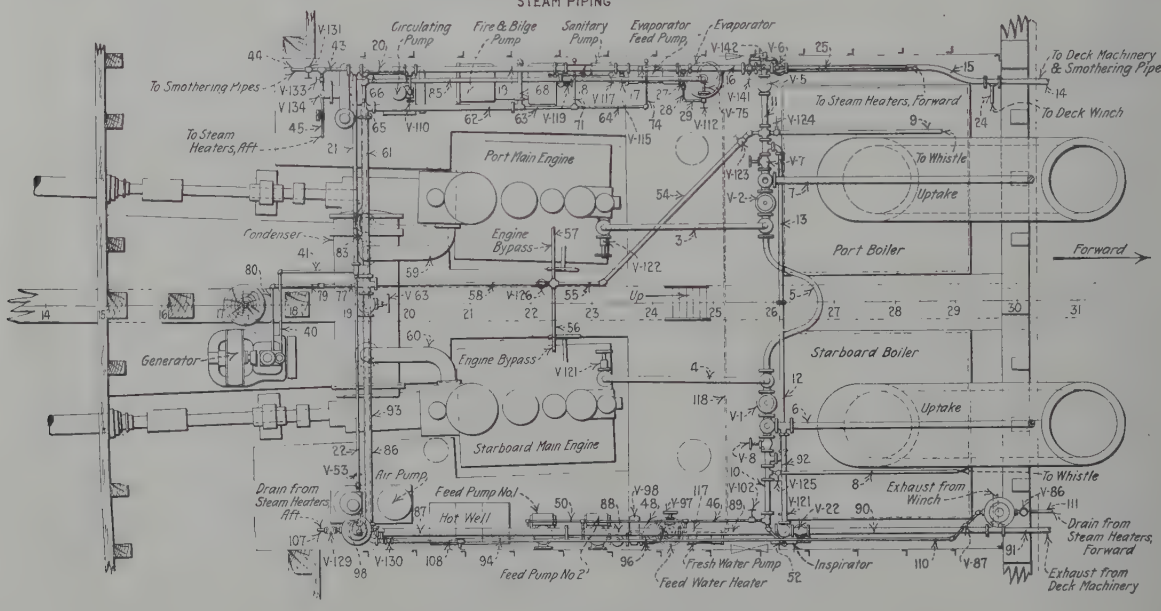
For Arrangement Plans See Pages 648-649-650 and 651

LIST OF VALVES FOR ONE SHIP—Continued

No.	Material	Size	Type	Type Bonnet	Ends	Pressure	Service
V-71	Composition	2″	Angle	Screw	Screw	100	Blow-off to evaporator.
V-72	Composition	1½″	Angle	Screw	Screw	100	Sanitary pump discharge.
V-73	Composition	2½″	Angle	Screw	Flanged	100	Sanitary pump suction.
V-74	Composition	1″	Globe	Screw	Flanged	100	Ash connection.
V-75	Composition	2½″	Globe	Screw	Screw	50	Vapor line to condenser.
V-76	Composition	¾″	Angle	Screw	Screw	100	Drain to evaporator trap.
V-77	Composition	1″	Relief	Screw	Screw	150	Fire line.
V-78	Composition	1¼″	Angle	Screw	Screw	50	Evaporator pump suction.
V-79	Composition	¾″	Angle	Screw	Screw	100	Feed stop to evaporator.
V-80	Composition	¾″	Check	Screw	Screw	100	Feed check to evaporator.
V-81	Composition	3″	Check	Screw	Flanged	50	Bilge manifold.
V-82	Composition	3″	Cross	Screw	Flanged	50	Forward bilge suction.
V-83	Composition	3″	Cross	Screw	Flanged	50	Forward bilge suction.
V-84	Composition	3″	Cross	Screw	Flanged	50	Engine room suction.
V-85	Composition	3″	Angle	Screw	Flanged	50	After bilge suction.
V-86	Composition	1¼″	Globe	Screw	Screw	250	Forward steam heat, trap.
V-87	Composition	1″	Check	Screw	Screw	100	Trap check.
V-88	Cast iron, brass fitted	3″	Angle	Bolted	Flanged	50	No. 1 feed pump suction.
V-89	Cast iron, brass fitted	3″	Angle	Bolted	Flanged	50	No. 2 feed pump suction.
V-90	Composition	2″	Globe	Screw	Screw	50	Feed suction line stop.
V-91	Composition	2″	Angle	Bolted	Flanged	300	No. 1 feed pump discharge.
V-92	Composition	2″	Angle	Bolted	Flanged	300	No. 2 feed pump discharge.
V-93	Composition	2″	Globe	Bolted	Flanged	300	Auxiliary feed line stop.
V-94	Composition	2″	Globe	Bolted	Flanged	300	Main feed line stop.
V-95	Composition	2″	Cross	Bolted	Flanged	300	Heater bypass.
V-96	Composition	2″	Cross	Bolted	Flanged	300	Heater bypass.
V-97	Cast iron, brass fitted	4″	Globe	Bolted	Flanged	50	Heater exhaust.
V-98	Cast iron, brass fitted	3″	Globe	Bolted	Flanged	50	Heater back pressure.
V-99	Composition	1″	Globe	Screw	Screw	50	Heater trap drain.
V-100	Composition	1¼″	Globe	Screw	Screw	50	Fresh water pump suction.
V-101	Composition	1″	Globe	Screw	Screw	100	Fresh water pump discharge.
V-102	Composition	1″	Globe	Screw	Screw	250	Steam hose conn., star. side.
V-103	Composition	1¼″	Globe	Screw	Screw	250	Inspirator hose connection.
V-104	Composition	1¼″	Globe	Screw	Screw	50	No. 1 feed pump exhaust.
V-105	Composition	1″	Globe	Screw	Screw	250	No. 1 feed pump steam.
V-106	Composition	1″	Globe	Screw	Screw	50	No. 2 feed pump exhaust.
V-107	Composition	1″	Globe	Screw	Screw	250	No. 2 feed pump steam.
V-108	Composition	⅜″	Globe	Screw	Screw	250	Fresh water pump steam.
V-109	Composition	½″	Globe	Screw	Screw	50	Fresh water pump exhaust.
V-110	Composition	1½″	Globe	Screw	Screw	250	Circulating pump steam.
V-111	Composition	1½″	Globe	Screw	Screw	50	Circulating pump exhaust.
V-112	Composition	1¼″	Angle	Screw	Screw	250	Steam to evaporator.
V-113	Composition	⅜″	Globe	Screw	Screw	250	Steam to sea strainer.
V-114	Composition	⅜″	Angle	Screw	Screw	250	Steam to sea strainer.
V-115	Composition	½″	Globe	Screw	Screw	250	Steam to evaporator pump.
V-116	Composition	¾″	Globe	Screw	Screw	50	Exhaust to evaporator pump.
V-117	Composition	½″	Globe	Screw	Screw	250	Steam to sanitary pump.
V-118	Composition	¾″	Globe	Screw	Screw	50	Exhaust to sanitary pump.
V-119	Composition	2″	Globe	Screw	Screw	250	Steam to fire and bilge pump.
V-120	Composition	2½″	Globe	Screw	Flanged	50	Exhaust to fire and bilge pump.
V-121	Steel	3″	Globe	Bolted	Flanged	300	Star. engine stop.
V-122	Steel	3″	Globe	Bolted	Flanged	300	Port engine stop.
V-123	Composition	1″	Globe	Screw	Screw	250	Steam hose conn., port side.
V-124	Composition	1½″	Globe	Screw	Screw	250	Whistle stop, port boiler.
V-125	Composition	1½″	Globe	Screw	Screw	250	Whistle stop, star. boiler.
V-126	Composition	2″	Globe	Screw	Screw	250	Bleeder stop to condenser.
V-127	Composition	1½″	Globe	Screw	Screw	250	Steam to generator.
V-128	Composition	2″	Globe	Screw	Screw	50	Exhaust to generator.
V-129	Composition	1¼″	Globe	Screw	Screw	250	After steam heat, trap.
V-130	Composition	1″	Check	Screw	Screw	50	Trap check.
V-131	Composition	1½″	Globe	Screw	Screw	250	After smothering line.
V-132	Composition	⅜″	Angle	Screw	Screw	250	Steam to sea strainer.
V-133	Composition	1″	Globe	Screw	Screw	250	Steam heat., aft.
V-134	Composition	1″	Reducing	Screw	Screw	250	Steam heat., aft.
V-135	Composition	1″	Globe	Screw	Screw	50	Water service to main engines.
V-136	Composition	1¼″	Globe	Screw	Screw	250	Engine drain to air pump suct.
V-137	Steel	3″	Throttle	Bolted	Flanged	300	Star. main engine.
V-138	Steel	3″	Throttle	Bolted	Flanged	300	Port main engine.
V-139	Composition	⅜″	Globe	Screw	Screw	250	Steam to sea strainer.
V-140	Composition	¼″	Globe	Screw	Screw	250	To steam heat, gauge, aft.
V-141	Composition	1″	Reducing	Screw	Screw	250	Steam heat., forward.
V-142	Composition	1″	Globe	Screw	Screw	250	Steam heat., forward.
V-143	Composition	¼″	Globe	Screw	Screw	250	To steam heat, gauge, forward.



PORT ELEVATION LOOKING OUTBOARD
STEAM PIPING

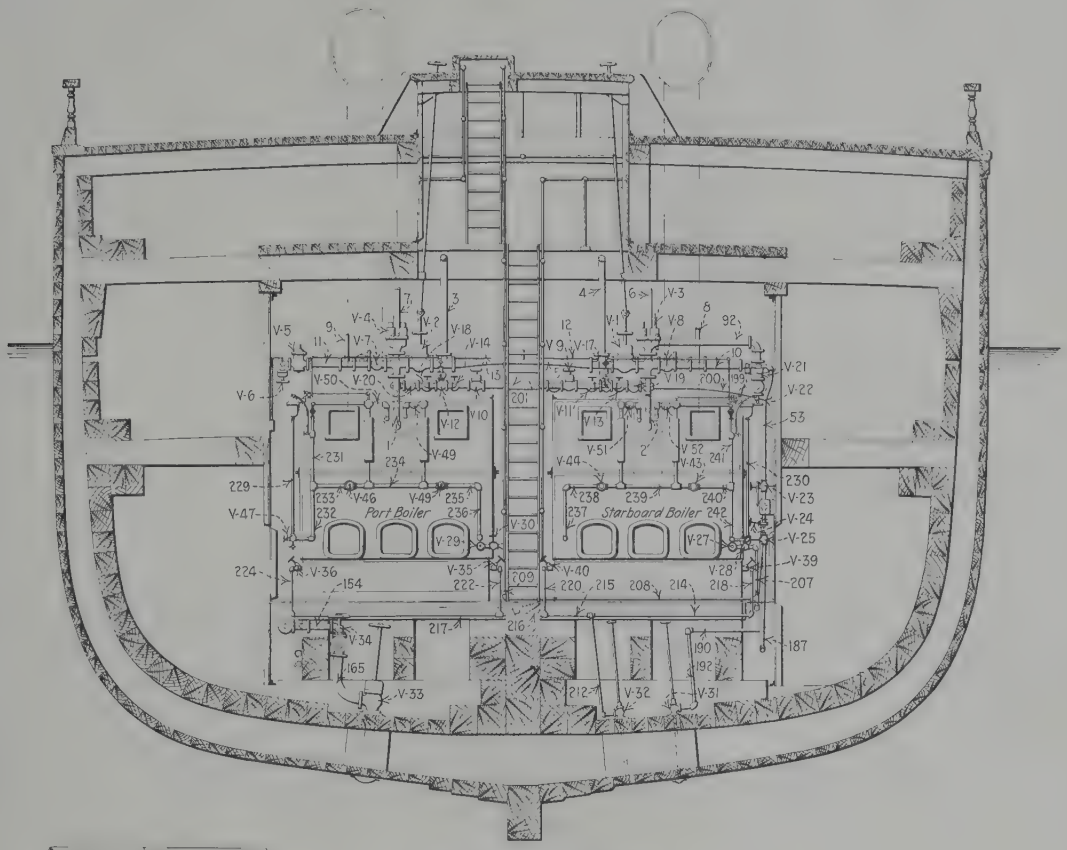


PLAN VIEW
STEAM PIPING

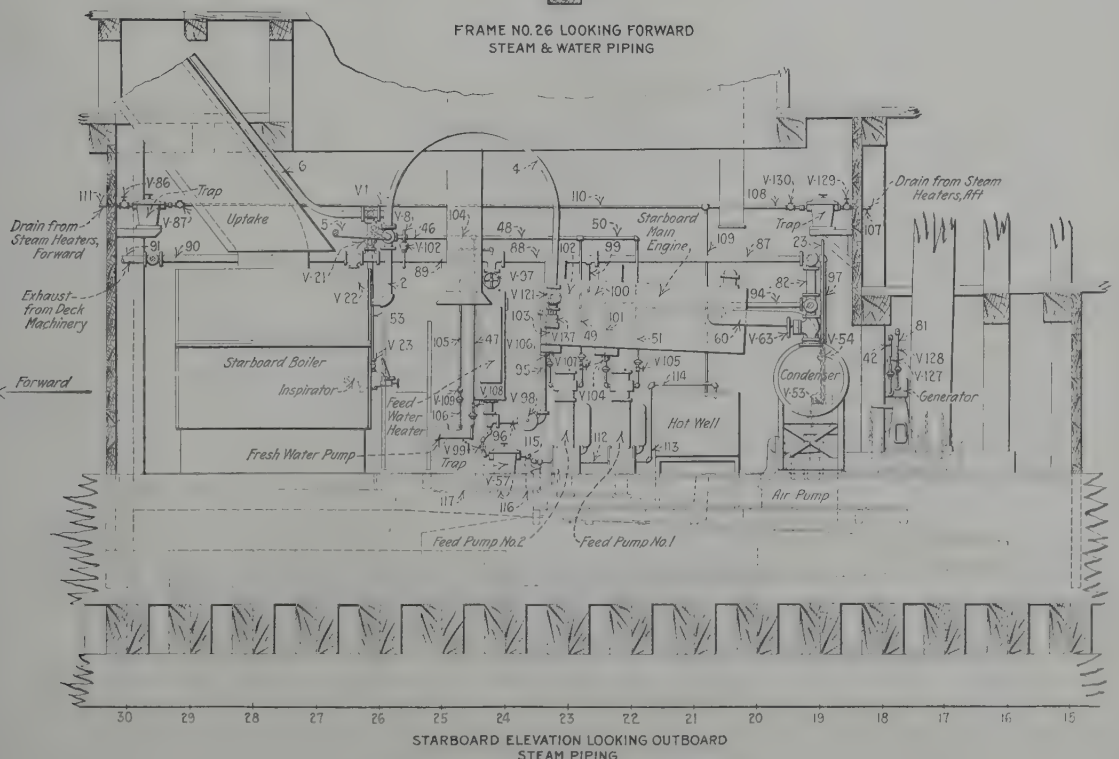
AUXILIARY FIVE MASTED SCHOONER

Designed by Cox & Stevens, New York City

See Pages 643. 644, 645, 646 and 647



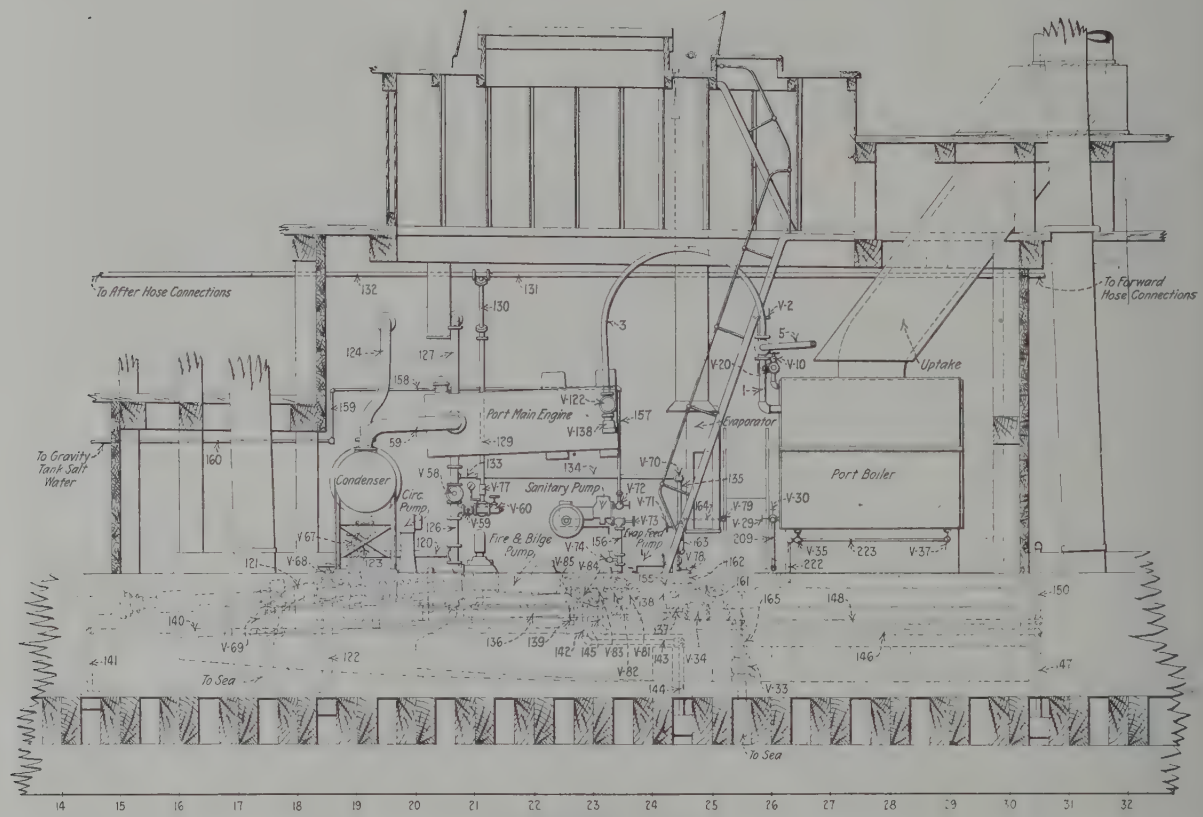
FRAME NO. 26 LOOKING FORWARD
STEAM & WATER PIPING



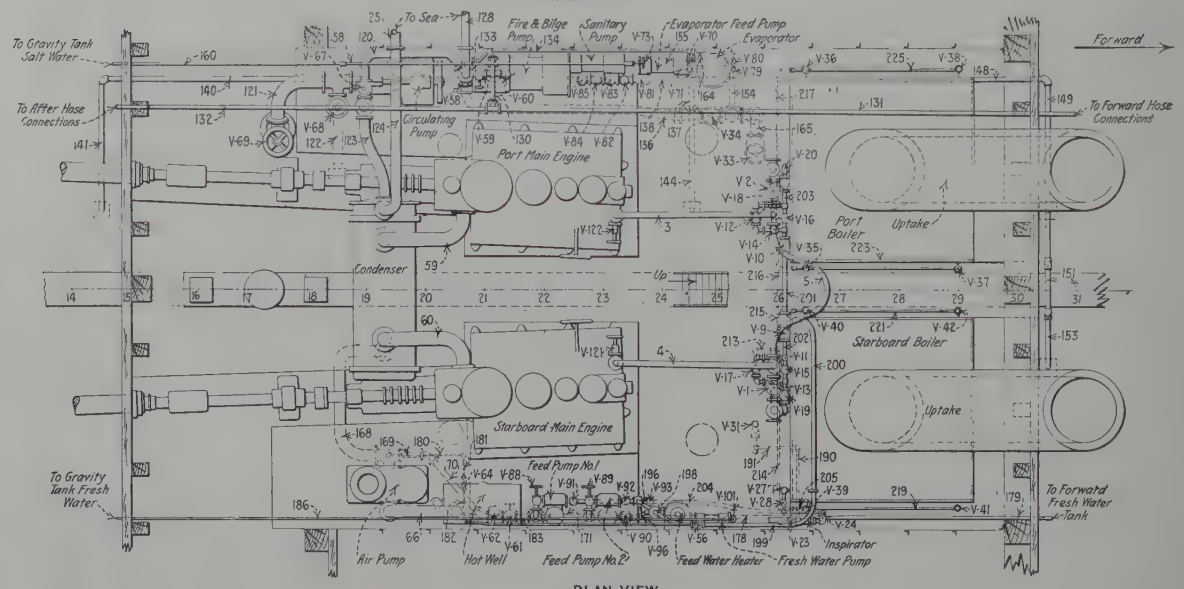
STARBOARD ELEVATION LOOKING OUTBOARD
STEAM PIPING

AUXILIARY FIVE MASTED SCHOONER
Designed by Cox & Stevens, New York City

See Pages 643, 644, 645, 646 and 647



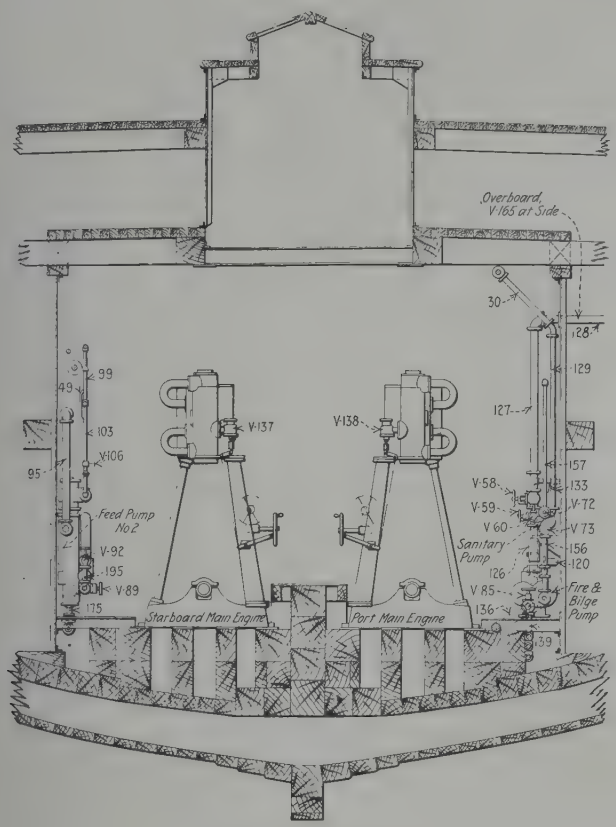
PORT ELEVATION LOOKING OUTBOARD
WATER PIPING



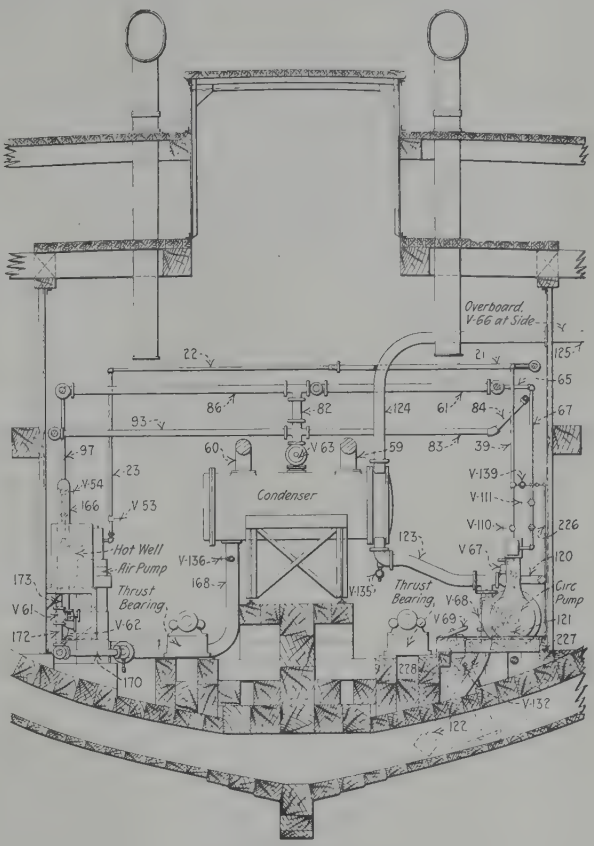
PLAN VIEW
WATER PIPING

AUXILIARY FIVE MASTED SCHOONER
Designed by Cox & Stevens, New York City

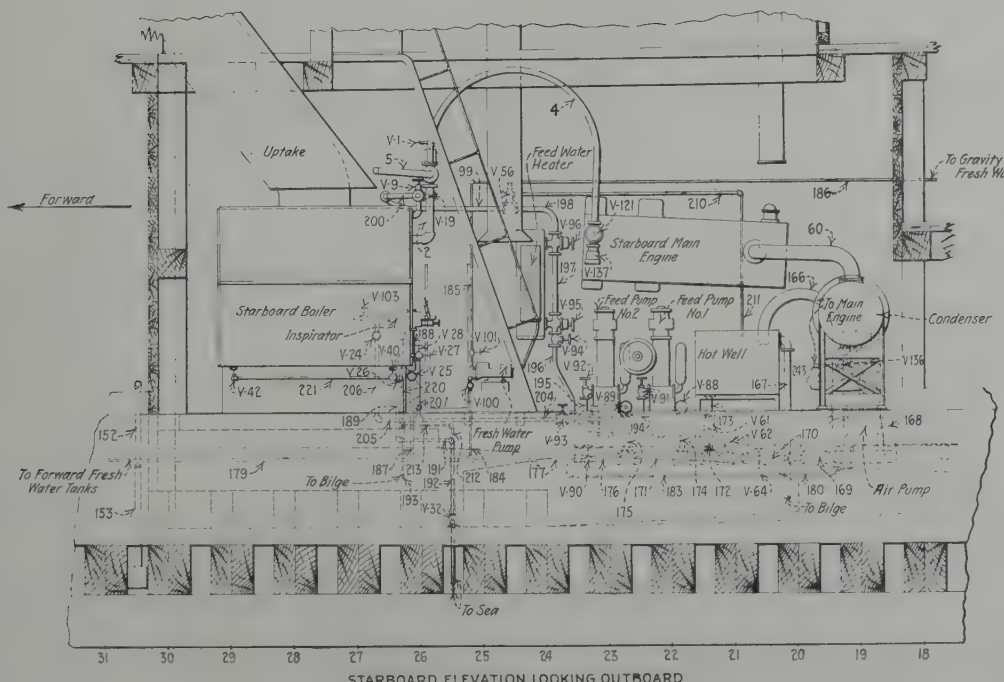
See Pages 643, 644 645, 646 and 647



FRAME NO. 23 LOOKING AFT
STEAM & WATER PIPING



FRAME NO. 20 LOOKING AFT
STEAM & WATER PIPING



STARBOARD ELEVATION LOOKING OUTBOARD

AUXILIARY FIVE MASTED SCHOONER
Designed by Cox & Stevens, New York City
See Pages 643, 644, 645, 646 and 647

STEEL SEA-GOING TUG

For Arrangement Plan See Opposite Page

LIST OF PIPES FOR ONE SHIP

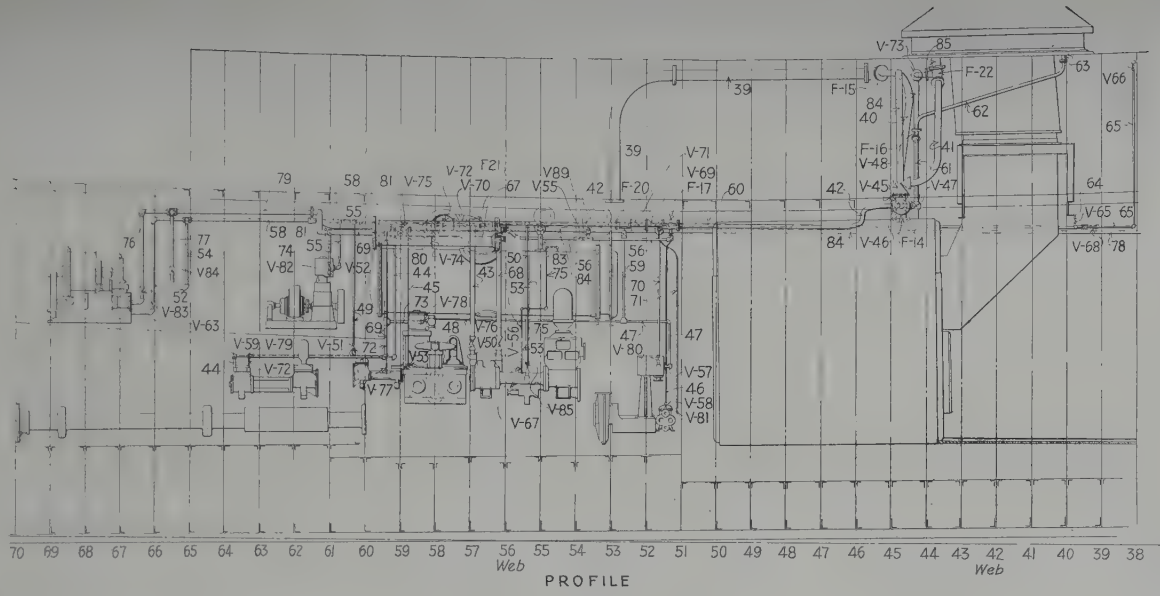
Pc. No.	Name	Material	Remarks
39	6" Pipe, .280" thk.....	Steel.	Main steam.
40	4½" Pipe, .246" thk.....	Steel.	Main steam.
41	3½" Pipe, #14 B.W.G....	Copper.	Main escape.
42	2½" Pipe, .204" thk.....	Steel.	Auxiliary steam.
43	2½" Pipe, ex. h'vy.....	Bl'k I.	Aux. steam to fire pump.
44	1¼" Pipe, ex. h'vy.....	Bl'k I.	Aux. steam to feed pump.
45	½" Pipe, ex. h'vy.....	Bl'k I.	Aux. steam to sanitary pump.
46	½" Pipe, ex. h'vy.....	Bl'k I.	Aux. steam to boiler circ. pump.
47	1¼" Pipe, ex. h'vy.....	Bl'k I.	Aux. steam to circulating pump.
48	1" Pipe, ex. h'vy.....	Bl'k I.	Aux. steam to air pump.
49	1¼" Pipe, ex. h'vy.....	Bl'k I.	Aux. steam to syphon.
50	2" Pipe, ex. h'vy.....	Bl'k I.	Aux. steam to injector.
51	1½" Pipe, ex. h'vy.....	Bl'k I.	Aux. steam to windlass.
52	1½" Pipe, ex. h'vy.....	Bl'k I.	Aux. steam to steering engine.
53	½" Pipe, ex. h'vy.....	Bl'k I.	Aux. steam to reversing engine.
54	1½" Pipe, ex. h'vy.....	Bl'k I.	Aux. steam to gypsy.
55	1¼" Pipe, ex. h'vy.....	Bl'k I.	Aux. steam to dynamo.
56	1¼" Pipe, ex. h'vy.....	Bl'k I.	Aux. steam to by-pass.
57	½" Pipe, ex. h'vy.....	Bl'k I.	Aux. steam to sea-boxes.
58	2" Pipe, ex. h'vy.....	Bl'k I.	Aux. steam line.
59	1½" Pipe, ex. h'vy.....	Bl'k I.	Aux. steam line.
60	1½" Pipe, ex. h'vy.....	Bl'k I.	Aux. steam forward.
61	1½" Pipe, #11 B.W.G....	Copper.	Steam to whistle.
62	2" Pipe, #10 B.W.G.....	Copper.	Steam to whistle.
63	2" Pipe, ex. h'vy.....	Bl'k I.	Steam to whistle.
64	1¼" Pipe, ex. h'vy.....	Bl'k I.	Steam to jet.
65	¾" Pipe, ex. h'vy.....	Bl'k I.	Steam to lamp room.
66	1" Pipe, ex. h'vy.....	Bl'k I.	Steam to heating system.
67	14" Pipe, #8 B.W.G.....	Copper.	Main exhaust.
68	3" Pipe, st'd.....	Bl'k I.	Aux. exh. from fire pump.
69	¾" Pipe st'd.....	Bl'k I.	Aux. exh. from san. pump.
70	1½" Pipe, st'd.....	Bl'k I.	Aux. exh. from circ. pump.
71	¾" Pipe, st'd.....	Bl'k I.	Aux. exh. from boiler circ. pump.
72	1½" Pipe, st'd.....	Bl'k I.	Aux. exh. from feed pump.
73	1¼" Pipe, st'd.....	Bl'k I.	Aux. exh. from air pump.
74	1½" Pipe, st'd.....	Bl'k I.	Aux. exh. from dynamo.
75	½" Pipe, st'd.....	Bl'k I.	Aux. exh. from rev. eng.
76	2" Pipe, st'd.....	Bl'k I.	Aux. exh. from steer. eng.
77	2" Pipe, st'd.....	Bl'k I.	Aux. exh. from gypsy.
78	2" Pipe, st'd.....	Bl'k I.	Aux. exh. from windlass.
79	2½" Pipe, st'd.....	Bl'k I.	Aux. exh. line.
80	2" Pipe, st'd.....	Bl'k I.	Aux. exh. line.
81	3½" Pipe, #14 B.W.G....	Copper.	Aux. exh. line.
82	3½" Pipe, #14 B.W.G....	Copper.	Aux. exh. to condenser.
83	2½" Pipe, st'd.....	Bl'k I.	Aux. exh. to condenser.
84	3" Pipe, #14 B.W.G.....	Copper.	Aux. exh. to atmosphere.
85	5" Pipe, st'd.....	Wro't I.	Aux. exh. to atmosphere.
86	1" Pipe, st'd.....	Bl'k I.	Cylinder drain to condenser.

LIST OF VALVES FOR ONE SHIP

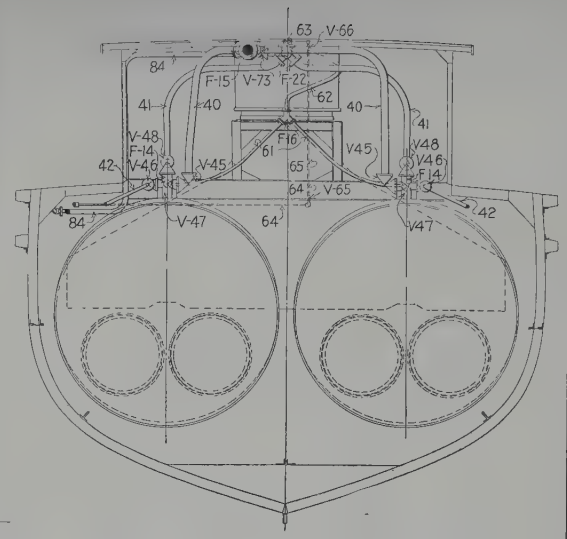
Pc. No.	Name	Material	Remarks
V45	4½" Fl'g'd ang.....	I.B.B.M.	Main steam stop.
V46	2½" Fl'g'd ang.....	I.B.B.M.	Aux. steam stop.
V47	1½" Fl'g'd ang.....	Comp.	Whistle stop.
V48	3½" Fl'g'd ang.....	I.B.B.M.	Safety valve.
V49	1½" Scr'd ang.....	Comp.	Aux. steam forward.
V50	2½" Fl'g'd globe.....	I.B.B.M.	Aux. steam to fire pump.
V51	1¼" Scr'd globe.....	Comp.	Aux. steam to syphon.
V52	1¼" Scr'd globe.....	Comp.	Aux. steam to dynamo.
V53	½" Scr'd globe.....	Comp.	Aux. steam to san. pump.
V54	½" Scr'd globe.....	Comp.	Aux. steam to sea-boxes.
V55	1½" Scr'd globe.....	Comp.	Aux. steam to by-pass.
V56	2" Scr'd globe.....	Comp.	Aux. steam to injector.
V57	1¼" Scr'd ang.....	Comp.	Aux. steam to circ. pump.
V58	½" Scr'd globe.....	Comp.	Aux. steam to boiler circ. pump.
V59	1¼" Scr'd ang.....	Comp.	Aux. steam to feed pump
V60	1¼" Scr'd cock.....	Comp.	Aux. steam to feed pump.
V61	1" Scr'd globe.....	Comp.	Aux. steam to air pump.
V62	½" Scr'd globe.....	Comp.	Aux. steam to rev. eng.
V63	1¼" Scr'd globe.....	Comp.	Aux. steam to steer. eng.
V64	1½" Scr'd globe.....	Comp.	Aux. steam to gypsy.
V65	1¼" Scr'd Globe.....	Comp.	Aux. steam to jet.
V66	¾" Scr'd globe.....	Comp.	Aux. steam to lamp room.
V67	1" Scr'd globe.....	Comp.	Aux. steam to heat. system.
V68	1½" Scr'd globe.....	Comp.	Aux. steam to windlass.
V69	2½" Fl'g'd globe.....	I.B.B.M.	Aux. steam.
V70	2" Fl'g'd globe.....	Comp.	Aux. steam.
V71	2½" Fl'g'd red.....	I.B.B.M.	Aux. steam.
V72	2" Fl'g'd red.....	Comp.	Aux. steam.
V73	3" Fl'g'd globe.....	I.B.B.M.	Aux. exh. to atmosphere.
V74	3½" Fl'g'd ang.....	I.B.B.M.	Aux. exh. to condenser.
V75	3½" Fl'g'd cross.....	I.B.B.M.	Aux. exh. to heater.
V76	3" Scr'd globe.....	I.B.B.M.	Aux. exh. from fire pump.
V77	¾" Scr'd globe.....	Comp.	Aux. exh. from san. pump.
V78	1¼" Scr'd ang.....	Comp.	Aux. exh. from air pump.
V79	1½" Scr'd ang.....	Comp.	Aux. exh. from feed pump.
V80	1½" Scr'd globe.....	Comp.	Aux. exh. from circ. pump.
V81	¾" Scr'd globe.....	Comp.	Aux. exh. from boiler circ. pump.
V82	1½" Scr'd globe.....	Comp.	Aux. exh. from dynamo.
V83	2" Scr'd globe.....	Comp.	Aux. exh. from steer. eng.
V84	2" Scr'd globe.....	Comp.	Aux. exh. from gypsy.
V85	½" Scr'd globe.....	Comp.	Aux. exh. from rev. eng.
V86	2" Scr'd globe.....	Comp.	Aux. exh. from windlass.
V87	1" Scr'd globe.....	Comp.	Cylinder drains.
V88	½" Scr'd ang.....	Comp.	Aux. steam to sea-boxes.
V89	1½" Scr'd cross.....	Comp.	Aux. steam to by-pass.
V90	2½" Fl'g'd back press.	I.B.B.M.	Aux. exh. to condenser.
V91	1" Scr'd red.....	Comp.	Aux. steam to heat. system.

LIST OF FITTINGS FOR ONE SHIP

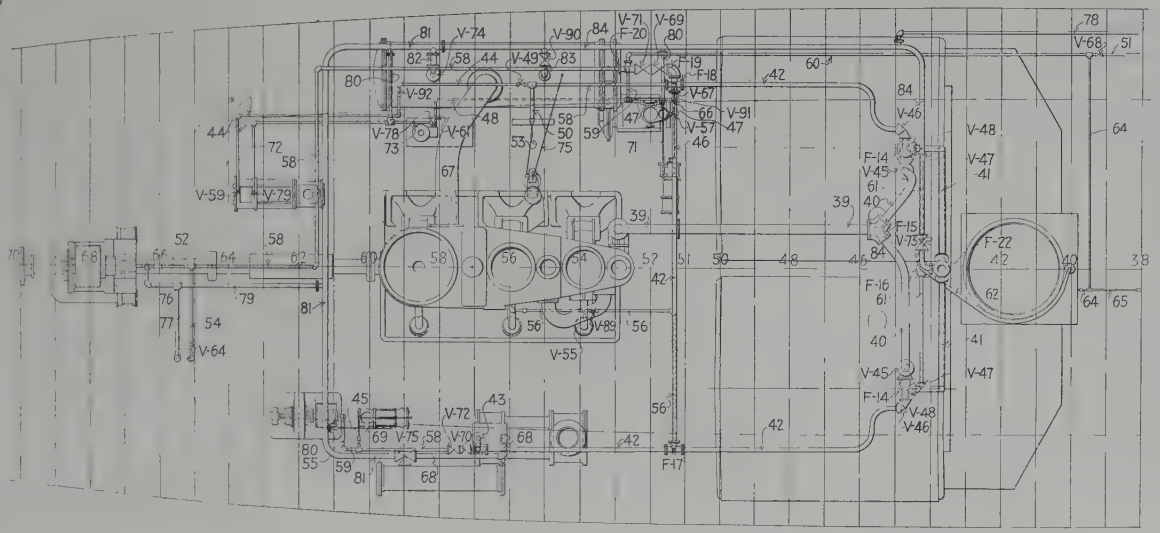
Pc. No.	Name	Material	Remarks
F14	5"x3½"x4½"x2½"x1½" Manifold...	C.S.	Steam lines.
F15	6¼"x4½"x4½" Y	C.S.	Main steam line.
F16	2"x2"x2" Y.....	C.I.	Whistle steam.
F17	2½" Tee, 1½" tap.....	C.S.	Aux. steam line.
F18	2½"x2½"x2½"x2" Cross, 1" and ½" tap.	C.S.	Aux. steam line.
F19	2½" Elbow	C.S.	Aux. steam line.
F20	2½"x2"x1½" Tee, 1½" tap.....	C.S.	Aux. steam line.
F21	2½"x2"x2½" Tee	C.S.	Fire pump steam.
F22	5"x3"x3½", 3" Y Outlet.....	C.S.	Aux. exh. to atmosphere.

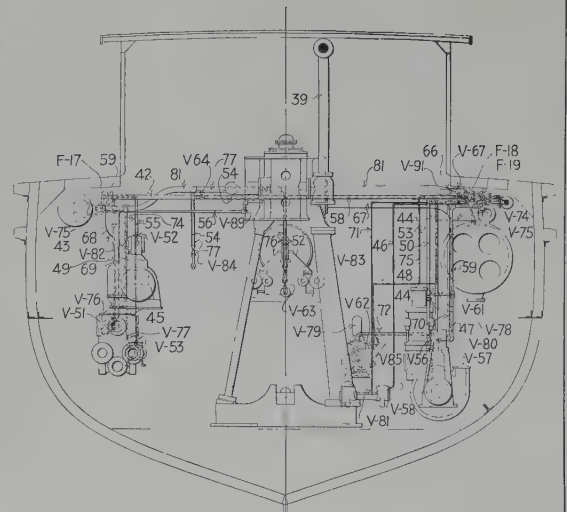


PROFILE



SECTION AT BULKHEAD #51 LOOKING FORWARD





SECTION AT BULKHEAD NO. 51 LOOKING AFT

STEEL SEA-GOING TUG

Staten Island Shipbuilding Co., Staten Island, N. Y.

See Opposite Page

STEEL SEA-GOING TUG

For Arrangement Plan See Opposite Page

LIST OF PIPES FOR ONE SHIP

Pc. No.	Name	Mat'l	Service
1	8" Pipe, No. 11 B.W.G.	Copper.	Circ. pump sea suction.
2	6" Pipe, No. 12 B.W.G.	Copper.	Circ. pump disch. overboard.
3	6" Pipe, No. 12 B.W.G.	Copper.	Fire pump suction—sea.
4	4" Pipe, No. 14 B.W.G.	Copper.	Fire pump suction—bilge.
5	5" Pipe, No. 12 B.W.G.	Copper.	Fire pump suction—deck.
6	3" Pipe Standard	G. iron.	Fire pump suction—condenser.
7	4" Pipe, No. 14 B.W.G.	Copper.	Fire pump suction—bilge manifold.
8	2½" Pipe Standard	G. iron.	Fire pump suction—tank manifold.
9	2½" Pipe Standard	G. iron.	Fire pump suction—B. R. bilge.
10	5" Pipe, No. 12 B.W.G.	Copper.	Fire pump disch.—overboard.
11	4" Pipe, No. 11 B.W.G.	Copper.	Fire pump disch.—condenser.
12	2½" Pipe, No. 9 B.W.G.	Copper.	Fire pump disch.—boiler.
13	2½" Pipe Standard	G. iron.	Fire pump disch.—filter box.
14	2½" Pipe Standard	G. iron.	Fire pump disch.—fire lines.
15	2½" Pipe Standard	G. iron.	Fire pump disch.—ash eject.
16	2½" Pipe, No. 14 B.W.G.	Copper.	Sani. pump sea suction.
17	1½" Pipe Standard	Brass.	Sani. pump discharge.
18	2½" Pipe Standard	G. iron.	Forward tank line.
19	2½" Pipe Standard	G. iron.	After tank line.
20	2" Pipe Standard	G. iron.	Syphon suction.
21	2" Pipe, No. 14 B.W.G.	Copper.	Syphon discharge.
22	2½" Pipe Standard	G. iron.	Feed pump suct.—tank manifold.
23	2½" Pipe Standard	G. iron.	Feed pump suct.—filter box.
24	2½" Pipe, No. 9 B.W.G.	Copper.	Feed pump disch.—main feed line.
25	2" Pipe, No. 10 B.W.G.	Copper.	Injector disch. aux. feed line.
26	1¼" Pipe Standard	G. iron.	Injector disch.—deck.
27	6" Pipe, No. 12 B.W.G.	Copper.	Air pump suction—condenser.
28	5" Pipe, No. 12 B.W.G.	Copper.	Air pump disch.—overboard.
29	4" Pipe, No. 14 B.W.G.	Copper.	Air pump disch.—filter box.
30	1½" Pipe, No. 11 B.W.G.	Copper.	B. C. pump suction—boiler.
31	2" Pipe, No. 10 B.W.G.	Copper.	B. C. pump discharge.
32	2" Pipe, No. 10 B.W.G.	Copper.	Feed pump discharge boiler.
33	2" Pipe, No. 10 B.W.G.	Copper.	Injector discharge—boiler.
34	1½" Pipe, No. 11 B.W.G.	Copper.	Boiler blows.
35	1¼" Pipe, No. 12 B.W.G.	Copper.	Water column—connections.
36	¾" Pipe Standard	G. iron.	Heater drain—filter box.
37	1" Pipe Standard	G. iron.	Ash wetting.
38	2½" Pipe Standard	G. iron.	Fire pump suct.—for'd hold.
86	2" Pipe, No. 11 B.W.G.	Copper.	B. circulating pump suct.

LIST OF VALVES FOR ONE SHIP

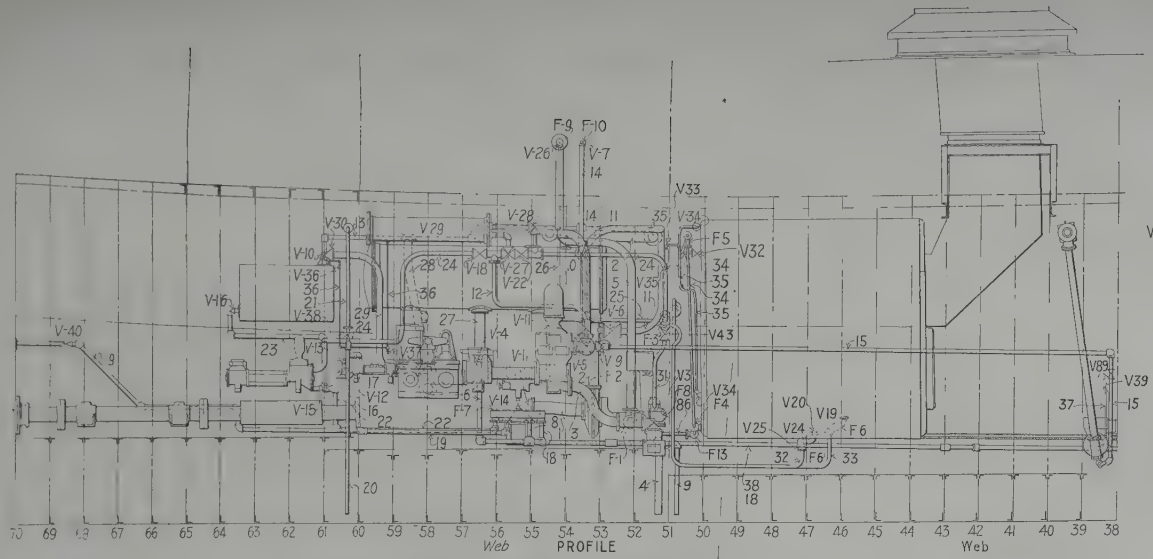
Pc. No.	Name	Mat'l	Service
V-1	8" Flg'd angle	I.B.B.M.	Circ pump sea suction.
V-2	6" Flg'd angle	I.B.B.M.	Fire pump suct.—sea.
V-3	4" Flg'd angle	I.B.B.M.	Fire pump suct.—bilge.
V-4	3" Scr'd angle	I.B.B.M.	Fire pump suct.—cond.
V-5	5" Flg'd angle	I.B.B.M.	Fire pump disch.—over.
V-6	4" Flg'd gate	I.B.B.M.	Fire pump disch.—cond.

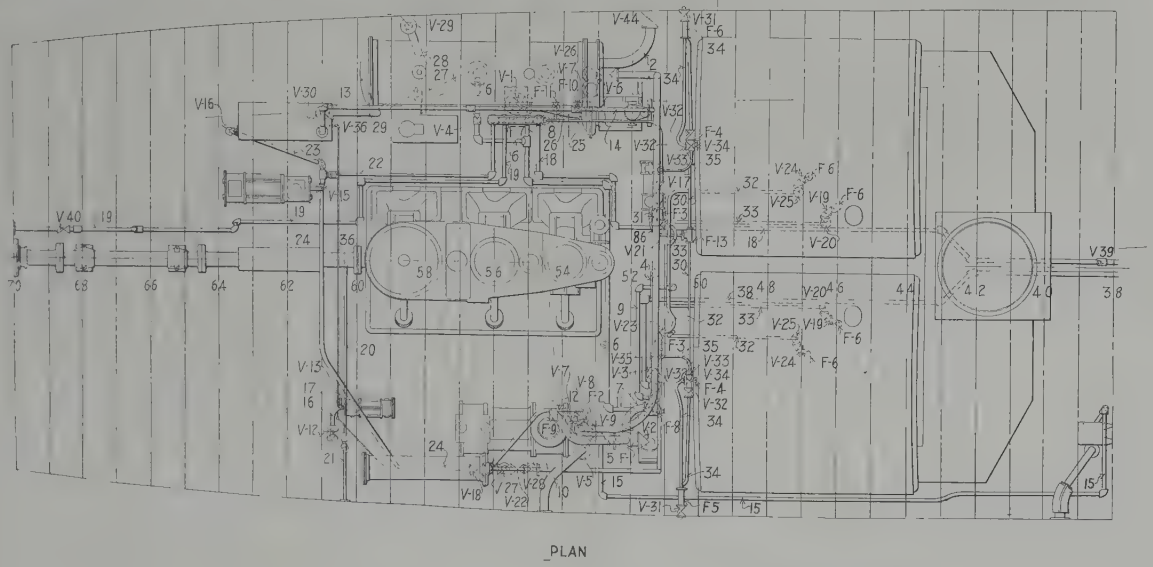
LIST OF VALVES FOR ONE SHIP—Continued

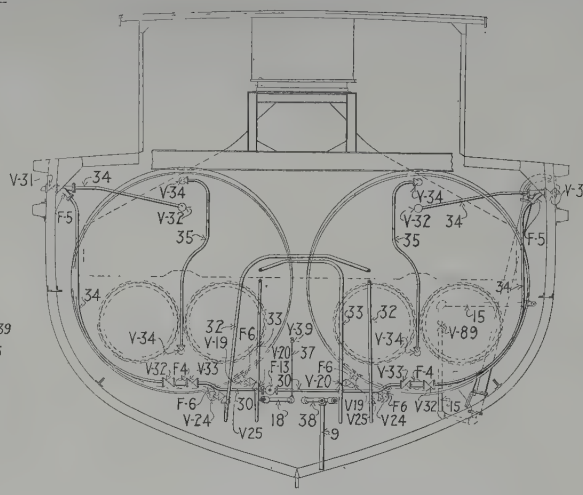
Pc. No.	Name	Mat'l	Service
V-7	2½" Scr'd angle	Comp.	Fire pump disch.—F. lines.
V-8	2½" Flg'd angle	I.B.B.M.	Fire pump disch.—boiler.
V-9	2½" Flg'd angle	I.B.B.M.	Fire pump disch.—ash ejector.
V-10	2½" Scr'd globe	I.B.B.M.	Fire pump disch.—filter.
V-11	4" Flg'd gate	I.B.B.M.	Fire pump disch.
V-12	2½" Flg'd angle	I.B.B.M.	Sani. pump sea suction.
V-13	1½" Scr'd angle	Comp.	Sani. pump discharge.
V-14	2" Scr'd globe	Comp.	Inj. suct. — tank manifold.
V-15	2½" Scr'd angle	I.B.B.M.	Feed pump suction.
V-16	2½" Scr'd angle	I.B.B.M.	Feed pump suction—filter.
V-17	2" Flg'd globe	Comp.	Inj. disch.—aux. feed.
V-18	2½" Flg'd globe	Comp.	Feed pump discharge.
V-19	2" Flg'd angle	Comp.	Inj. disch—boiler.
V-20	2" Flg'd angle	Comp.	Inj. disch—boiler.
V-21	2" Flg'd angle	Comp.	Inj. disch.—aux. feed
V-22	2½" Flg'd globe	Comp.	Feed pump disch.—by-pass. H.
V-23	2½" Flg'd angle	Comp.	Feed pump disch.—main feed.
V-24	2" Flg'd angle	Comp.	Feed pump disch.—boiler.
V-25	2" Flg'd angle	Comp.	Feed pump disch.—boiler.
V-26	1½" Flg'd angle	Comp.	Injector disch.—deck.
V-27	2½" Flg'd cross	Comp.	Feed pump disch.—by-pass. H.
V-28	2½" Flg'd angle	Comp.	Feed pump disch.—by-pass. H.
V-29	5" Flg'd angle	I.B.B.M.	Air pump disch.—overboard.
V-30	4" Flg'd angle	I.B.B.M.	Air pump disch.—filter.
V-31	1½" Flg'd cock	Comp.	Boiler blows.
V-32	1½" Flg'd cock	Comp.	Boiler blows.
V-33	1½" Flg'd globe	Comp.	B. C. pump suct.—boiler.
V-34	1¼" Flg'd angle	Comp.	Water column conn.
V-35	No. 7 Prismatic		Water columns.
V-36	¾" Scr'd globe	Comp.	Heater drain—filter.
V-37	¾" Scr'd globe	Comp.	Heater drain—bilge.
V-38	2" Scr'd cock	Comp.	Syphon discharge.
V-39	1" Scr'd angle	Comp.	Ash wetting.
V-40	2½" Scr'd globe	I.B.B.M.	After peak tank.
V-41	¾" Scr'd globe	Comp.	Inj. disch.—eng. room.
V-42	2½" Scr'd angle	I.B.B.M.	For'd peak tank.
V-43	2" Flg'd globe	Comp.	B.C. pump discharge.
V-44	6" Flg'd gate	I.B.B.M.	Circ. pump disch.—overboard.
V-89	2½ Scr'd throt	I.B.B.M.	Fire pump disch.—ash eject.

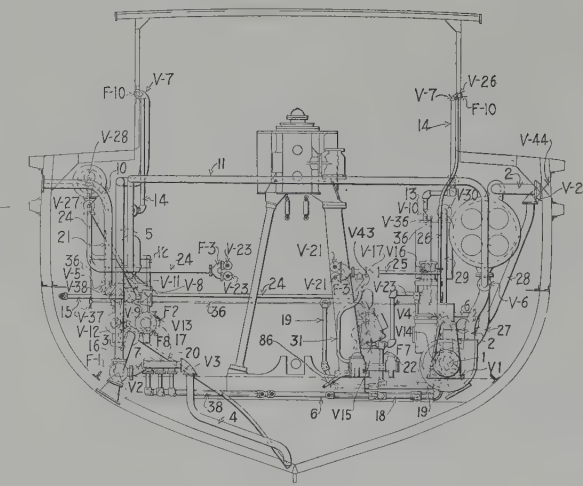
LIST OF FITTINGS FOR ONE SHIP

Pc. No.	Name	Mat'l	Service
F-1	6"x6"x5" Tee-4" out	C. iron.	Fire pump suct.
F-2	5"x2½"x5"x2½" Cross-4" out.	C. iron.	Fire pump disch.
F-3	2½"x2"x2" Y	C. iron.	Main and aux. feeds.
F-4	2"x2"x2" Tee	C. steel.	Boiler blows.
F-5	1½"x1½"x1½" Y	C. iron.	Boiler blows.
F-6	2" Elbow	C. steel.	Main and aux. feeds.
F-7	2½"x2½"x2"x2½"x2½" Box Man.	C. iron.	Tank manifold.
F-8	2½"x2½"x3" Box Man, 4 outs.	C. iron.	Bilge manifold.
F-9	5" Hose connection	Comp.	Fire pump suct.
F-10	2½" Hose connection	Comp.	Fire pump disch.
F-11	1½" Hose connection	Comp.	Injector disch.
F-12	1½" Blow-off ell.	C. iron.	Boiler blows.
F-13	1½"x1½"x2" Tee	C. iron.	B.C. pump suct.









STEEL SEA-GOING TUG

Staten Island Shipbuilding Co., Staten Island, N. Y.

See Opposite Page

STEEL HARBOR TUG

For Arrangement Plan See Opposite Page

LIST OF PIPES FOR ONE SHIP

Pc.No.	Name	Material	Remarks
50	6" Pipe, .280" thk.....	Steel	Main steam
51	5" Pipe, No. 12 B.W.G...	Copper	Main escape
52	5" Pipe, st'd.....	Bl'k I.	Main escape
53	2" Pipe, st'd.....	Bl'k I.	Steam to whistle
54	2" Pipe, No. 11 B.W.G...	Copper	Steam to whistle
55	1½" Pipe, st'd.....	Bl'k I.	Steam to jet and fuel oil system, etc.
56	1" Pipe, st'd.....	Bl'k I.	Steam to jet
57	1½" Pipe, st'd.....	Bl'k I.	Steam to bunker, steaming out
58	¾" Pipe, st'd.....	Bl'k I.	Steam to fuel oil blower
59	1½" Pipe, st'd.....	Bl'k I.	Steam to fuel oil system and lamp room
60	1" Pipe, st'd.....	Bl'k I.	Steam to fuel oil heater coils
61	1¼" Pipe, st'd.....	Bl'k I.	Steam to fuel oil pumps, etc.
62	¾" Pipe, st'd.....	Bl'k I.	Steam to lamp room
63	1½" Pipe, st'd.....	Bl'k I.	Fuel oil tank heater coils
65	¾" Pipe, st'd.....	Bl'k I.	Steam to heating system
66	3" Pipe, .216" thk.....	Steel	Aux. steam lines
67	2½" Pipe, .203" thk.....	Steel	Aux. steam lines
68	2" Pipe, st'd.....	Bl'k I.	Aux. steam lines
69	1½" Pipe, st'd.....	Bl'k I.	Aux. steam lines
70	1½" Pipe, st'd.....	Bl'k I.	Cylinder drain
71	2" Pipe, st'd.....	Bl'k I.	Steam to fire pump
72	1¼" Pipe, st'd.....	Bl'k I.	Steam to steering engine
73	1¼" Pipe, st'd.....	Bl'k I.	Steam to syphon
74	1" Pipe, st'd.....	Bl'k I.	Steam to dynamo
75	1½" Pipe, st'd.....	Bl'k I.	Steam to by-pass
76	1¼" Pipe, st'd.....	Bl'k I.	Steam to circ. pump
77	½" Pipe, st'd.....	Bl'k I.	Steam to sanitary pump
78	½" Pipe, st'd.....	Bl'k I.	Steam to boiler circ. pump
79	1¼" Pipe, st'd.....	Bl'k I.	Steam to feed pump
80	1" Pipe, st'd.....	Bl'k I.	Steam to air pump
81	2" Pipe, st'd.....	Bl'k I.	Steam to injector
82	½" Pipe, st'd.....	Bl'k I.	Steam to revers. engine
83	½" Pipe, st'd.....	Bl'k I.	Steam to sea boxes
84	1¼" Pipe, st'd.....	Bl'k I.	Steam to after gypsy capstan
85	12" Pipe, No. 9 B.W.G.....	Copper	Main exhaust.
86	3" Pipe, No. 14 B.W.G.....	Copper	Aux. exh. to condenser and heater
87	2½" Pipe, st'd.....	Bl'k I.	Aux. exh. to atmosphere
88	2½" Pipe, st'd.....	Bl'k I.	Aux. exh. from fire pump
89	1½" Pipe, st'd.....	Bl'k I.	Aux. exh. from feed pump
90	¾" Pipe, st'd.....	Bl'k I.	Aux. exh. from sani. pump
91	¾" Pipe, st'd.....	Bl'k I.	Aux. exh. from boiler circ. pump
92	1½" Pipe, st'd.....	Bl'k I.	Aux. exh. from circ. pump
93	1¼" Pipe, st'd.....	Bl'k I.	Aux. exh. from air pump
94	½" Pipe, st'd.....	Bl'k I.	Aux. exh. from revers. eng.
95	1½" Pipe, st'd.....	Bl'k I.	Aux. Exh. from dynamo
96	1½" Pipe, st'd.....	Bl'k I.	Aux. exh. from steer. eng.
97	2" Pipe, st'd.....	Bl'k I.	Aux. exh. from after gypsy capstan
98	2" Pipe, st'd.....	Bl'k I.	Aux. exh. from for'd. gypsy and fuel oil
99	1" Pipe, st'd.....	Bl'k I.	Aux. exh. from heater coils to filter box
100	1½" Pipe, st'd.....	Bl'k I.	Aux. exh. from fuel oil pumps, etc.
101	1½" Pipe, #11 B.W.G.....	Copper	Surface blow
102	2" Pipe, #11 B.W.G.....	Copper	Bottom blow
103	2" Pipe, st'd.....	Bl'k I.	Boiler blows
104	2" Pipe.....	Bl'k I.	Steam to syphon

LIST OF VALVES FOR ONE SHIP

Pc.No.	Name	Material	Remarks
V-40	6" Angle valve, fl'g'd....	I.B.B.M.	Main steam stop
V-41	3½" Twin valve, fl'g'd....	I.B.B.M.	Safety valve
V-42	3" Angle valve, fl'g'd.....	I.B.B.M.	Aux. st. stop
V-43	2" Angle valve. fl'g'd.....	Comp.	Whistle stop
	2" Globe valve, scr'd.....	Comp.	Aux. st.—fire pump
V-45	¾" Globe valve, scr'd....	Comp.	Aux. st.—lamp room
V-46	1" Angle valve, scr'd.....	Comp.	Aux. st.—jet
	1" Angle valve, scr'd.....	Comp.	Aux. st.—dynamo
V-48	1" Globe valve, scr'd.....	Comp.	Aux. st.—dynamo
	½" Globe valve, scr'd....	Comp.	Aux. st.—boiler circ. pump

LIST OF VALVES FOR ONE SHIP—(Continued)

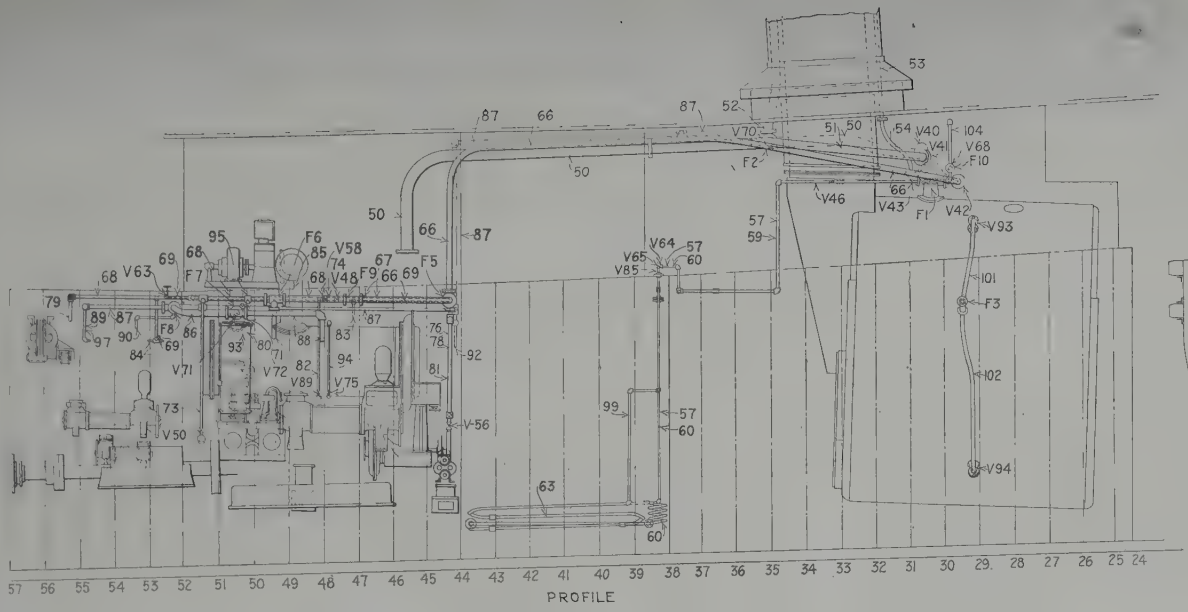
Pc. No.	Name	Material	Remarks
V-50	1¼" Globe valve, scr'd....	Comp.	Aux. st—syphon
	1¼" Globe valve, scr'd....	Comp.	Aux. st.—feed pump
	1½ Globe valve, scr'd.....	Comp.	Aux. st.—steer. eng.
	1" Globe valve, scr'd.....	Comp.	Aux. st.—air pump.
V-54	¾" Globe valve, scr'd.....	Comp.	Aux. st.—heat. system
V-55	¾" Reduc. valve, scr'd....	Comp.	Aux. st.—heat. system
V-56	2" Globe valve, scr'd.....	Comp.	Aux. st—injector
V-57	½" Angle valve, scr'd....	Comp.	Aux. st.—sea boxes
V-58	¾" Reduc. valve, scr'd...	Comp.	Aux. st.—dynamo
	1¼" Globe valve, scr'd....	Comp.	Aux. st.—circ. pump
	1½" Globe valve, scr'd....	Comp.	Aux. st—by-pass
	1½" Globe valve, scr'd....	Comp.	Aux. st.—capstan windlass for'd.
V-63	1½" Globe valve, scr'd....	Comp.	Aux. st.—gypsy capstan aft.
V-64	1½" Angle valve, scr'd....	Comp.	Aux. st.—fuel oil system — steaming out pipe
V-65	1" Angle valve, scr'd.....	Comp.	Aux. st.—fuel oil system steam coils
	¾" Globe valve, scr'd....	Comp.	Aux. st.—fuel oil system—blower
	½" Globe valve, scr'd.....	Comp.	Aux. st.—fuel oil system pumps
V-68	2" Angle valve, scr'd.....	Comp.	Steam to wrecking syphon
V-70	2½" Globe valve, scr'd.....	I.B.B.M.	Aux. exh.—atmosphere
V-71	3" Angle valve, fl'g'd.....	I.B.B.M.	Aux. exh.—cond.
V-72	3½" Angle valve, fl'g'd....	I.B.B.M.	Aux. exh.—heater
	2½" Globe valve, scr'd....	I.B.B.M.	Aux. exh.—fire pump
	¾" Globe valve, scr'd....	Comp.	Aux. exh.—sani. pump
V-75	½" Globe valve, scr'd....	Comp.	Aux. exh.—revers. eng.
	¾" Globe valve, scr'd....	Comp.	Aux. exh.—boiler circ. pump
	1½" Globe valve, scr'd.....	Comp.	Aux. exh.—air pump. pump
	1¼" Globe valve, scr'd.....	Comp.	Aux. exh.—air pump
	1½" Globe valve, scr'd.....	Comp.	Aux. exh.—feed pump
	1½" Globe valve, scr'd.....	Comp.	Aux. exh.—steer. eng.
	1½" Globe valve, scr'd.....	Comp.	Aux. exh.—dynamo
	2" Globe valve, scr'd.....	Comp.	Aux. exh.—capstan windlass for'd.
	2" Globe valve, scr'd.....	Comp.	Aux. exh.—Gypsy capstan aft.
	¾" Globe valve, scr'd.....	Comp.	Aux. exh.—fuel oil system pumps
V-85	1" Angle valve, scr'd.....	Comp.	Aux. exh.—fuel oil system heater coils
	1½" Globe valve, scr'd.....	Comp.	Aux. exh.—fuel oil system blower.
	1" Globe valve, scr'd.....	Comp.	Cylinder drain.
V-88	1¼" Chrono. valve, scr'd...	Comp.	Aux. st.—feed pump
V-89	½" Globe valve, scr'd.....	Comp.	Aux. Steam Revers. blows
	1" Globe valve, scr'd.....	Comp.	Cylinder Drains
V-91	1½" Globe valve, scr'd....	Comp.	Aux. Steam.
V-92	2" Hor. check valve, fl'g'd..	Comp.	Over-board boiler blows
V-93	1½" Angle valve, fl'g'd....	Comp.	Surface blow
V-94	2" Angle valve, fl'g'd.....	Comp.	Bottom blow

LIST OF FITTINGS FOR ONE SHIP

Pc.No.	Name	Material	Remarks
F-1	7⅜"x6⅜"x6⅜"x3"x2" bilge manifold	C.S.	Main and aux. st. line
F-2	5" Ell-2½" side outlet....	C.I.	Main escape
F-3	2"x2"x2" Y.....	C.I.	Boiler blow
F-4	2" Blow off ell.....	C.I.	Boiler blow
F-5	3"x2½"x3"x2" cross 1½" tap	C.S.	Aux. st .line
F-6	3"x2"x2" Tee.....	C.S.	Aux. st .line
F-7	3"x2½"x3½" Tee.....	C.I.	Aux. exh. line
F-8	3"x3"x2½"x2½" Cross ¾" tap	C.I.	Aux. exh. line
F-9	2½"x2"x1½" and 1" Tap—½" side outlet.....	C.S.	Aux. st. line
F-10	2" Hose connection.....	Comp.	St. to wrecking syphon

LIST OF AUXILIARIES

Sanitary pump—hor. duplex, 4½"x3¾"x4".
Circulating pump, 6" engine, 6"x6".
Boiler circulating pump, hor. duplex, 4½"x2¾"x4".
Feed water heater, 14"—Cir.
Injector 13½".
Steering engine, size 12"x36".
Dynamo.
Dynamo engine.
Fire pump—hor. duplex, 12"x8½"x12".
Feed pump—hor. duplex, 7½"x5"x10".
Air pump—vert. simplex, 7½"x14½"x8".
Oil pump—hor. duplex, 4½"3"x4". Upper pump.
Oil pump—hor. duplex, 4½"x3"x4". Lower pump.
Blower.



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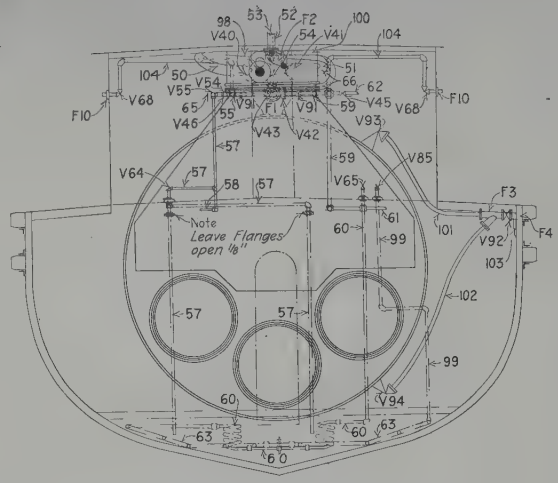
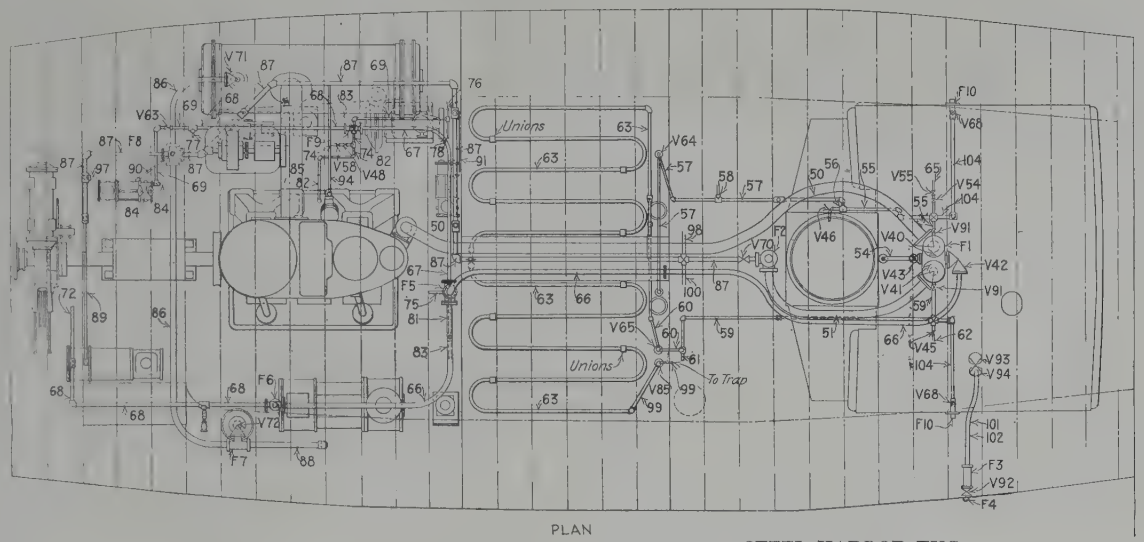
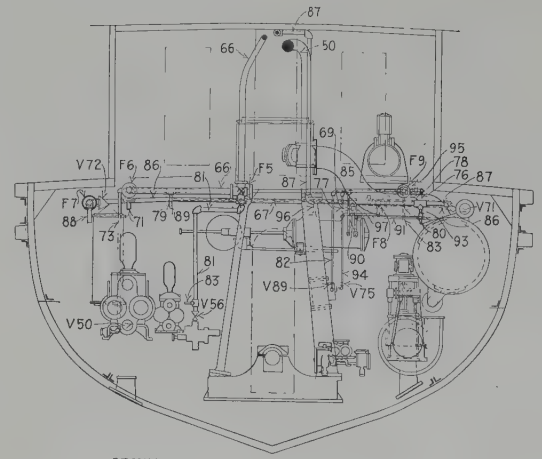


SECTION THRU FRAME #38-LOOKING FORWARD



PLAN



SECTION AT FRAME #44 LOOKING AFTERWARD

STEEL HARBOR TUG

Staten Island Shipbuilding Co., Staten Island, N. Y.

See Opposite Page

STEEL HARBOR TUG

For Arrangement Plan See Opposite Page

LIST OF PIPES FOR ONE SHIP

Pc. No.	Name	Material	Service
1	8" Pipe, #11 B.W.G...	Copper	Circulating pump—suction.
2	6" Pipe, #12 B.W.G...	Copper	Circulating pump—discharge.
3	6" Pipe, #12 B.W.G...	Copper	Fire pump suction—sea.
4	3" Pipe, st'd.....	G.I.	Fire pump suction—bilge manifold.
5	2½" Pipe, st'd.....	G.I.	Fire pump suction—tank.
6	3" Pipe, st'd.....	G.I.	Fire pump suction—engine room bilge.
7	2½" Pipe, st'd.....	G.I.	Fire pump suction—boiler room bilge.
8	2½" Pipe, st'd.....	G.I.	Fire pump suction—forward hold.
9	4½" Pipe, st'd.....	G.I.	Fire pump discharge—overboard.
10	4½" Pipe, st'd.....	G.I.	Fire pump discharge—fire lines.
11	3½" Pipe, st'd.....	G.I.	Fire pump discharge—fire lines.
12	2" Pipe, st'd.....	G.I.	Syphon suction.
13	2" Pipe, #15 B.W.G...	Copper	Syphon discharge.
14	2½" Pipe, #15 B.W.G.	Copper	Sanitary pump suction.
15	1½" Pipe, st'd.....	Brass	Sanitary pump discharge.
16	2½" Pipe, st'd.....	G.I.	Forward tank line.
17	2½" Pipe, st'd.....	G.I.	After tank line.
18	2½" Pipe, st'd.....	G.I.	Feed pump suction—tank manifold.
19	2½" Pipe, st'd.....	G.I.	Feed pump suction—filter box.
20	2½" Pipe, st'd.....	G.I.	Feed pump suction.
21	2" Pipe, st'd.....	G.I.	Injector suction—tank manifold.
22	2" Pipe, #11 B.W.G...	Copper	Injector discharge—auxiliary feed.
23	1½" Pipe, st'd.....	G.I.	Injector discharge—deck.
24	¾" Pope, st'd.....	G.I.	Injector discharge — engine room.
25	2½" Pipe, #10 B.W.G.	Copper	Feed pump discharge—heater.
26	2½" Pipe, #10 B.W.G.	Copper	Main feed line.
27	2" Pipe, #11 B.W.G...	Copper	Auxiliary feed line.
28	2" Pipe, #11 B.W.G...	Copper	Boiler circulating pump suction—boiler.
29	2" Pipe, #11 B.W.G...	Copper	B. C. pump suction—tank manifold.
30	1½" Pipe, #11 B.W.G.	Copper	B. C. pump discharge—Auxiliary feed line.
31	6" Pipe, #12 B.W.G...	Copper	Air pump suction.
32	5" Pipe, #12 B.W.G...	Copper	Air pump discharge—overboard.
33	3½" Pipe, #14 B.W.G.	Copper	Air pump discharge—filter box.
34	2" Pipe, st'd.....	G.I.	Heater Drain.
35	1¼" Pipe, #12 B.W.G.	Copper	Water column connections.
36	¾" Pipe, st'd.....	G.I.	Heater drain to filter box.
37	½" Pipe, st'd.....	G.I.	Heater drain to bilge.
38	3" Pipe, st'd.....	G.I.	Fire pump discharge to nozzle.
39	4" Pipe, st'd.....	B.I.	Fuel oil filling pipe.
40	4" Pipe, st'd.....	B.I.	Fuel oil ventilating pipe.
41	1½" Pipe, st'd.....	B.I.	Fuel oil sounding pipe.
42	2½" Pipe, st'd.....	B.I.	Fuel oil tank low suction.
43	4" Pipe, st'd.....	B.I.	Fuel oil tank high suction and equalizer.
44	2½" Pipe, st'd.....	B.I.	Fuel oil tank high suction.
45	6" Pipe, st'd.....	G.I.	Fire pump wrecking suction.
46	6" Pipe, st'd.....	G.I.	Circ. pump bilge suction.

LIST OF VALVES FOR ONE SHIP

Pc. No.	Name	Material	Service
V1	8" Angle valve, fl'g'd.....	I.B.B.M.	Circulating pump suction—6" side outlet.
V2	6" Angle valve, fl'g'd.....	I.B.B.M.	Fire pump suction—sea.
V3	4½" Angle valve, scr'd..	I.B.B.M.	Fire Pump suction—bilge manifold.
V4	3" Angle valve, fl'g'd.....	I.B.B.M.	Fire pump discharge—overboard.
V5	2½" Angle valve, scr'd...	Comp.	Fire pump discharge—fire lines.
V6	2½" Angle valve, scr'd...	I.B.B.M.	Forward tank line.
V7	2½" Angle valve, scr'd...	I.B.B.M.	After tank line.
V8	2½" Angle valve, fl'g'd...	I.B.B.M.	Sanitary pump suction.
V9	1½" Angle valve, scr'd...	Comp.	Sanitary pump discharge.
V10	2" Globe valve, scr'd.....	Comp.	Injector suction — tank manifold.
V11	2" Globe valve, scr'd.....	Comp.	Injector discharge—Auxiliary feed.
V12	1½" Globe valve, scr'd...	Comp.	Injector discharge—deck.
V13	¾" Globe valve, scr'd...	Comp.	Injector discharge—eng. room.
V14	2½" Globe valve, scr'd...	I.B.B.M.	Feed pump suction—filter box.
V15	2½" Cross valve, fl'g'd...	I.B.B.M.	Feed pump discharge—heater.

LIST OF VALVES FOR ONE SHIP—Continued

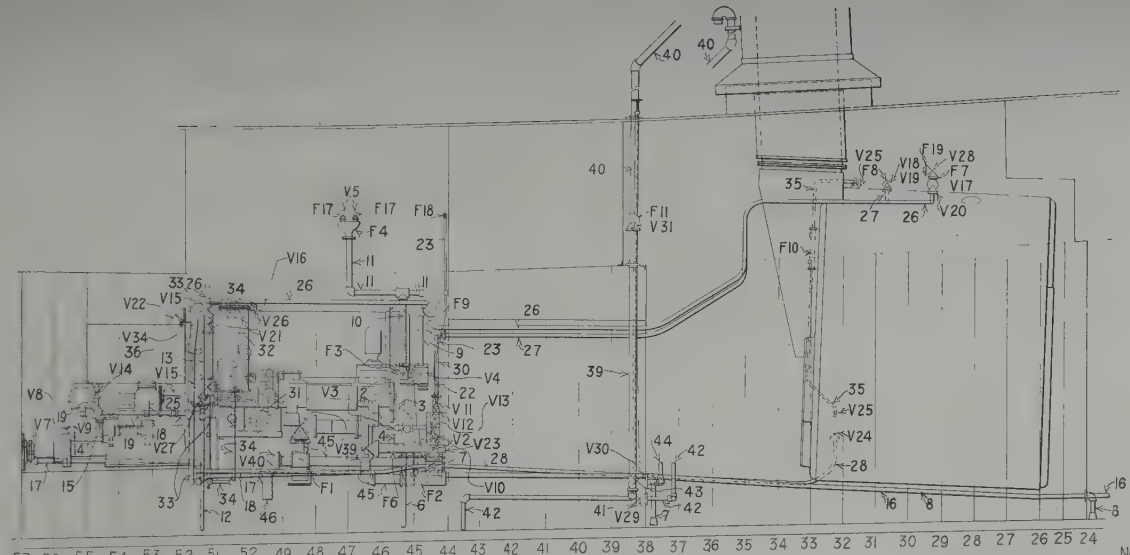
Pc. No.	Name	Material	Service
V16	2½" Globe valve, fl'g'd...	I.B.B.M.	Feed pump discharge—heater bypass.
V17	2½" Globe valve, fl'g'd...	Comp.	Feed pump discharge—to boiler.
V18	2½" Globe valve, fl'g'd...	Comp.	Injector discharge — to boiler.
V19	2½" Angle valve, fl'g'd...	Comp.	Injector discharge — to boiler.
V20	2½" Angle valve, fl'g'd...	Comp.	Feed pump discharge—to boiler.
V21	5" Angle valve, fl'g'd...	Comp.	Air pump discharge—overboard.
V22	3½" Angle valve, fl'g'd...	Comp.	Air pump discharge—filter box.
V23	2" Angle valve, fl'g'd.....	Comp.	B. C. pump suction—tank manifold.
V24	2" Angle valve, fl'g'd.....	Comp.	B. C. pump suction—boiler.
V25	1¼" Angle valve, fl'g'd...	Comp.	Water column connection.
V26	2" Angle valve, scr'd.....	Comp.	Heater drain.
V27	2" Cock valve, scr'd.....	Comp.	Syphon discharge.
V28	2½" Angle valve, fl'g'd...	Comp.	Valve.
V29	2½" Gate valve, fl'g'd....	I.B.B.M.	Fuel oil low suction.
V30	4" Gate valve, fl'g'd.....	I.B.B.M.	Fuel oil high suction and equalizer.
V31	4" Angle valve, fl'g'd.....	I.B.B.M.	Fuel oil filling.
V32	3" Angle valve, fl'g'd.....	I.B.B.M.	Fire pump discharge to nozzle.
V33	2" Back pressure valve...		Feed heater drain.
V34	¾" Angle valve, scr'd....	Comp.	Feed heater drain to filter box.
V35	½" Angle valve, scr'd....	Comp.	Feed heater drain to bilge.
V36	6" Gate valve, fl'g'd.....	I.B.B.M.	Circulating pump discharge—overboard.
V37	2" Check valve, fl'g'd.....	Comp.	Syphon discharge—overboard.
V38	3" Check valve, fl'g'd....	I.B.B.M.	Fire pump discharge—overboard.
V38	5" Check valve, fl'g'd....	I.B.B.M.	Fire pump discharge—overboard.
V39	6" Angle valve, fl'g'd...	I.B.B.M.	Fire pump wrecking suction.
V40	6" Angle valve fl'g'd.....	I.B.B.M.	Circ. pump bilge suction.

LIST OF FITTINGS FOR ONE SHIP

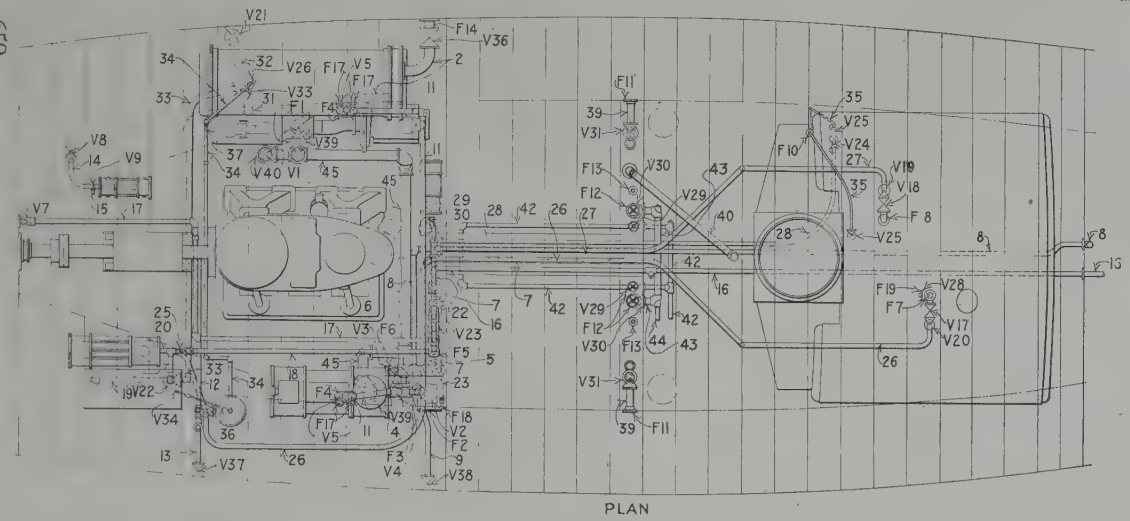
Pc. No.	Name	Material	Service
F1	8" Sea box.....	C.I.	Circ. pump suction.
F2	6" Sea box.....	C.I.	Fire pump suction—sea.
F3	5"x4¼"x5" Tee.....	C.I.	Fire pump discharge.
F4	3½"x2½"x2½" Manifold.	C.I.	Fire pump discharge—fire line.
F5	2½"x2½"x2" Tap, 2½" outlet x 2½"x2½" valve manifold.	C.I.	Tank lines.
F6	2½"x2½"x2½"x3 Valve manifold x 3" tap.....	C.I.	Fire pump suction.
F7	2½" Ell—2½" outlet. .	C.S.	Main feed line.
F8	2½" Ell.....	C.S.	Auxiliary feed line.
F9	2"x2"x2" Tee.....	C.S.	Auxiliary feed line.
F10	1¾" Water column.....	C.I.	Water column.
F11	4" scr'd fl'g'd Hose con...	C.I.	Fuel oil filling pipe.
F12	1" Valve stem stuffing box.	Comp.	Fuel oil suction pipe.
F13	1½" Deck sounding plate.	Comp.	Fuel oil sounding pipe.
F14	6" Distance piece.....	C.I.	Circ. pump discharge.
F15	Long turn ell.....	C.I.	Injector discharge and syphon line.
F16	Stand for pilot house noz.	C.I.	Fire pump discharge to pilot house.
F17	2½" Hose connection....	Comp.	Fire pump discharge to fire lines.
F18	1½" Hose connection....	Comp.	Injector discharge to deck.
F19	2½" Hose connection....	Comp.	Connection and cap.

LIST OF AUXILIARIES FOR ONE SHIP

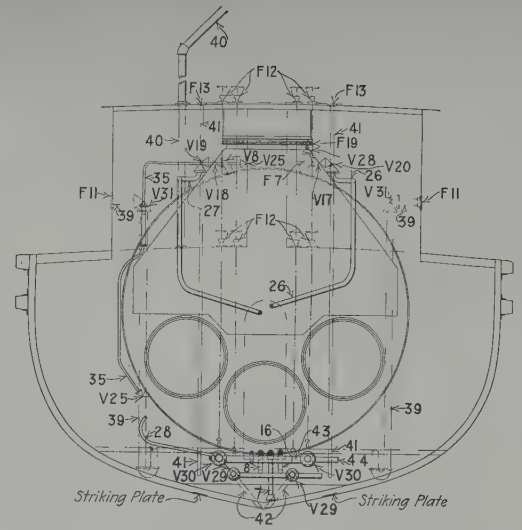
Sanitary pump—horizontal duplex, 4½"x3¾"x4".
Circulating pump, 6"x6".
Boiler circ. pump—horizontal duplex, 4½"x2¾"x4".
Feed water heater.
Injector, 13½".
Steering engine, 12"x36".
Dynamo engine—speed 600.
Generator.
Fire pump—horizontal duplex, 12"x8½"x12".
Feed pump—horizontal duplex, 7½"x5"x10".
Air pump—vertical simplex, 7½"x14½"x8".
Oil pump—horizontal duplex, 4½"x3"x4".
Blower.



PROFILE

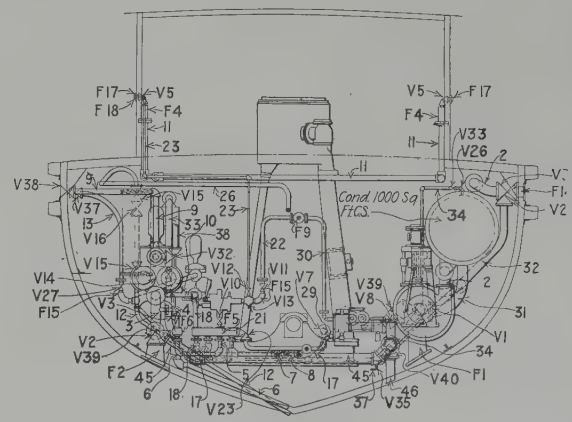


PLAN



Note:
All Pipes fitted with bosses and to drain properly

SECTION AT FRAME #38 LOOKING FORWARD.

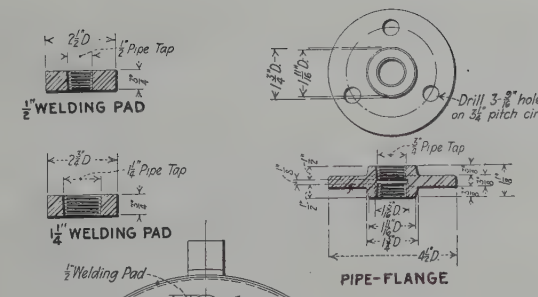


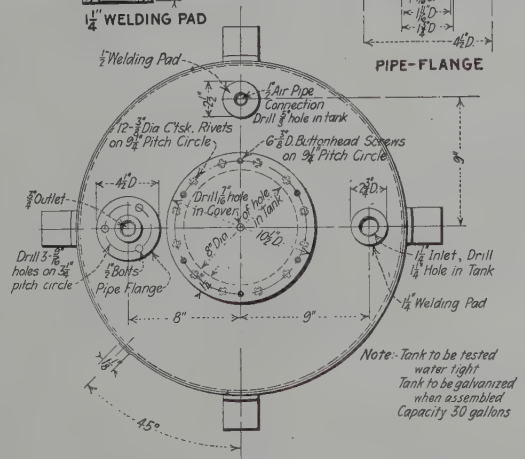
SECTION AT FRAME #44
LOOKING AFT.

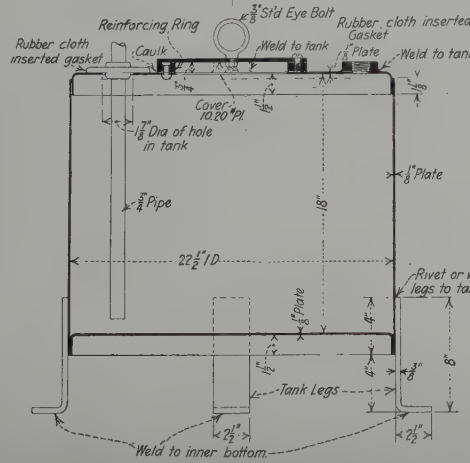
STEEL HARBOR TUG

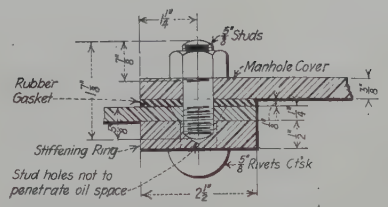
Staten Island Shipbuilding Co., Staten Island, N. Y.

See Opposite Page

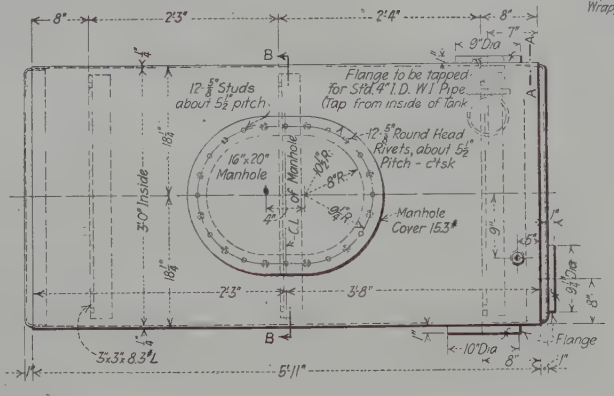


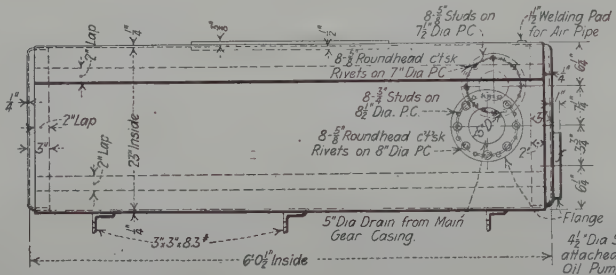

1/2" Welding Pad
1" Air Pipe Connection
Drill 3/8" hole in tank
12-3/8" Dia C'tsk. Rivets on 9 1/4" Pitch Circle
6-3/8" D. Buttonhead Screws on 9 1/4" Pitch Circle
Drill 7/16" hole in Cover
Drill 7/16" hole in tank
8" Dia
10 1/2" D
1/4" Inlet, Drill 1/4" Hole in Tank
1 1/4" Welding Pad
Drill 3-7/8" holes on 5 3/4" pitch circle
3/8" Bolts
Pipe Flange
8"
9"
45°
Note: Tank to be tested water tight
Tank to be galvanized when assembled
Capacity 30 gallons



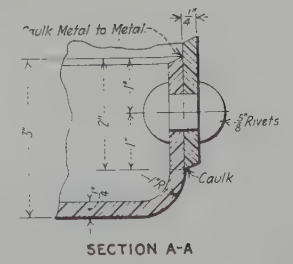


DETAIL OF MANHOLE CONNECTION



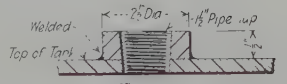

8-5/8" Studs on 7 1/2 Dia P.C.
1" Welding Pad for Air Pipe
2" Lap
8-3/8" Roundhead c'tsk Rivets on 7" Dia P.C.
8-3/4" Studs on 8 1/2" Dia. P.C.
2" Lap
8-5/8" Roundhead c'tsk Rivets on 8" Dia P.C.
23" Inside
3"
5" Dia Drain from Main Gear Casing.
Flange
3"x3"x8.3#
6'-0 1/2" Inside
4 1/2" Dia Suction to attached Lubricating Oil Pumps.

LUBRICATING OIL DRAIN TANK

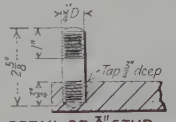


SECTION A-A

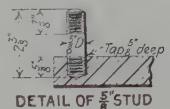
NOTES
All outside seams to be caulked oil tight metal to metal
Tank to be tested to 15# pressure (hydrostatic)
Estimated weight of of tank, 1000 lbs
Capacity 214.5 gallons
Wrapper plate may be made in one piece



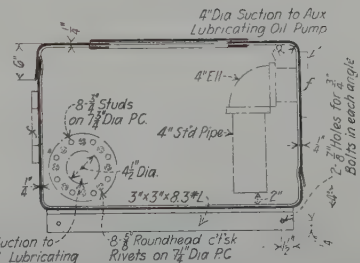
DETAIL OF 1 1/2" WELDING PAD



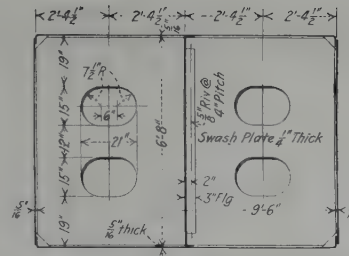
DETAIL OF 3/4" STUD



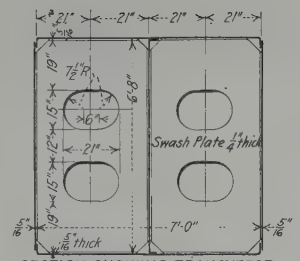
DETAIL OF 5/8" STUD


4" Dia Suction to Aux Lubricating Oil Pump
4" Ell
8-3/4" Studs on 7 1/8" Dia P.C.
4" Std Pipe
4 1/2" Dia.
3"x3"x8.3#L
2 7/8" Holes for 3/4" Bolts in each angle
8-5/8" Roundhead c'tsk Rivets on 7 1/4" Dia P.C.

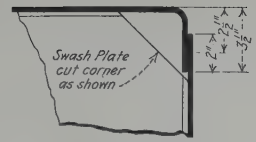
SECTION B-B



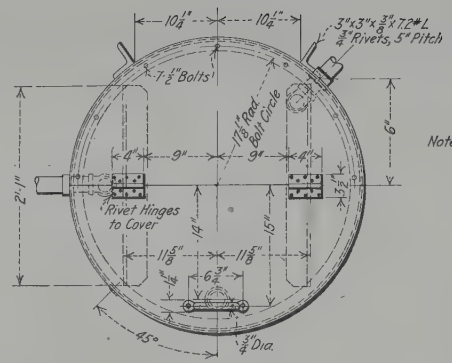
SECTION SHOWING LONGITUDINAL SWASH PLATE



SECTION SHOWING TRANSVERSE SWASH PLATE



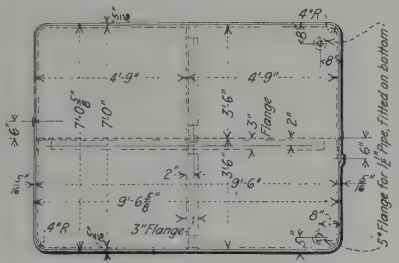
DETAIL OF CORNER



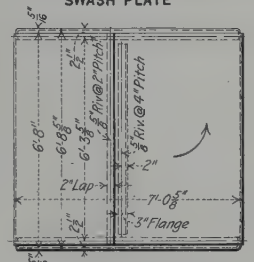
PLAN

Note:- Use 3/8" Rivets, 4 Pitch except as noted

Capacity of Tank 200 Gallons



PLAN VIEW OF TOP

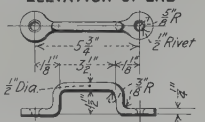


ELEVATION OF END

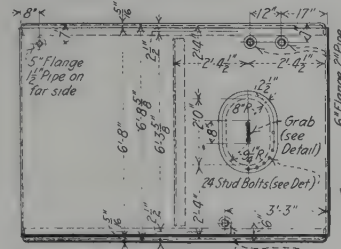
NOTES

2-2" Pipe Flanges, 6" Dia.
5-1 1/2" Pipe Flanges, 5" Dia.
All seams of tank proper caulked on the outside only.
Swash plates not to be caulked.
Rivets in swash plates to be caulked outside.
Tanks to be tested water tight.
Paint one coat black asphaltum paint on the outside only before shipment

Capacity { 12.3 tons (of 2240 lbs)
443 cu. ft.
3300 gallons

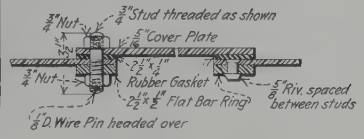


DETAIL OF GRAB



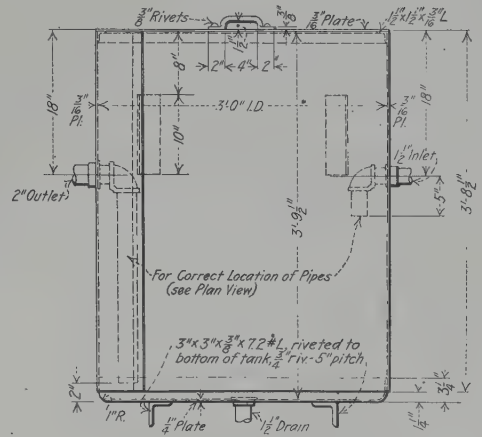
2-5" Flanges - 1 1/2" Pipe, 1 on inside - 1 on outside
1/2" Elbow Fitted on inside on far side of tank

ELEVATION OF SIDE



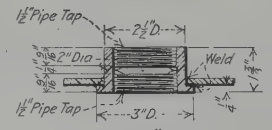
DETAIL OF MANHOLE

FRESH WATER TANK

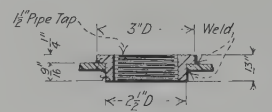


ELEVATION

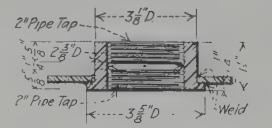
INSPECTION TANK



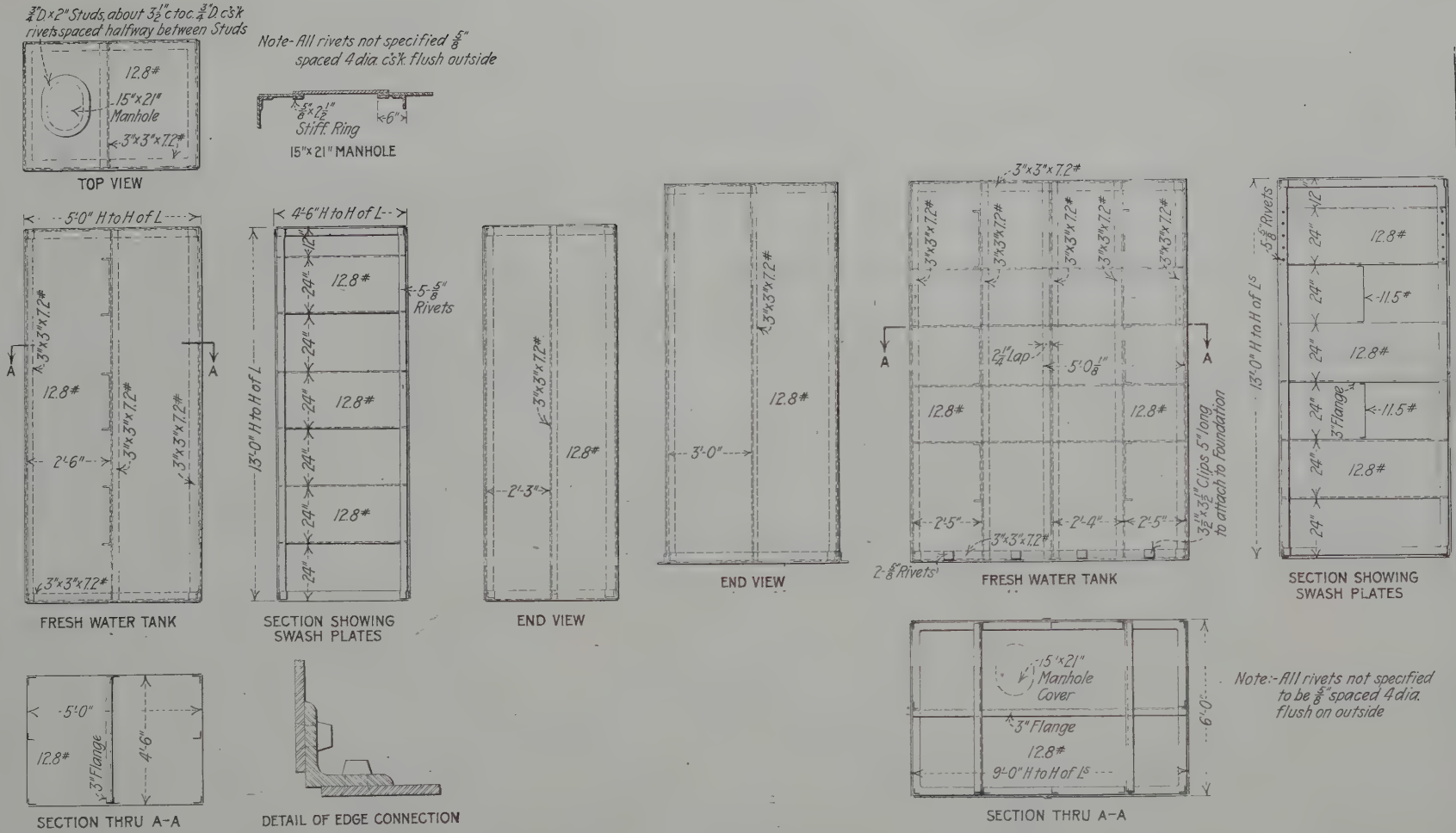
DETAIL OF 1 1/2" TWO-TAP WELDING PAD

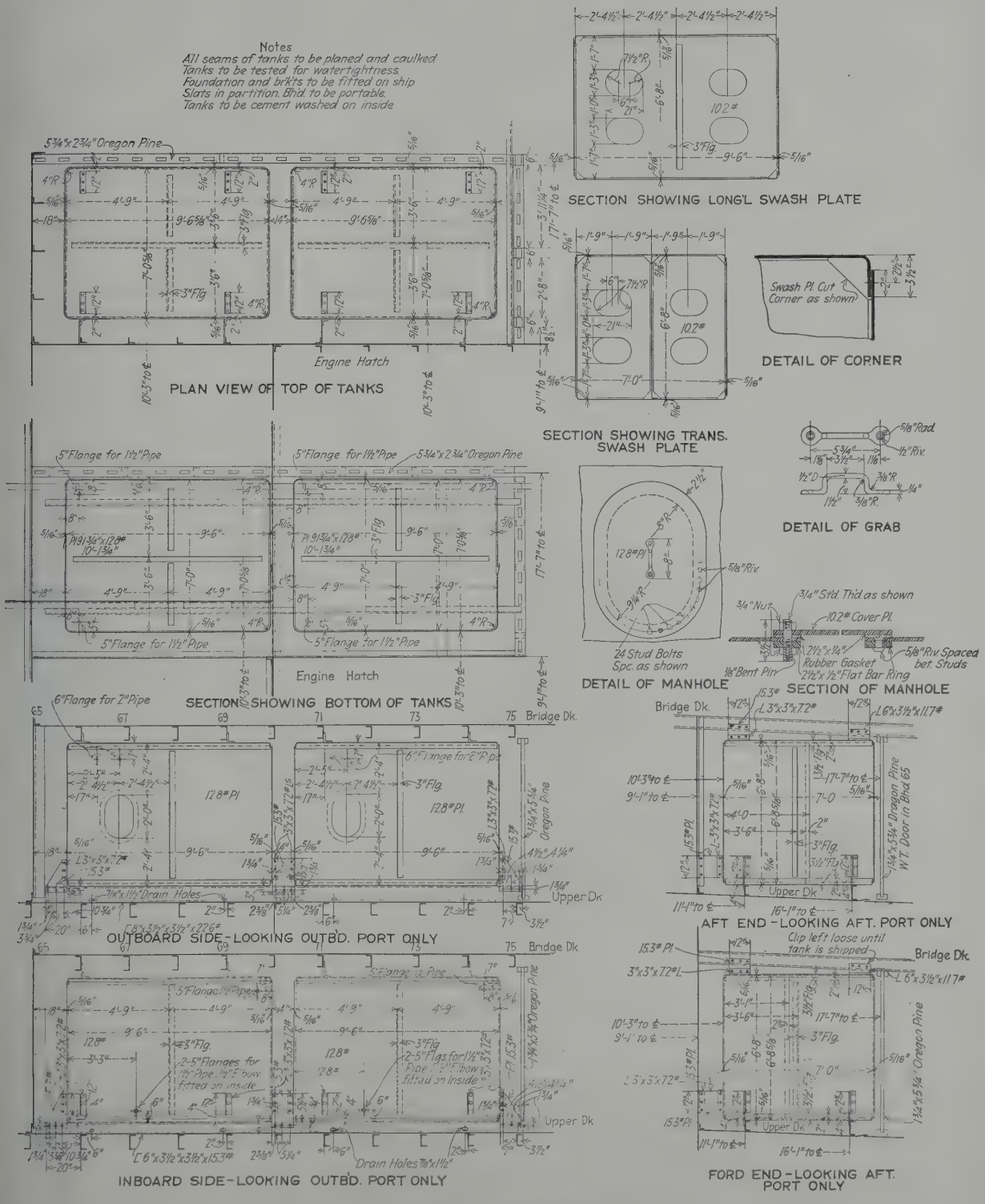


DETAIL OF 1 1/2" SINGLE TAP WELDING PAD

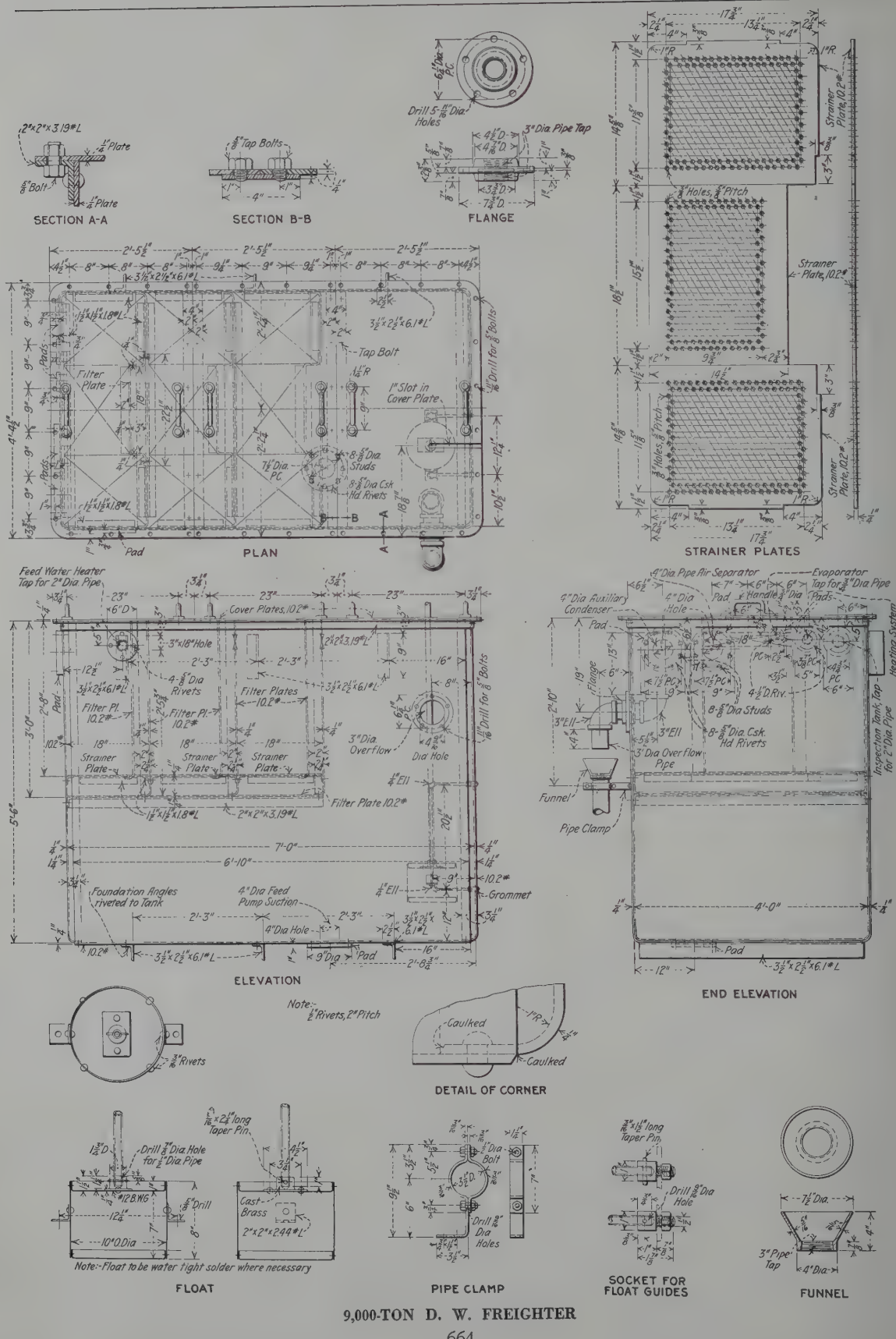


DETAIL OF 2" TWO-TAP WELDING PAD

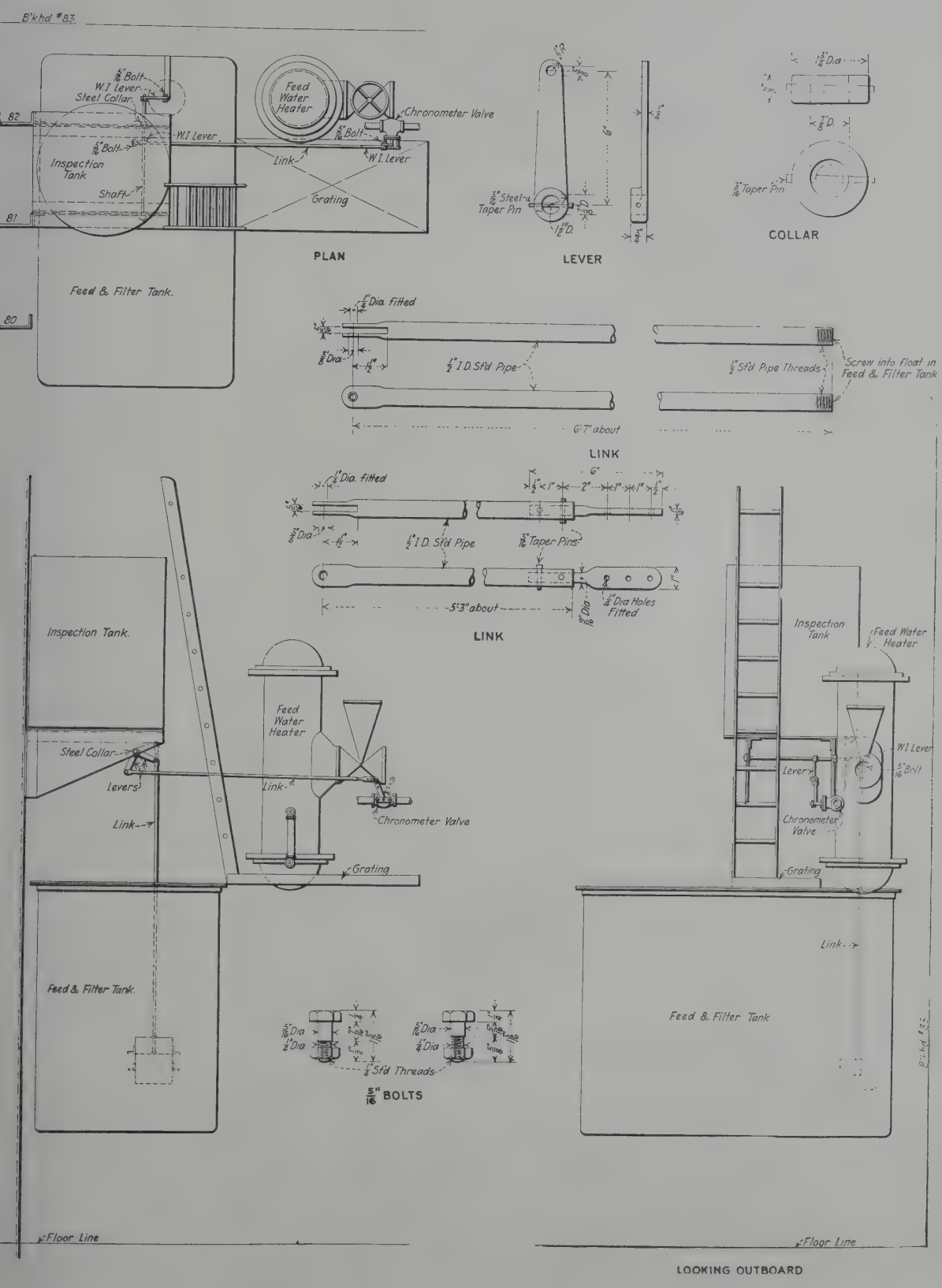

3/4"D x 2" Studs, about 3 1/2" c to c. 3/4"D c's'k rivets spaced halfway between Studs
12.8#
15"x21" Manhole
3"x3"x7.2#
TOP VIEW
Note- All rivets not specified 5/8" spaced 4 dia. c's'k. flush outside
5/8"x2 1/2" Stiff. Ring
6"
15"x21" MANHOLE
5'-0" H to H of L
3"x3"x7.2#
12.8#
2'-6"
A
FRESH WATER TANK
4'-6" H to H of L
13'-0" H to H of L
24"
5-5/8" Rivets
SECTION SHOWING SWASH PLATES
END VIEW
2'-3"
3'-0"
2 1/4" Lap
5'-0 1/8"
2'-5"
2'-4"
3"x3"x7.2#
3 1/2"x3 1/2" Clips 5" long to attach to Foundation
2-5/8" Rivets
FRESH WATER TANK
5-5/8" Rivets
11.5#
3" Flange
SECTION SHOWING SWASH PLATES
5'-0"
4'-6"
SECTION THRU A-A
DETAIL OF EDGE CONNECTION
15"x21" Manhole Cover
6'-0"
9'-0" H to H of Ls
SECTION THRU A-A
Note:- All rivets not specified to be 5/8" spaced 4 dia. flush on outside


Notes
All seams of tanks to be planed and caulked
Tanks to be tested for watertightness
Foundation and brkts to be fitted on ship
Slats in partition. Bhd. to be portable.
Tanks to be cement washed on inside
5¾"x 2¾" Oregon Pine
PLAN VIEW OF TOP OF TANKS
Engine Hatch
SECTION SHOWING LONG'L SWASH PLATE
SECTION SHOWING TRANS. SWASH PLATE
Swash Pl. Cut Corner as shown
DETAIL OF CORNER
5/8"Rod
DETAIL OF GRAB
5"Flange for 1½"Pipe
5¾"x 2¾" Oregon Pine
SECTION SHOWING BOTTOM OF TANKS
24 Stud Bolts Spc. as shown
DETAIL OF MANHOLE
¾" Std. Thd. as shown
10.2# Cover Pl.
Rubber Gasket
2½"x ½" Flat Bar Ring
⅛" Bent Pin
5/8" Riv. Spaced bet. Studs
SECTION OF MANHOLE
6"Flange for 2"Pipe
Bridge Dk.
Upper Dk
Drain Holes
OUTBOARD SIDE-LOOKING OUTBD. PORT ONLY
INBOARD SIDE-LOOKING OUTBD. PORT ONLY
AFT END-LOOKING AFT. PORT ONLY
Clip left loose until tank is shipped
FORD END-LOOKING AFT. PORT ONLY

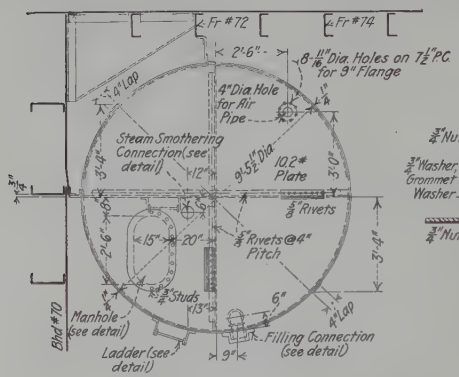
9,000-TON D. W. FREIGHTER


SECTION A-A
SECTION B-B
FLANGE
PLAN
STRAINER PLATES
ELEVATION
END ELEVATION
DETAIL OF CORNER
FLOAT
PIPE CLAMP
SOCKET FOR FLOAT GUIDES
FUNNEL

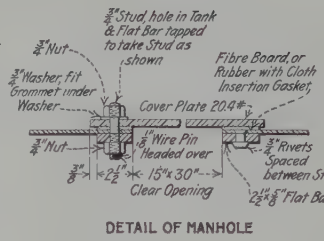
ARR'G'T. OF CHRONOMETER VALVE GEAR



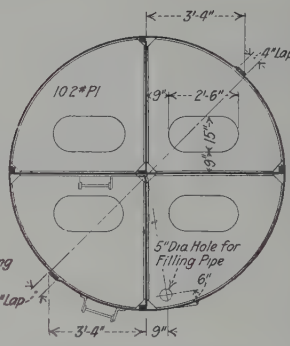
FUEL OIL SETTLING TANK



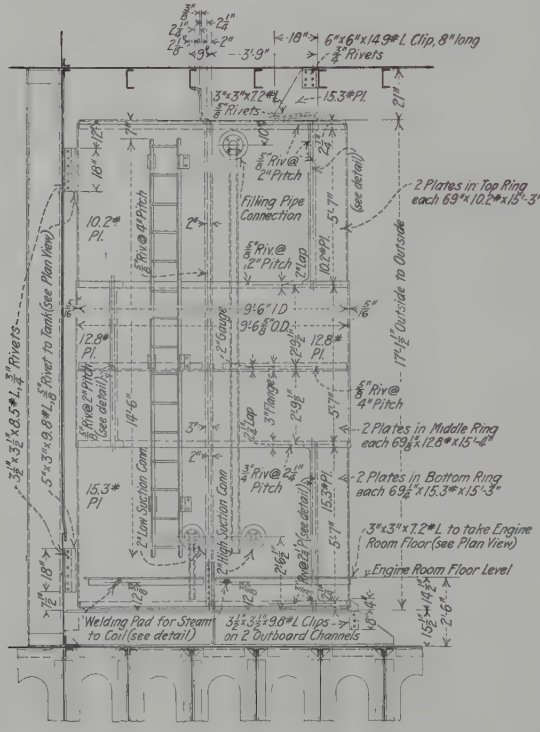
PLAN VIEW AT TOP OF TANK


¾" Stud, hole in Tank & Flat Bar tapped to take Stud as shown
¾" Nut
¾" Washer, fit Grommet under Washer
Fibre Board or Rubber with Cloth Insertion Gasket
Cover Plate 20.4#
⅜" Wire Pin Headed over
¾" Nut
¾" Rivets Spaced between Studs
⅜"
2½"
15"x30" Clear Opening
2½"x⅝" Flat Bar Ring

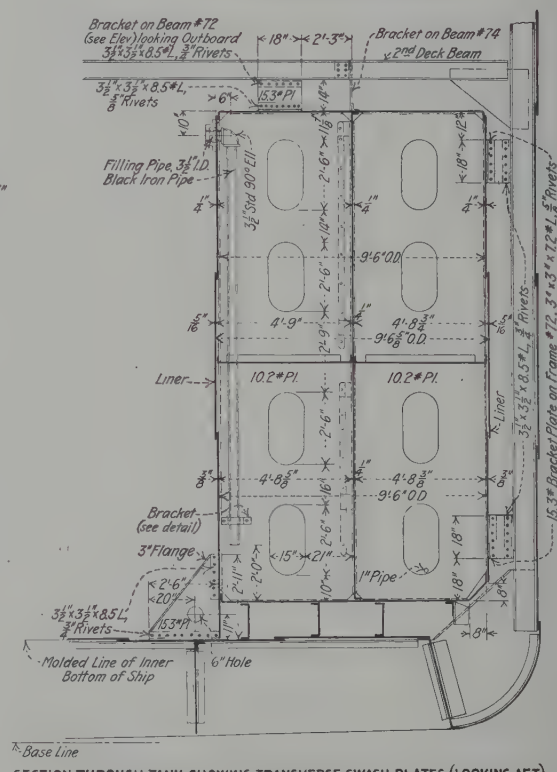
DETAIL OF MANHOLE



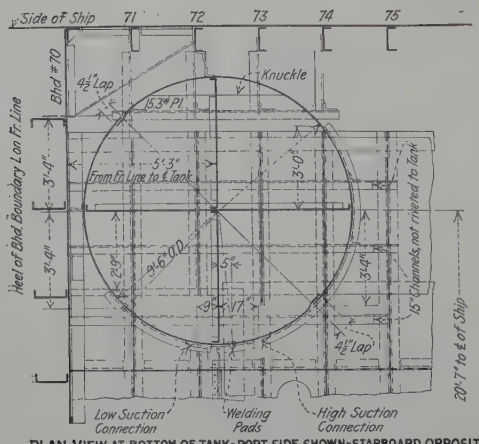
SECTION THROUGH TANK SHOWING HORIZONTAL SWASH PLATES



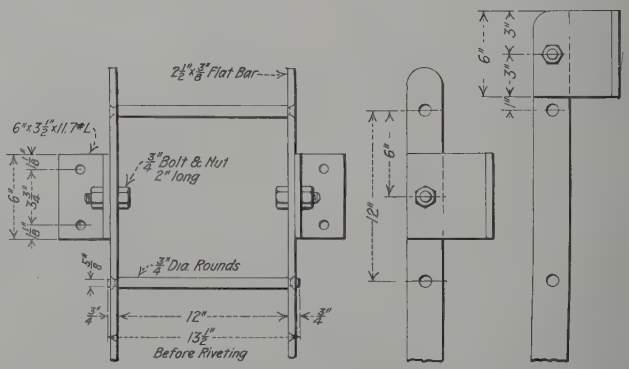
ELEVATION OF INBOARD SIDE (LOOKING OUTBOARD)



SECTION THROUGH TANK SHOWING TRANSVERSE SWASH PLATES (LOOKING AFT)



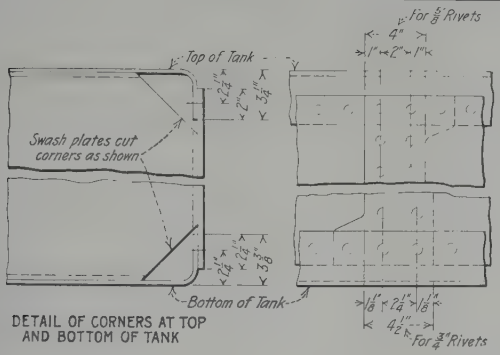
PLAN VIEW AT BOTTOM OF TANK-PORT SIDE SHOWN-STARBOARD OPPOSITE



LADDER DETAILS

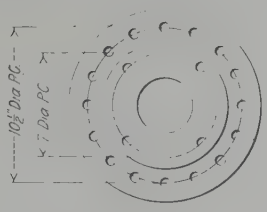
See Opposite Page

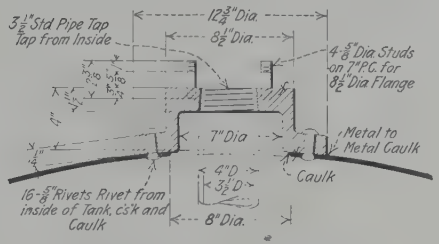
FUEL OIL SETTLING TANK



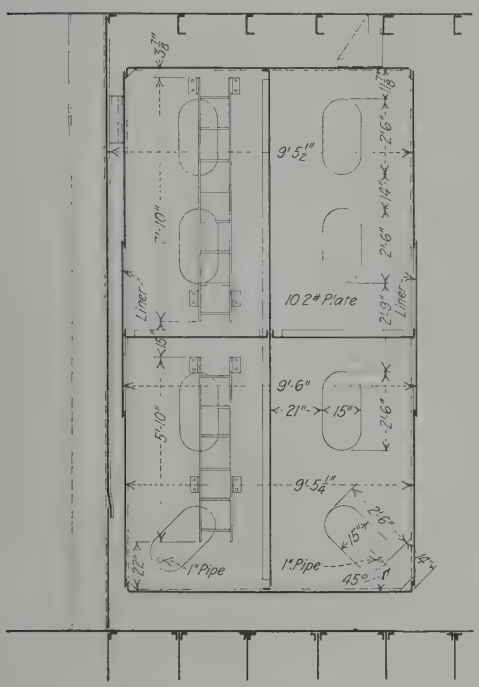
DETAIL OF CORNERS AT TOP AND BOTTOM OF TANK

DETAIL OF LAPS

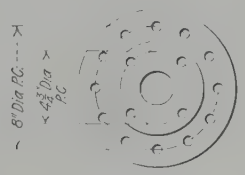


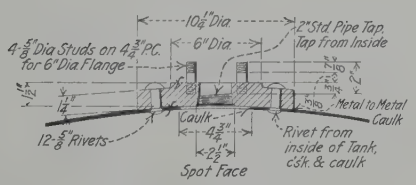

3 1/8" Std Pipe Tap
Tap from Inside
12 3/4" Dia.
8 1/2" Dia.
4 5/8" Dia Studs on 7" P.C. for 8 1/2 Dia Flange
7" Dia
Metal to Metal Caulk
Caulk
4" D
3 1/2" D
16-5/8" Rivets Rivet from inside of Tank, c'sk and Caulk
8" Dia.

DETAIL OF FITTING FOR FILLING PIPE

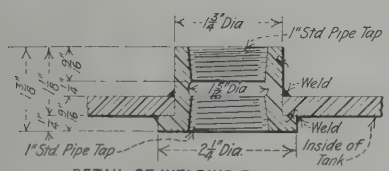


SECTION THROUGH TANK SHOWING LONGITUDINAL SWASH PLATE (LOOKING OUTBOARD)

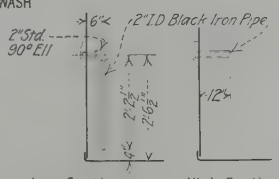



10 1/4" Dia.
2" Std Pipe Tap, Tap from Inside
4-5/8" Dia Studs on 4 3/4" P.C. for 6" Dia Flange
6" Dia
Metal to Metal Caulk
Caulk
12-5/8" Rivets
4 3/4"
2 1/2"
Rivet from inside of Tank, c'sk. & caulk
Spot Face

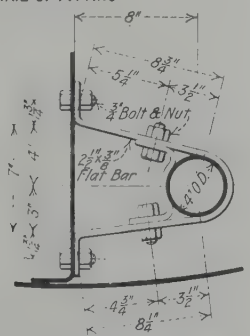
1-2" Fuel Oil Low Suction Connection
1-2" Fuel Oil High Suction Connection
DETAIL OF FITTING



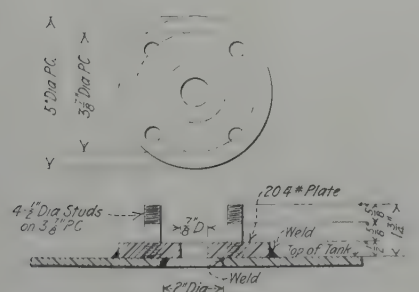
DETAIL OF WELDING PAD FOR STEAM TO COIL CONNECTION



DETAIL OF PIPE
(See Elevation & Plan View for Location)



DETAIL OF BRACKET AT LOWER END OF FILLING PIPE



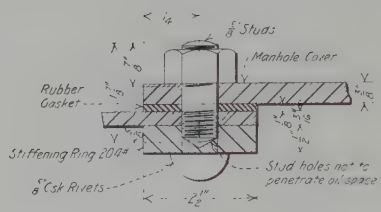
DETAIL OF PAD FOR STEAM SMOTHERING CONNECTION

Capacity One Tank { 1174 Cu Ft. / 8786 Gallons / 32.6 Tons (2240 lbs. @ 36 Cu. Ft.) }

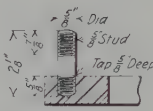
GENERAL NOTES

1- Two tanks required for each ship - one port - one starboard. Port tank shown - starboard to opposite hand
2- Tanks to receive one coat of red lead wax paint outside only before shipment from manufacturing works
3- Tanks to be tested by manufacturer completely filled with water and with a head of 12 feet of water over top of tank and to be made absolutely tight at this pressure

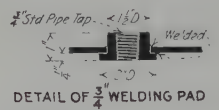
See Opposite Page



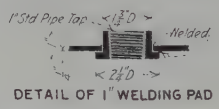
DETAIL OF MANHOLE CONNECTION



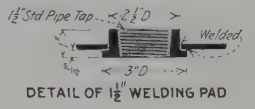
DETAIL OF STUD FOR DISCHARGE CONNECTION



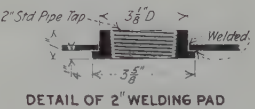
DETAIL OF ¾" WELDING PAD



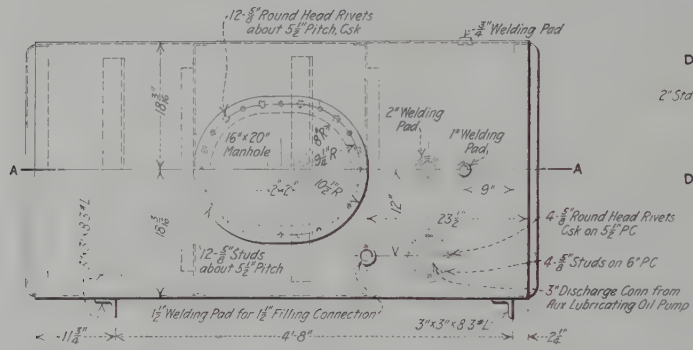
DETAIL OF 1" WELDING PAD



DETAIL OF 1½" WELDING PAD

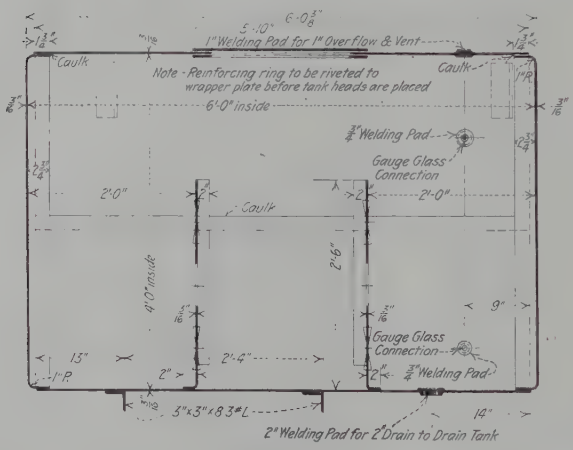


DETAIL OF 2" WELDING PAD

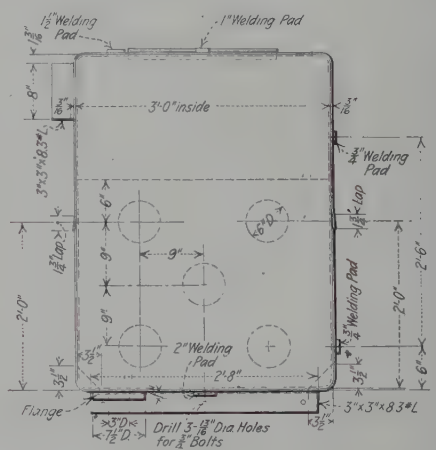

12-⅝" Round Head Rivets about 5⅛" Pitch, Csk
¾" Welding Pad
2" Welding Pad
1" Welding Pad
16"x20" Manhole
12-⅝" Studs about 5½" Pitch
4-⅝" Round Head Rivets Csk on 5½" PC
4-⅝" Studs on 6" PC
3" Discharge Conn from Aux Lubricating Oil Pump
1½" Welding Pad for 1½" Filling Connection
3"x3"x8.3#L
4'-8"

NOTES

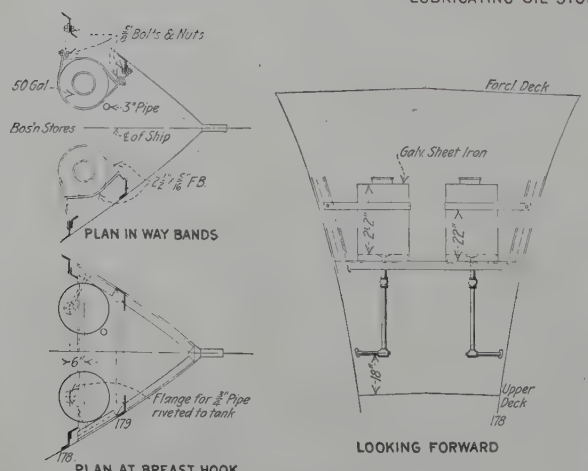
All outside seams to be caulked oiltight, metal to metal
Tank to be tested water tight
Estimated weight of tank 1190 lbs
Wrapper plate may be made in one piece
Capacity 535 gallons
Use ½ dia rivets in tank seams


1" Welding Pad for 1" Overflow & Vent
Caulk
Note - Reinforcing ring to be riveted to wrapper plate before tank heads are placed
6'-0" inside
¾" Welding Pad
Gauge Glass Connection
2'-0"
2'-6"
4'-0" inside
Gauge Glass Connection
¾" Welding Pad
3"x3"x8.3#L
2" Welding Pad for 2" Drain to Drain Tank

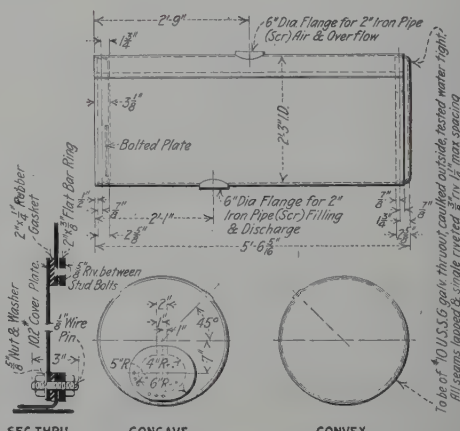
SECTION A-A



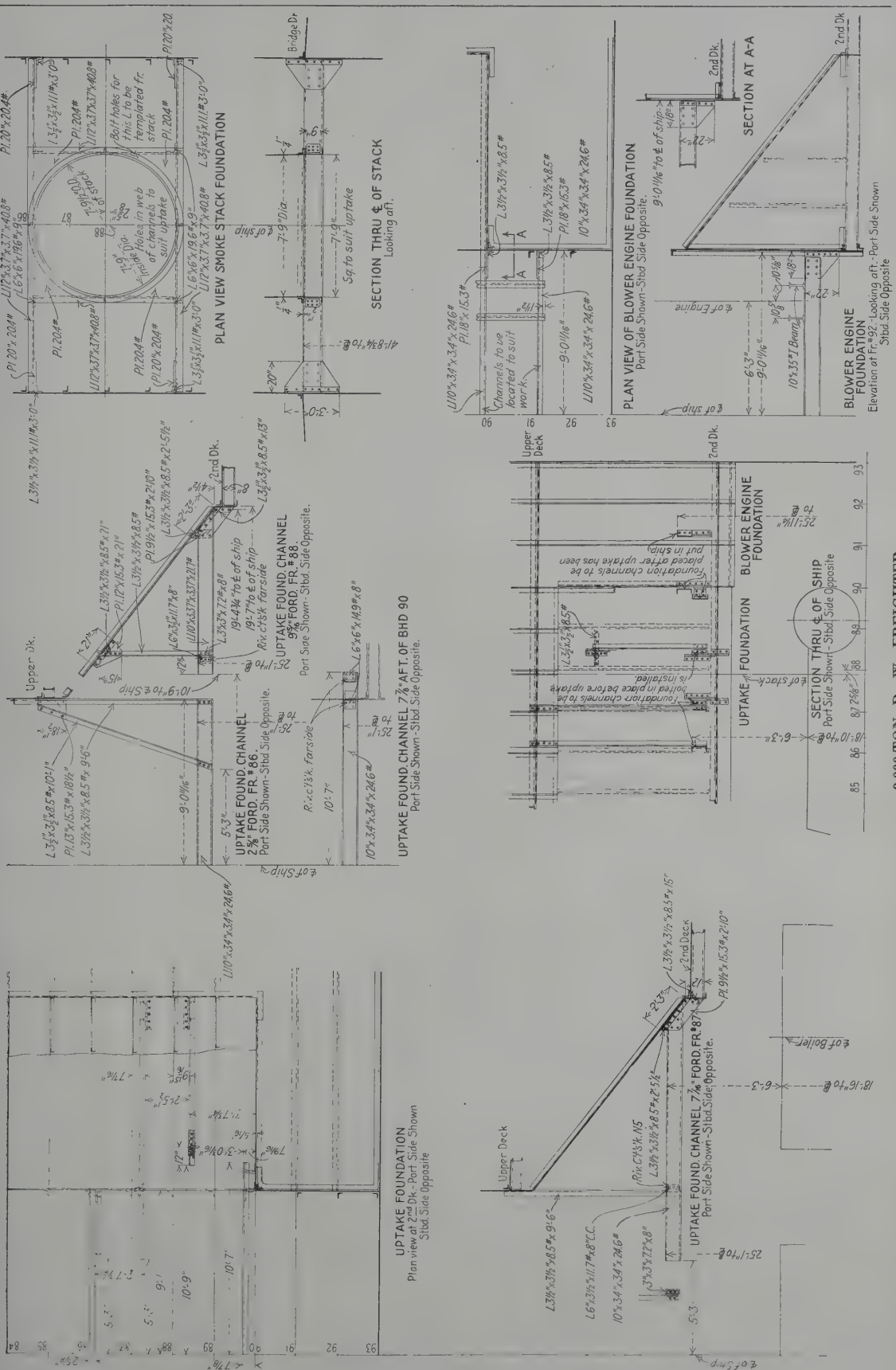
LUBRICATING OIL STORAGE TANK



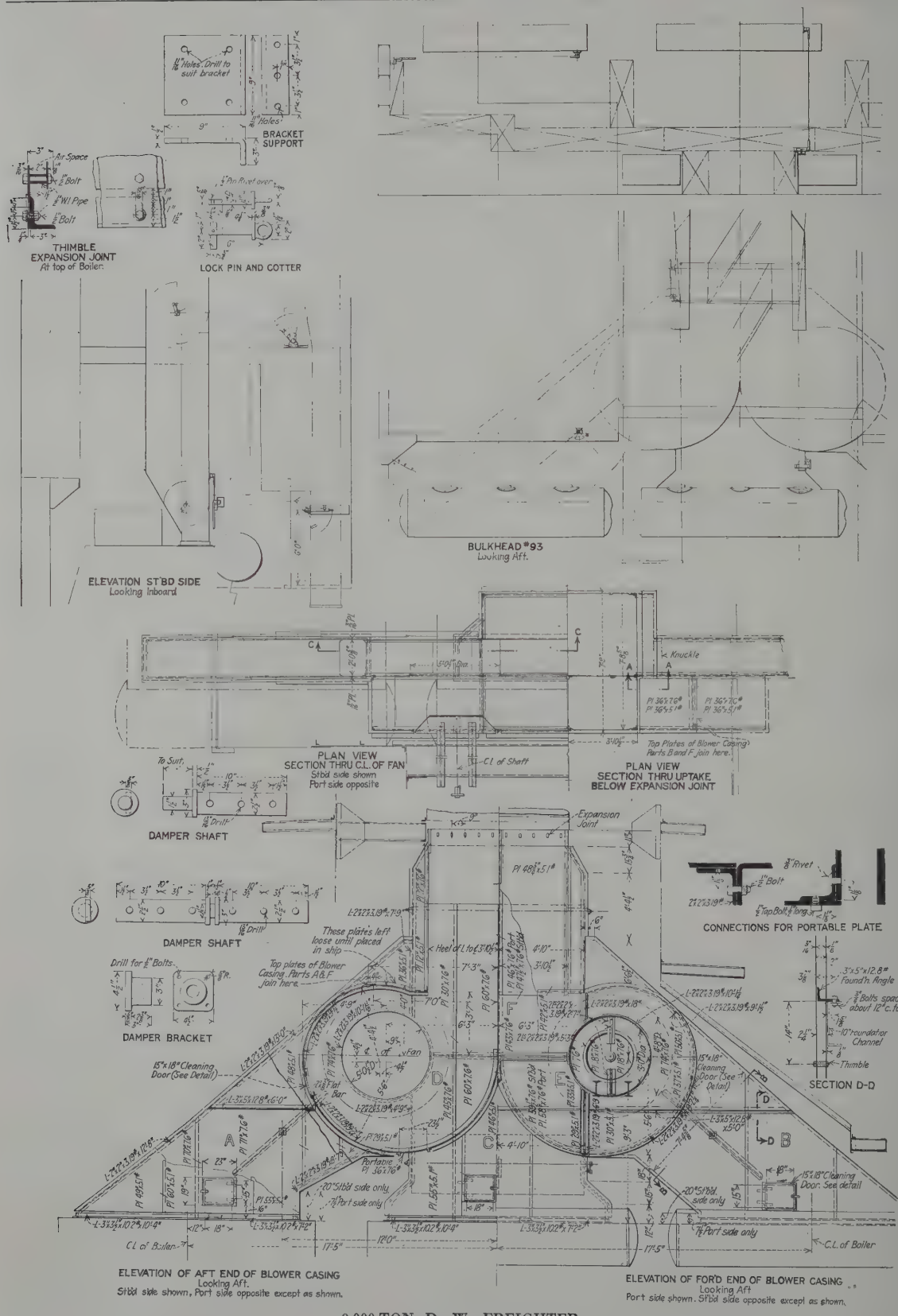
STORM OIL TANKS



SANITARY SYSTEM TANK


PLAN VIEW SMOKE STACK FOUNDATION
SECTION THRU ℄ OF STACK
Looking aft.
PLAN VIEW OF BLOWER ENGINE FOUNDATION
Port Side Shown-Stbd Side Opposite.
SECTION AT A-A
BLOWER ENGINE FOUNDATION
Elevation at Fr.#92 - Looking aft - Port Side Shown
Stbd Side Opposite
UPTAKE FOUND. CHANNEL
2% FORD. FR.# 86.
Port Side Shown-Stbd Side Opposite.
UPTAKE FOUND. CHANNEL
9% FORD. FR.# 88.
Port Side Shown-Stbd. Side Opposite.
UPTAKE FOUND. CHANNEL 7⅞" AFT. OF BHD 90
Port Side Shown-Stbd. Side Opposite.
UPTAKE FOUNDATION
Plan view at 2nd Dk.- Port Side Shown
Stbd. Side Opposite
UPTAKE FOUNDATION
BLOWER ENGINE FOUNDATION
SECTION THRU ℄ OF SHIP
Port Side Shown - Stbd. Side Opposite
UPTAKE FOUND. CHANNEL 7⅞" FORD. FR.# 87
Port Side Shown-Stbd. Side Opposite.

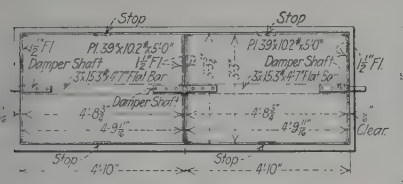
9,000-TON D. W. FREIGHTER



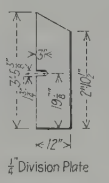
9,000-TON D. W. FREIGHTER

See Opposite Page

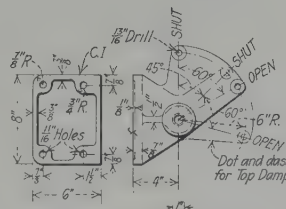
UPTAKE AND DETAILS

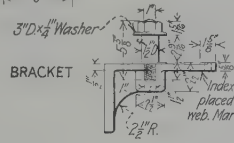


DAMPER FOR CENTER BOILER



¼" Division Plate

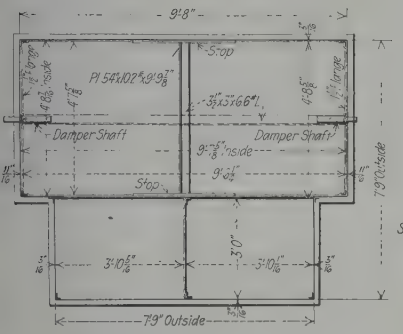




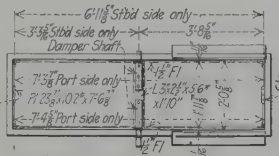
BRACKET

GENERAL NOTES.
Inner Casing ⅜" thick. Outer Casing ⅛" thick.
All angles 2"x2"x3.19# unless otherwise noted.
Air space between casing 2"
Thimbles spaced about 24" centers.
½" Lap at joints ⅞" Rivets 3" Pitch.
Sections to be fastened with ½" bolts spaced about 5" centers.
Thimbles below foundation angle to be spaced to clear 10" foundation channels. See detail Section D-D.

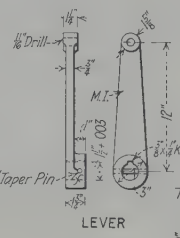
METHOD OF ASSEMBLING UPTAKE.
Part A Uptake to Starboard Boiler.
Part B Uptake to Port Boiler.
Part C Uptake to Center Boiler.
Part D Starboard Fan.
Part E Port Fan.
Part F Top of Uptake.
Install parts in alphabetical order.
Parts D and E must be installed before F.



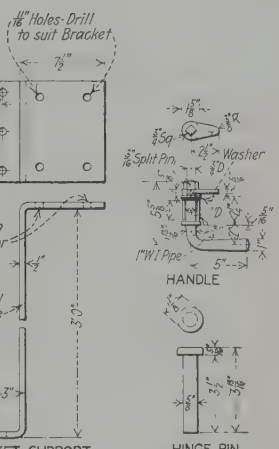
DAMPERS FOR NATURAL DRAFT

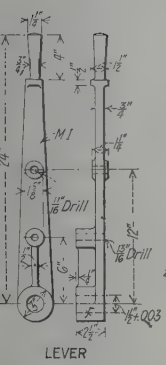


STBD DAMPER-SECTION AT B-B
Port side opposite except as shown.



LEVER





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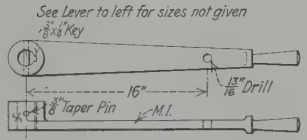
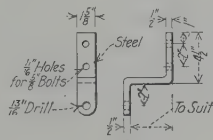
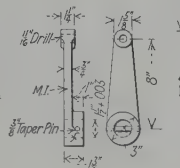


LEVER



STOP



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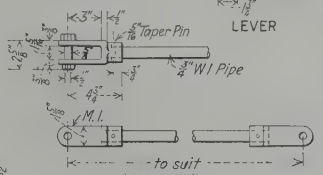
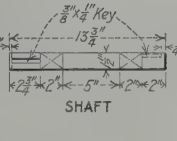
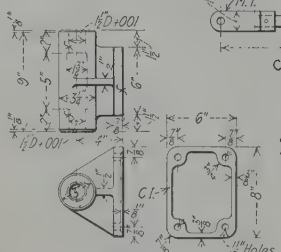


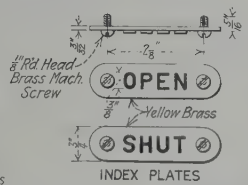
CONNECTOR



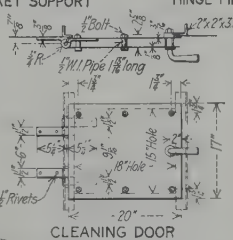
SHAFT

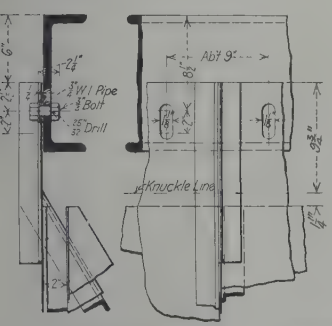


BRACKET

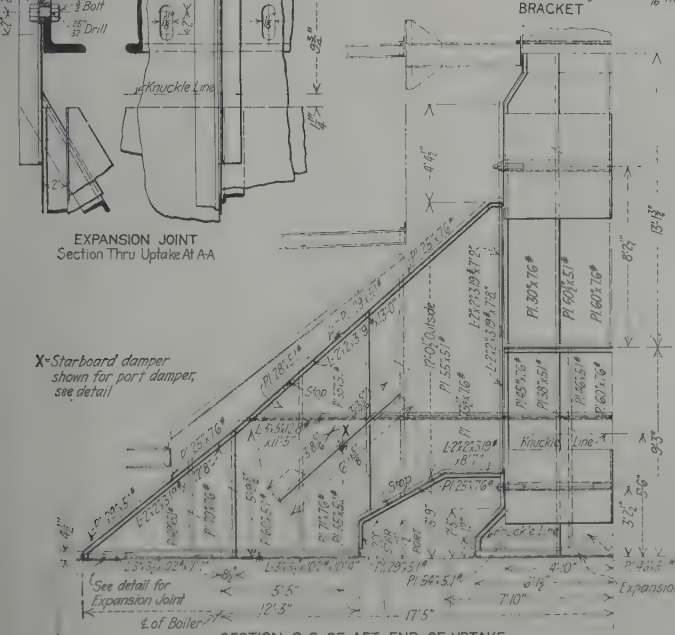


INDEX PLATES

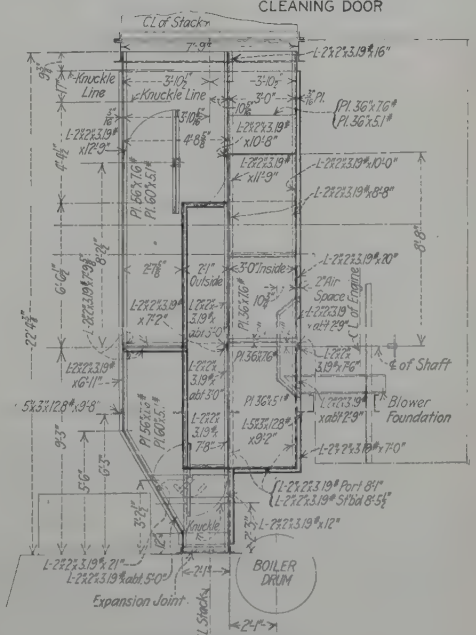




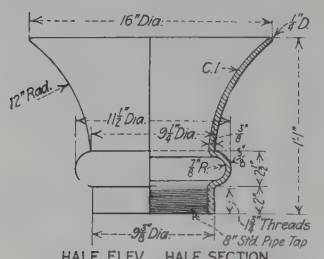
EXPANSION JOINT
Section Thru Uptake At A-A



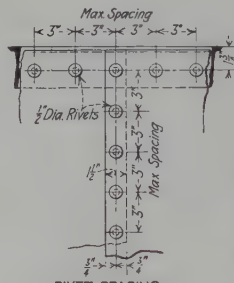
SECTION C-C OF AFT END OF UPTAKE
Looking Aft
Stbd side shown. Port side opposite except as shown.



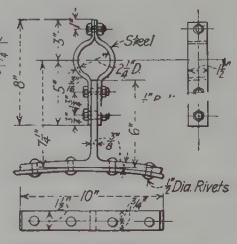
SECTION THRU CENTER LINE OF SHIP
Looking Outboard
Port side shown. Starboard side opposite.



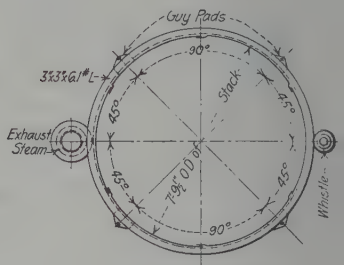
HALF ELEV. HALF SECTION



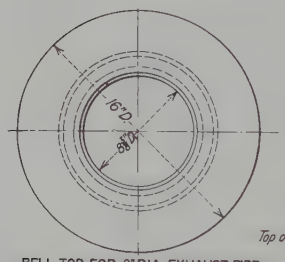
RIVET SPACING



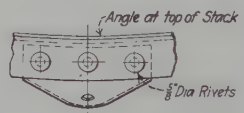
BRACKET FOR WHISTLE PIPE

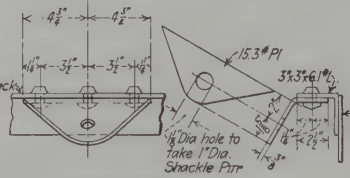


PLAN OF TOP OF STACK

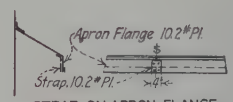


BELL TOP FOR 8"DIA. EXHAUST PIPE

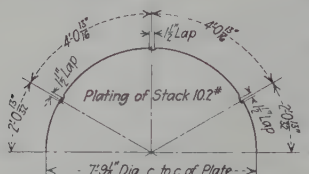




DETAIL OF GUY PADS

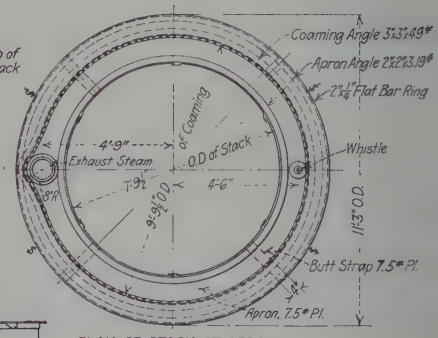


STRAP ON APRON FLANGE

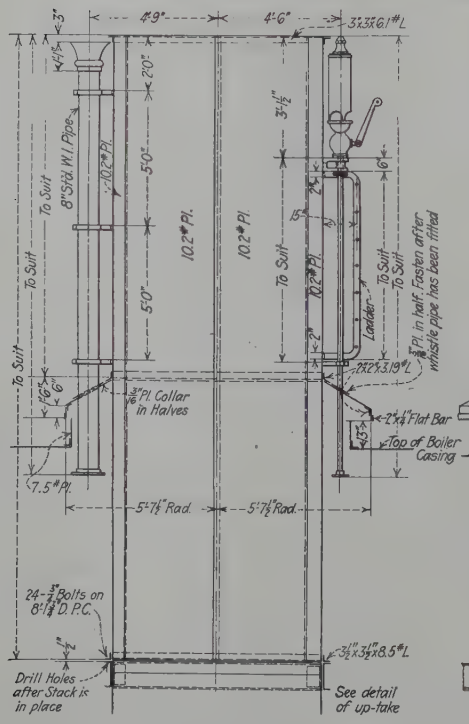


HALF PLAN SHOWING LOCATION OF LAPS.

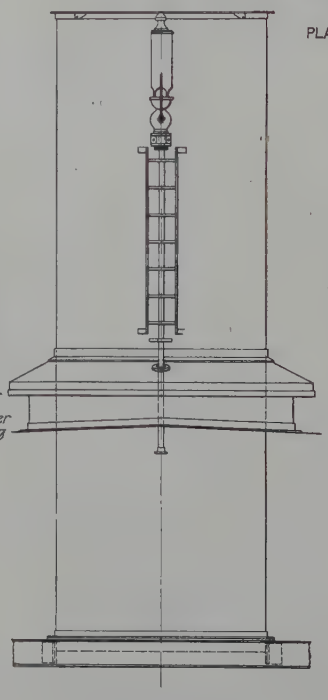
LADDER TO WHISTLE

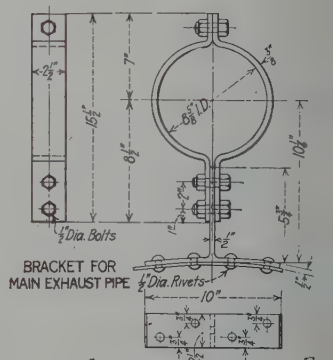


PLAN OF STACK AT APRON

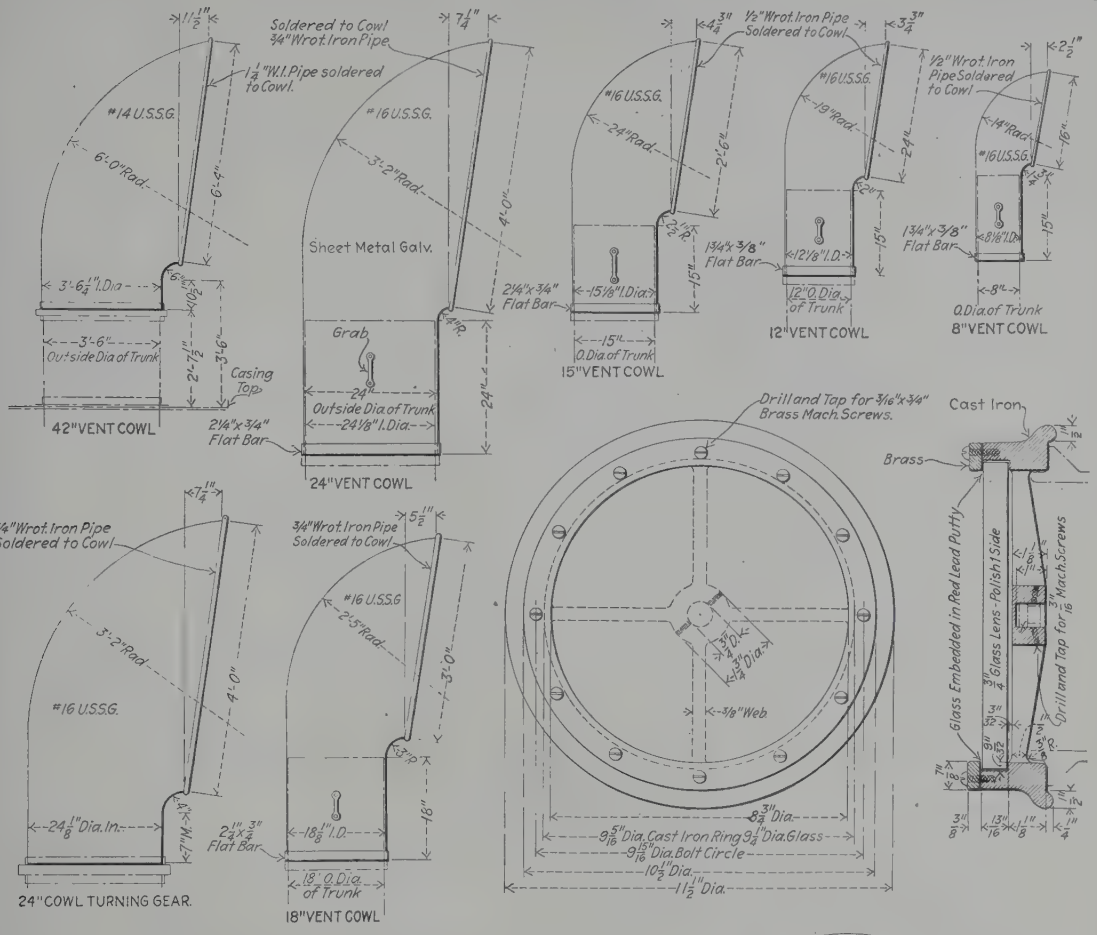


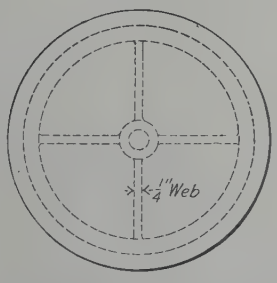
SECTION THRU STACK
On center line of ship.

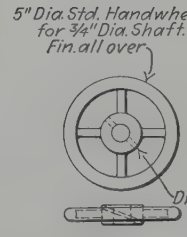

TRANSVERSE ELEV. OF STACK
Looking Aft.

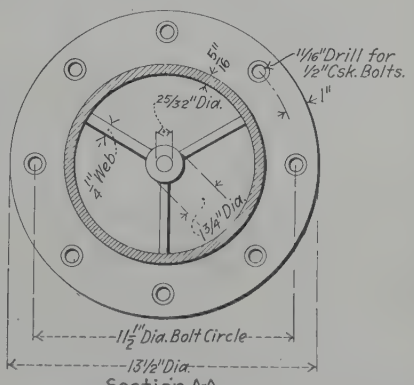


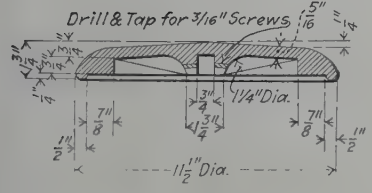
PLAN AT BOTTOM OF STACK.

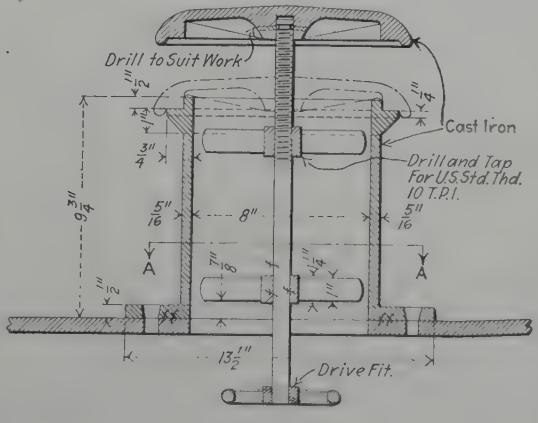

#14 U.S.S.G.
6'-0" Rad.
3'-6 1/4" I.Dia.
3'-6" Outside Dia of Trunk
Casing Top
2 1/4" x 3/4" Flat Bar
42" VENT COWL
Soldered to Cowl
3/4" Wrot. Iron Pipe
1/4" W.I. Pipe soldered to Cowl.
#16 U.S.S.G.
3'-2" Rad.
Sheet Metal Galv.
Grab
24" Outside Dia of Trunk
24 1/8" I.Dia.
24" VENT COWL
#16 U.S.S.G.
24" Rad.
15 1/8" I.Dia.
15" Q.Dia. of Trunk
15" VENT COWL
1/2" Wrot. Iron Pipe Soldered to Cowl
#16 U.S.S.G.
19" Rad.
12 1/8" I.D.
12" Q.Dia. of Trunk
12" VENT COWL
1/2" Wrot. Iron Pipe Soldered to Cowl
#16 U.S.S.G.
14" Rad.
8 1/8" I.D.
8" Q.Dia. of Trunk
8" VENT COWL
3/4" Wrot. Iron Pipe Soldered to Cowl
3'-2" Rad.
#16 U.S.S.G.
24 1/8" Dia. In.
24" COWL TURNING GEAR.
3/4" Wrot. Iron Pipe Soldered to Cowl
#16 U.S.S.G.
2'-5" Rad.
18 1/8" I.D.
18" Q.Dia. of Trunk
18" VENT COWL
Drill and Tap for 3/16" 4-3/4" Brass Mach. Screws.
3/8" Web
8 3/8" Dia.
9 5/16" Dia. Cast Iron Ring
9 1/4" Dia. Glass
9 15/16" Dia. Bolt Circle
10 1/2" Dia.
11 1/2" Dia.
Cast Iron
Brass
Glass Embedded in Red Lead Putty
3/4" Glass Lens - Polish 1 Side
Drill and Tap for 3/16" Mach. Screws

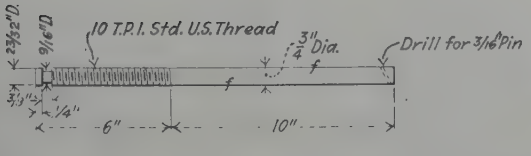

1" Web


5" Dia. Std. Handwheel for 3/4" Dia. Shaft. Fin. all over
Drill for 3/16" Pin

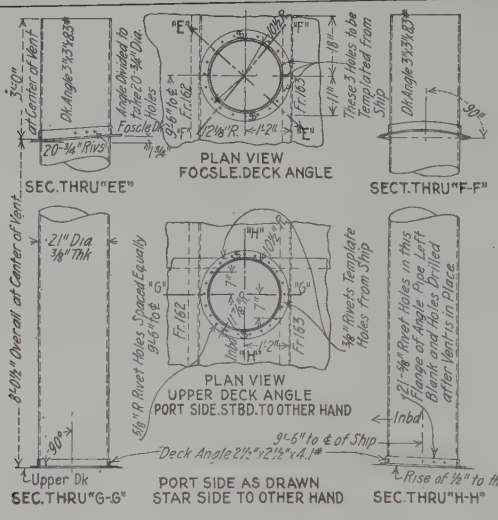

1 1/16" Drill for 1/2" Csk. Bolts.
25/32" Dia.
1" Web
3/4" Dia.
1" Dia. Bolt Circle
13 1/2" Dia.

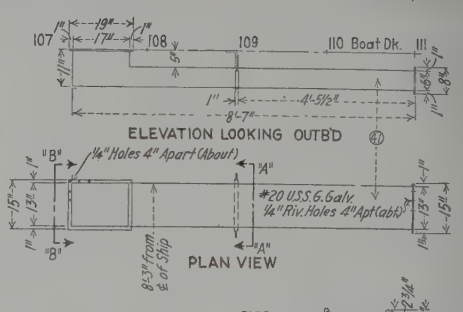

Drill & Tap for 3/16" Screws
1 1/4" Dia.
1 1/2" Dia.

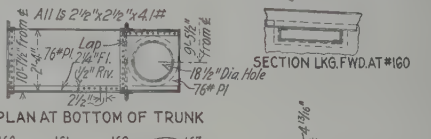

Section A-A
Drill to Suit Work
Cast Iron
Drill and Tap For U.S.Std. Thd. 10 T.P.I.
8"
13 1/2"
Drive Fit.

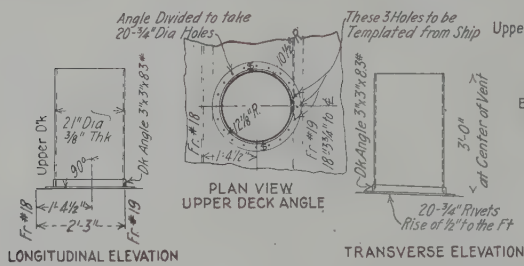

10 T.P.I. Std. U.S. Thread
3/4" Dia.
Drill for 3/16" Pin
6"
10"

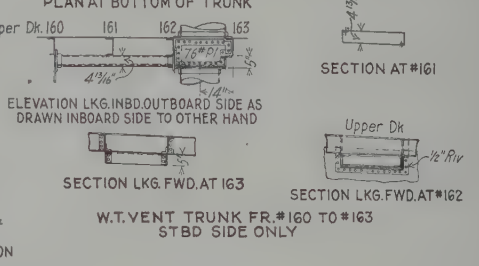
DETAILS OF VENTILATING SYSTEM

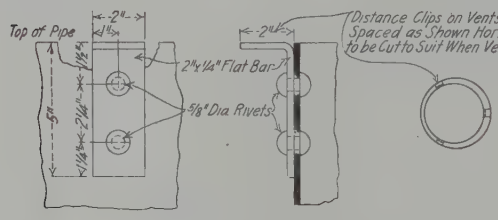

SEC. THRU "EE"
PLAN VIEW FOCSLE. DECK ANGLE
SECT. THRU "F-F"
PLAN VIEW UPPER DECK ANGLE PORT SIDE. STBD. TO OTHER HAND
PORT SIDE AS DRAWN STAR SIDE TO OTHER HAND
SEC. THRU "G-G"
SEC. THRU "H-H"

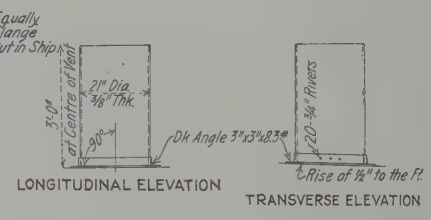


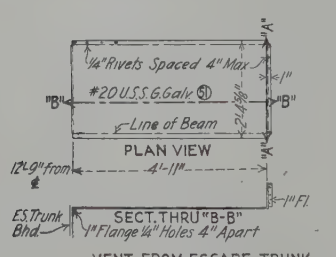


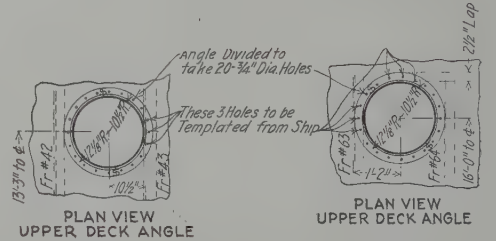


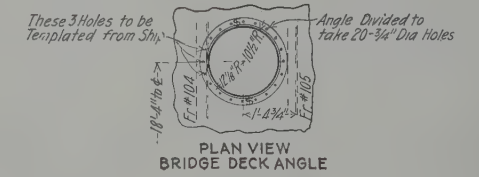

ELEVATION LKG. INBD. OUTBOARD SIDE AS DRAWN INBOARD SIDE TO OTHER HAND
SECTION AT #161
SECTION LKG. FWD. AT 163
SECTION LKG. FWD. AT #162
W.T. VENT TRUNK FR. #160 TO #163 STBD SIDE ONLY

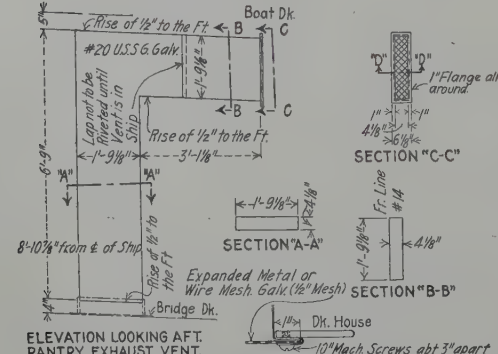

Distance Clips on Vents, 3 Clips Equally Spaced as Shown Horizontal Flange to be Cut to Suit When Vents are Put in Ship
2¼" x ¼" Flat Bar
⅝" Dia Rivets

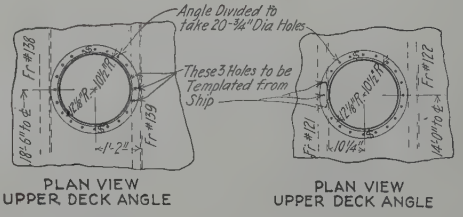






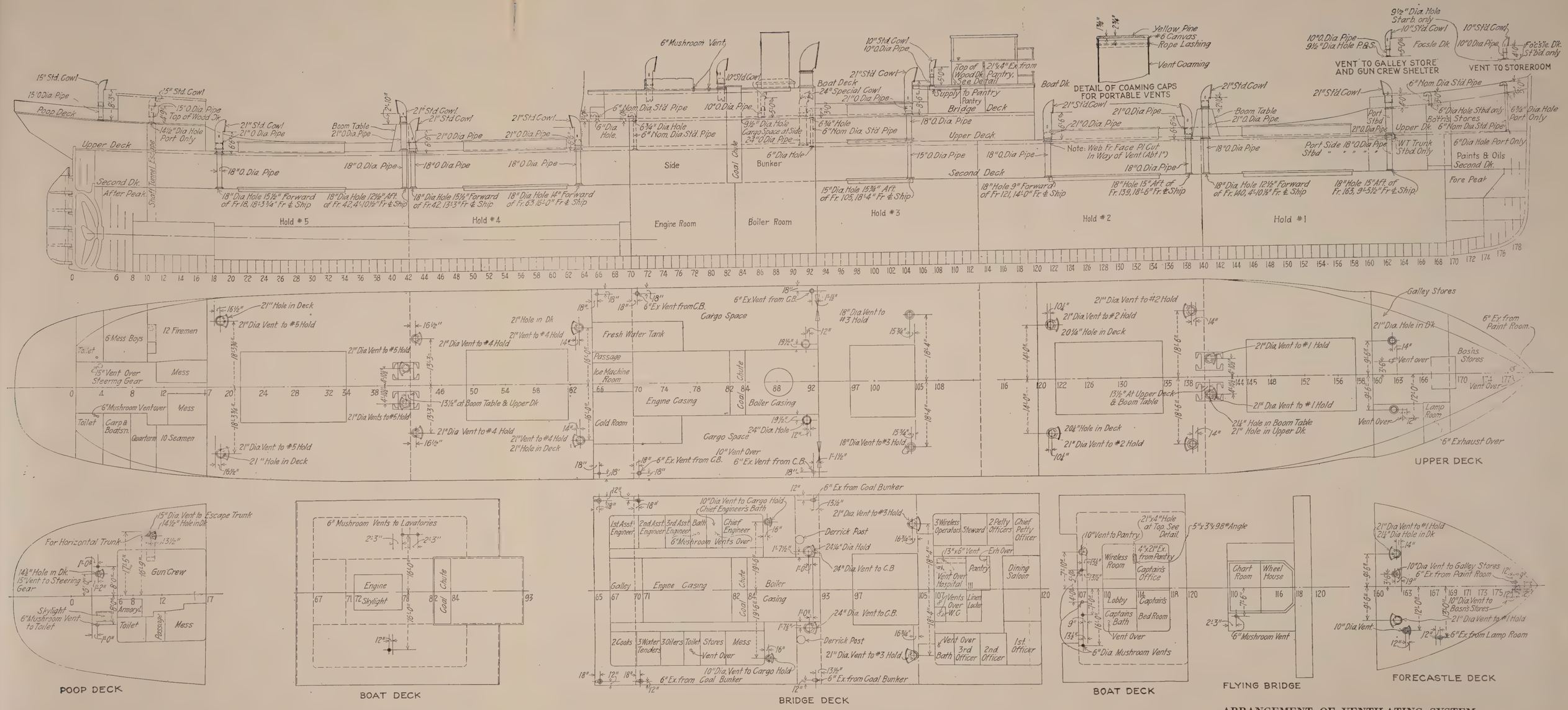






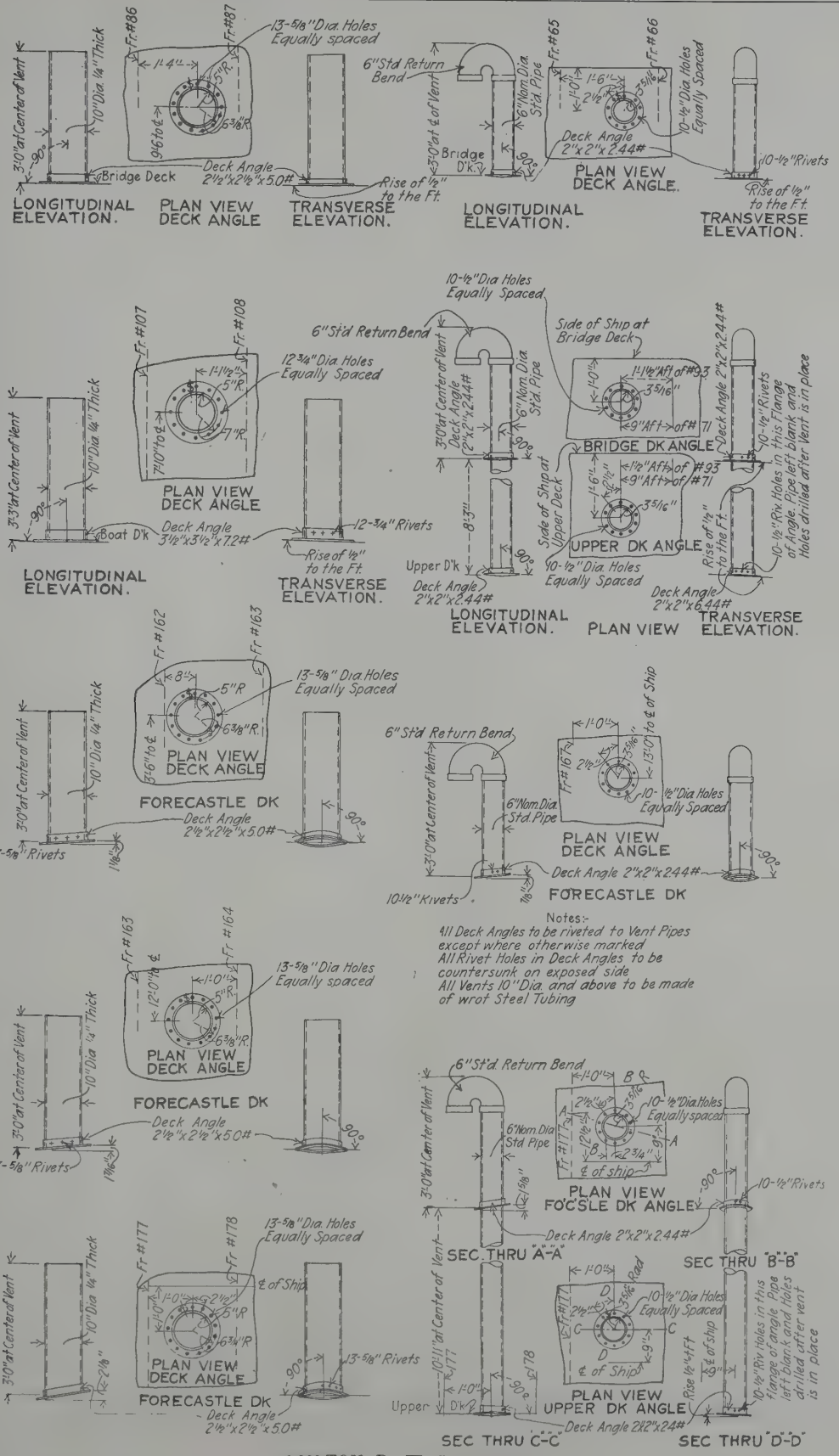
9,000-TON D. W. FREIGHTER

See Plate LI Opposite this Page


15" Std. Cowl
15" O.Dia. Pipe
Poop Deck
Upper Deck
Second Dk.
After Peak
Shaft Tunnel Escape
15" Dia. Hole Port Only
15" O.Dia. Pipe
Top of Wood Dk.
21" Std. Cowl
21" O. Dia Pipe
18" O. Dia. Pipe
Boom Table 21" O.Dia. Pipe
6" Mushroom Vent
10" Std. Cowl
6" Nom. Dia. Std. Pipe
10" O.Dia. Pipe
6" Dia. Hole.
6¾" Dia. Hole
6" Nom. Dia. Std. Pipe
9½" Dia. Hole Cargo Space at Side
24" O.Dia. Pipe
Coal Chute
Side
Bunker
Boat Deck
24" Special Cowl
21" O.Dia. Pipe
Supply To Pantry
Bridge Deck
Top of Wood Dk. See Detail
21¾" Ex. from Pantry.
6" Dia Hole
Upper Deck
15" O.Dia. Pipe
18" O.Dia. Pipe
Second Deck
Boat Dk.
DETAIL OF COAMING CAPS FOR PORTABLE VENTS
Yellow Pine
#6 Canvas
Rope Lashing
Vent Coaming
Note: Web Fr. Face Pl Cut In Way of Vent (Abt 1")
Boom Table 21" O.Dia. Pipe
Port Stbd 21" O.Dia. Pipe
Port Side 18" O.Dia. Pipe
Stbd " " "
W.T. Trunk Stbd Only
6" Dia Hole Port Only
Paints & Oils
Second Dk.
Fore Peak
9½" Dia. Hole Starb. only
10" O.Dia. Pipe
9½" Dia. Hole P&S
Focsle Dk.
Fo'c'sle Dk. Stbd only
VENT TO GALLEY STORE AND GUN CREW SHELTER
VENT TO STOREROOM
6" Dia Hole Stbd only Bottle Stores
6" Nom Dia Std Pipe
6¾" Dia. Hole Port Only
18" Dia. Hole 15½" Forward of Fr 18, 18'-3¾" Fr. & Ship
18" Dia. Hole 12½" Aft. of Fr. 42, 4'-10⅛" Fr. & Ship
18" Dia. Hole 15½" Forward of Fr. 42, 13'-3" Fr. & Ship
18" Dia. Hole 14" Forward of Fr. 63, 15'-0" Fr. & Ship
15" Dia. Hole 15¾" Aft. of Fr. 103, 18'-4" Fr. & Ship
18" Hole 9" Forward of Fr 121, 14'-0" Fr. & Ship
18" Hole 15" Aft of Fr. 139, 18'-6" Fr. & Ship
18" Dia. Hole 12½" Forward of Fr. 140, 4'-10¾" Fr. & Ship
18" Hole 15" Aft. of Fr. 163, 9'-5½" Fr. & Ship
Hold #5
Hold #4
Engine Room
Boiler Room
Hold #3
Hold #2
Hold #1
0 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50 52 54 56 58 60 62 64 66 68 70 72 74 76 78 80 82 84 86 88 90 92 94 96 98 100 102 104 106 108 110 112 114 116 118 120 122 124 126 128 130 132 134 136 138 140 142 144 146 148 150 152 154 156 158 160 162 164 166 168 170 172 174 176 178
6 Mess Boys
12 Firemen
Toilet
Mess
15" Vent Over Steering Gear
6" Mushroom Vent over
Carp & Boats'n.
Quarterm.
10 Seamen
16½"
21" Hole in Deck
21" Dia. Vent to #5 Hold
21" Dia Vent to #4 Hold
21" Hole in Dk
21" Vent to #4 Hold
21" Dia Vents to #5 Hold
13½" at Boom Table & Upper Dk
21" Dia Vent to #5 Hold
21" Hole in Deck
Fresh Water Tank
Passage
Ice Machine Room
Cold Room
Engine Casing
Boiler Casing
Cargo Space
6" Ex. Vent from C.B.
18" Dia. Vent to #3 Hold
24" Dia. Hole
10" Vent Over
6" Ex. Vent from C.B.
21" Dia. Vent to #2 Hold
20½" Hole in Deck
21" Dia Vent to #2 Hold
21" Dia. Vent to #1 Hold
13½" At Upper Deck & Boom Table
21" Dia. Vent to #1 Hold
20½" Hole in Deck
21" Dia Vent to #2 Hold
21¼" Hole in Boom Table
21" Hole in Upper Dk.
Galley Stores
21" Dia. Hole in Dk
6" Ex. from Paint Room.
Bosns Stores
6" Vent over
Vent Over
Lamp Room
6" Exhaust Over
UPPER DECK
15" Dia. Vent to Escape Trunk
14½" Hole in Dk.
For Horizontal Trunk
14¾" Hole in Dk. 15" Vent to Steering Gear
Gun Crew
Skylight
6" Mushroom Vent to Toilet
Armory
Toilet
Passage
Mess
POOP DECK
6" Mushroom Vents to Lavatories
Engine
Skylight
Coal Chute
BOAT DECK
6" Ex. from Coal Bunker
10" Dia. Vent to Cargo Hold Chief Engineer's Bath
1st Asst Engineer
2nd Asst Engineer
3rd Asst Engineer
Bath
Chief Engineer
6" Mushroom Vents Over
Derrick Post
24¼" Dia Hold
24" Dia Vent to C.B
24" Dia. Vent to C.B.
21" Dia. Vent to #3 Hold
Galley
Engine Casing
Boiler Casing
Coal Chute
2 Cooks
3 Water Tenders
3 Oilers
Toilet
Stores
Mess
Vent Over
10" Dia. Vent to Cargo Hold
6" Ex. from Coal Bunker
3 Wireless Operators
Steward
2 Petty Officers
Chief Petty Officer
(3"x6" Vent Exh Over)
Vent Over Hospital
Pantry
Dining Saloon
107 Vents Over W.C
Linen Locker
Vent Over Bath
3rd Officer
2nd Officer
1st Officer
BRIDGE DECK
21"x4" Hole at Top See Detail
5"x3"x.98" Angle
10" Vent to Pantry
Wireless Room
4"x21" Ex. from Pantry
Captain's Office
Lobby
Captain's
Captain's Bath
Bed Room
Vent Over
6" Dia. Mushroom Vents
BOAT DECK
Chart Room
Wheel House
6" Mushroom Vent
FLYING BRIDGE
21" Dia Vent to #1 Hold
21½" Dia Hole in Dk
10" Dia Vent to Galley Stores
6" Ex. from Paint Room
10" Dia Vent to Basns Stores
21" Dia Vent to #1 Hold
6" Ex. from Lamp Room
10" Dia. Vent
FORECASTLE DECK

ARRANGEMENT OF VENTILATING SYSTEM
9,000-TON D. W. FREIGHTER

PLATE LI

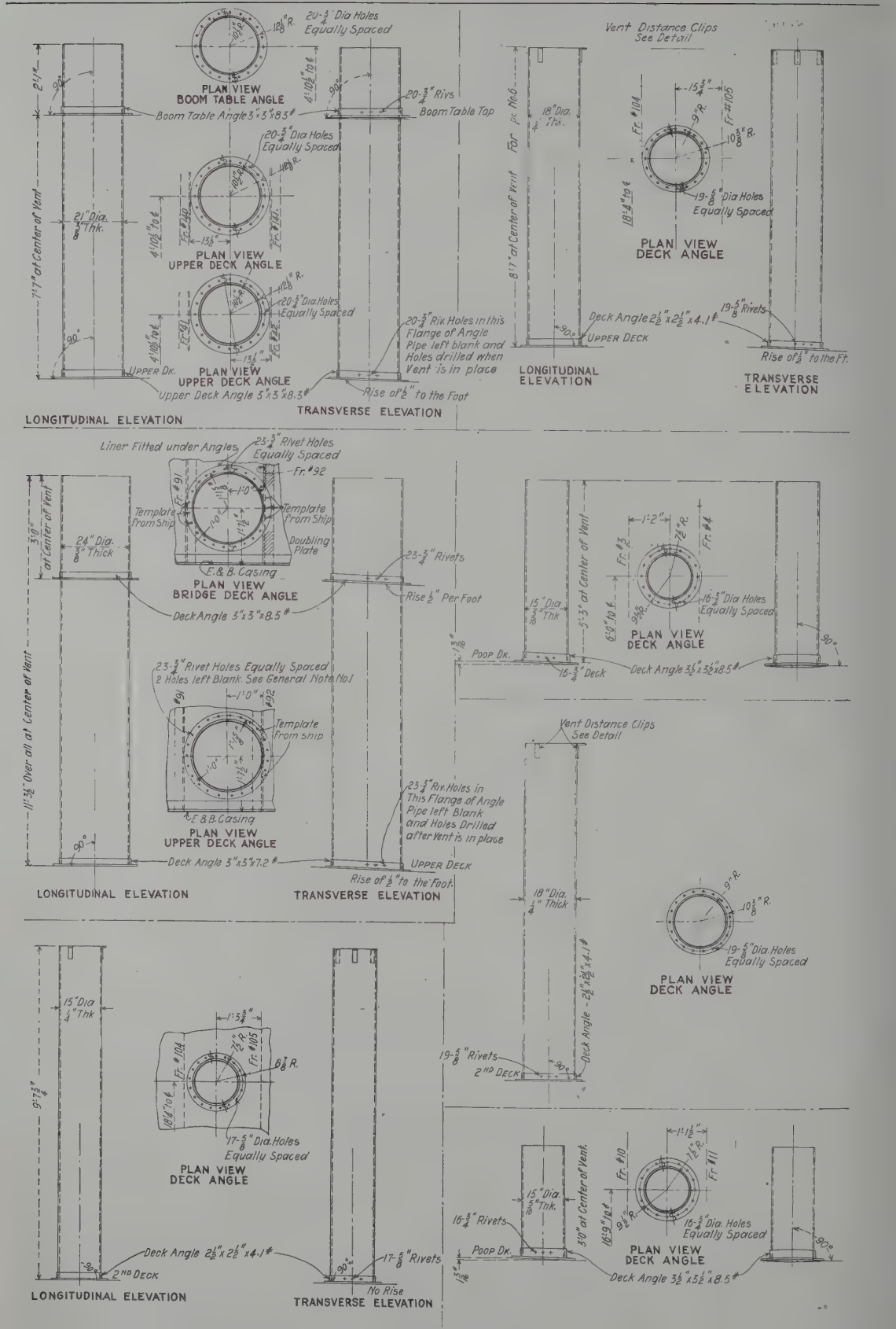


Notes:-
All Deck Angles to be riveted to Vent Pipes except where otherwise marked
All Rivet Holes in Deck Angles to be countersunk on exposed side
All Vents 10" Dia. and above to be made of wrot Steel Tubing

9,000-TON D. W. FREIGHTER

See Plate LI Opposite page 674

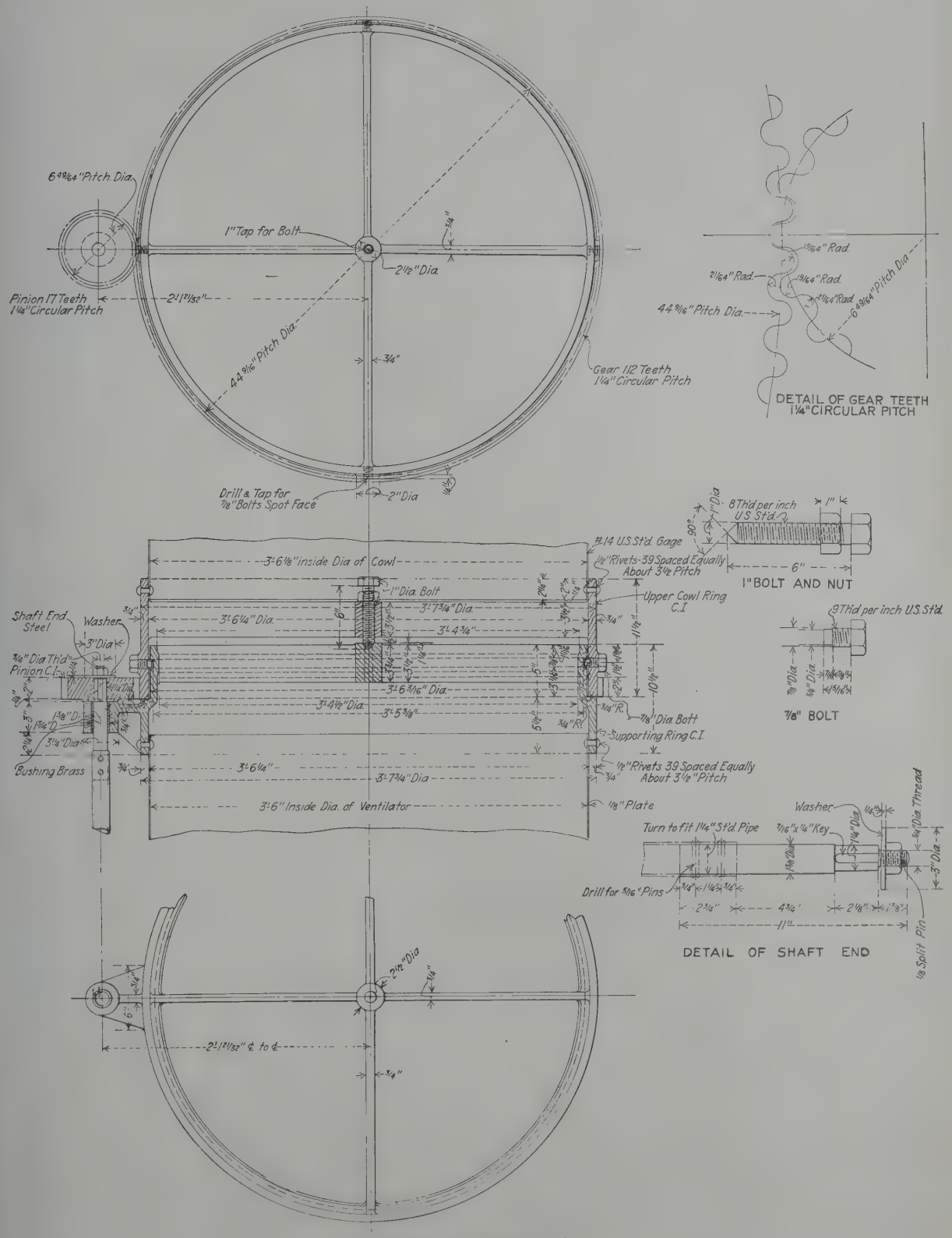
DETAILS OF VENTILATING SYSTEM



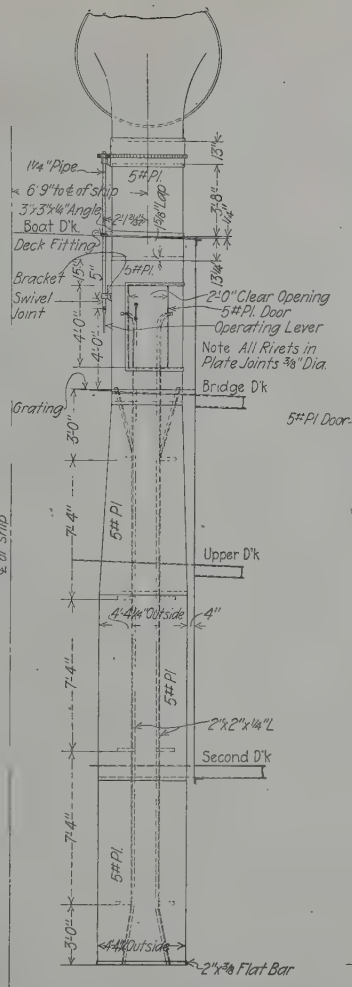
9,000-TON D. W. FREIGHTER

See Plate LI Opposite page 674

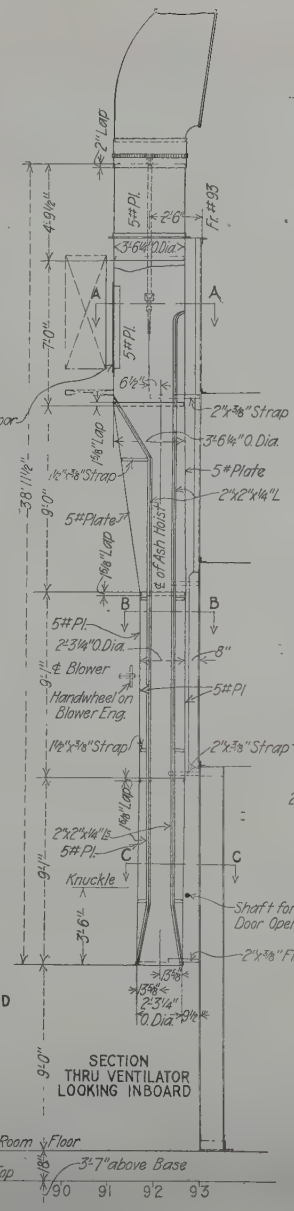
DETAILS OF TURNING GEAR FOR 42″ VENTILATORS



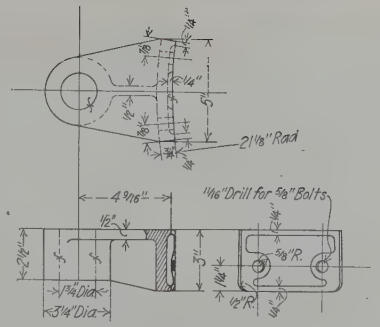
9,000-TON D. W. FREIGHTER



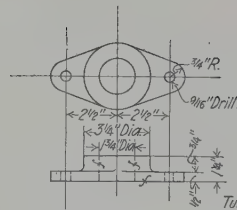
ELEVATION - STARB'D SIDE LOOKING FORWARD
PORT SIDE TO OTHER HAND



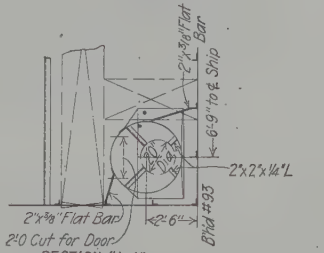
SECTION
THRU VENTILATOR
LOOKING INBOARD



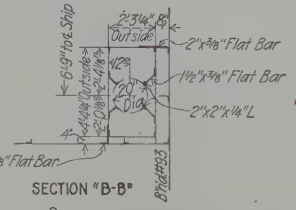
BRACKET
(CAST IRON)



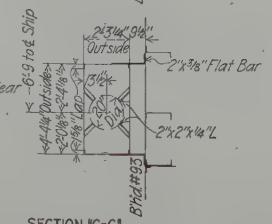
DECK FITTING
(CAST IRON)



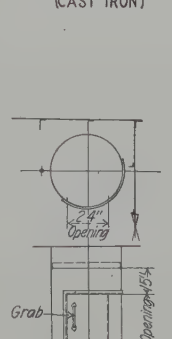
SECTION "A-A"



SECTION "B-B"

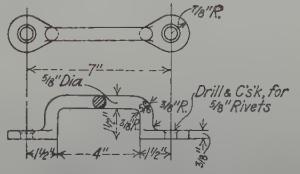


SECTION "C-C"

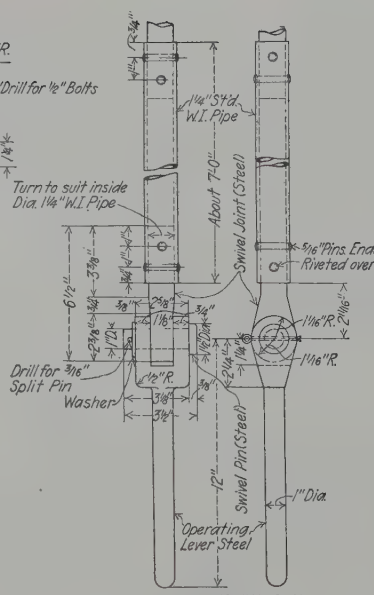


DETAIL OF VENTILATOR DOOR
LOOKING FORWARD
AS DRAWN FOR STARB'D-TO OTHER HAND FOR PORT.

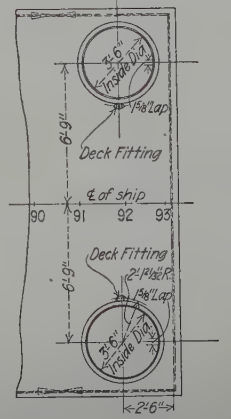
TYPE SECTION THRU DOOR



GRAB
(W.I.)



DETAIL OF TURNING GEAR
LOWER END.

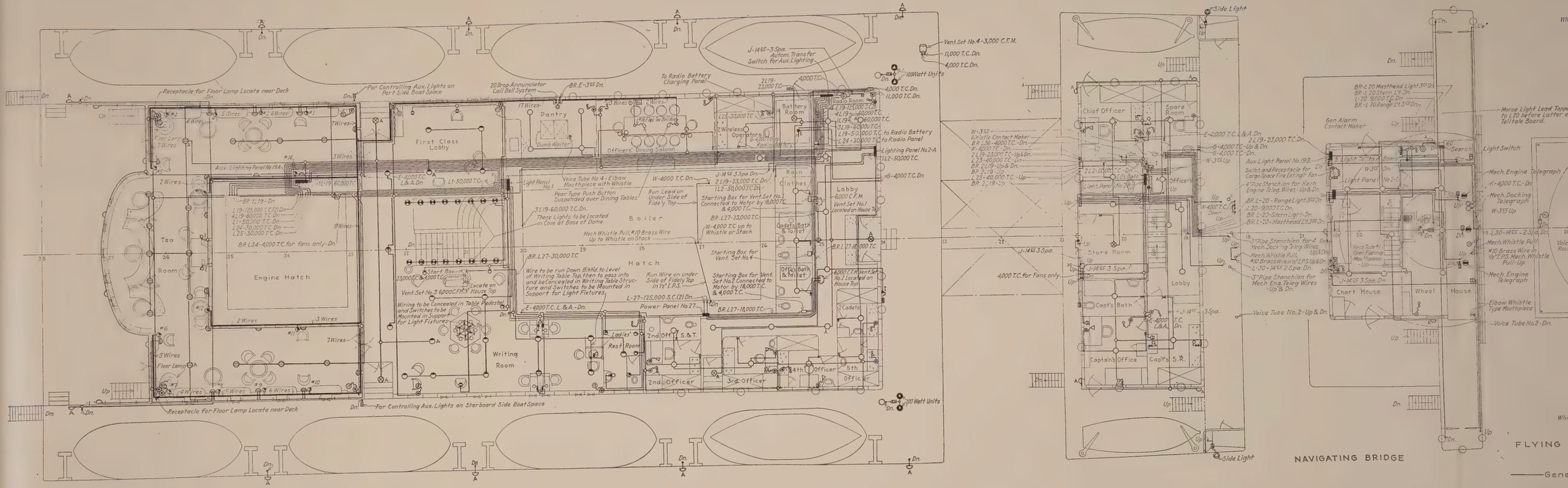


PLAN AT BOAT DECK

Switch No. on Switch Board	Feeder No.		Amperes Load	Size of Switch on Switchboard	Size of Fuse	Single Conductor, Leaded and Armored Feeder Circular Mils	Single Conductor, Leaded and Armored Feeder l'gth in ft.	Twin Conductor Feeder Circular Mils	Twin Conductor Feeder l'gth in ft.	Twin Conductor Branch Circular Mils	Twin Conductor Branch l'gth in ft.	Twin Conductor Branch Circular Mils	Twin Conductor Branch l'gth in ft.
22	L1	Boat Deck { 1st Cl. Lobby-Tea & Writing Rms-Veranda	30.5	60	40			50,000	150	4,000	1150		
26	L2	Officers' Qtrs. { Boat Deck Forward and Bridges	26.4	60	35			50,000	140				
	1L2	" " { Boat Deck Forward	14.6					50,000	45	4,000	450		
	2L2	Boat Deck Ford. & Bridges	11.8					50,000	75	4,000	640		
37	L3	Smoking Rm. 1st Class Entrance & Social Hall	50.2	100	65			60,000	80	4,000	1705		
27	L4	1st Cl. S.R.-Aft-Port-"A" Deck	32.4	60	40			40,000	70	4,000	330		
28	L5	" " " " Sfbd " "	30.9	60	40			40,000	100	4,000	1345		
23	L6	1st Cl. S.R. Ford. Port "A" Brge Dks.	23.9	30	30			50,000	210	4,000	945		
24	L7	" " " " Sfbd " "	21.6	30	30			60,000	225	4,000	965		
29	L8	1st Cl. S.R. Aft. Port "B" Deck	24.	60	35			50,000	145	4,000	1185		
30	L9	" " " " Sfbd " "	22.8	60	35			50,000	170	4,000	1295		
31	L10	1st Cl. S.R. Ford. "B" Deck	22.5	60	35			50,000	160	4,000	1245		
32	L11	Pantry, Galley, & Dining Saloon - Port	39.7	60	50			50,000	90	4,000	690		
36	L12	1st Cl. S.R. & Engrs. Qtrs. Dining Saloon, Sfbd	36	60	45			50,000	125	4,000	1290		
25	L13	Stewards' Qtrs. "B" Deck Ford.	11.6	30	15			40,000	235	4,000	545		
39	L14	Crews Qtrs Cold Stor. "C" Deck	40	60	50			22,000	331	4,000	2180		
42	L15	Stewards Qtrs "C" Deck Ford.	28.6	60	35			22,000	150	4,000	1250		
46	L16	3rd Class Quarters Aft.	30.2	60	40			60,000	230	4,000	905		
47	L17	Engine Room	28.7	60	35			30,000	55	4,000	1275		
33	L18	Fire Room	15.8	30	20			9,000	20	4,000	605		
38	L19	Auxiliary Lighting	57.8	100	75	125,000	180						
	1L19	Boat Bridge & "A" Decks Aft	14.4					30,000	105	4,000	1385		
	2L19	" " " " Ford.	8.					22,000	120	4,000	410		
	3L19	"B" Deck - Midship	22.2					60,000	100	4,000	1855		
	4L19	"A" B-C & D" Decks Aft	11.7					60,000	315	4,000	795		
34	L20	Running Lights	2.7	30	15			9,000	260	4,000	575	3cc	575
48	L21	Cargo Forward	30.	60	40			50,000	260	4,000	635	9,000	95
35	L22	" " Aft	11.	30	30			20,000	200	4,000	580		
40	L23	Searchlight	50.	100	65			40,000	230				
41	L24	Radio		100	65			30,000	175				
57	L25	Battery Charging (Radio & Telephone, etc. Bats.)		100	65			30,000	100				
9	L26	Workshop	38.2	100	65			40,000	50				
14	L27	Vent. Boat Dk. & Nav. Bridge	13.4	200	175	125,000	175			30,000	55	4,000	55
										25,000	50	18,000	115
										20,000	210	14,000	18
15	L28	Vent. "A" & "B" Decks-Aft	14.65	200	200	250,000	75			40,000	18	11,000	825
										18,000	155	4,000	70
43	L29	Engine Rev. Telegraph		30	10	4,000	40					20cc	275
45	L30	Helm Indicator		30	10	4,000	65					14cc	450
16	L31	Misc. Power { Pantry & Galley Equipment	12.6	200	150	125,000	50			11,000	40	4,000	365
										14,000	55		
17	L32	Vent. & Carpenter Shop	11.45	200	150	250,000	280			40,000	80		
										18,000	290		
8	L33	Laundry Equipment	7.15	100	75			40,000	60	1,000	80		
58	L34	Heaters & Fans-Aft-Port-"A" Dk.	8.2	100	95	75,000	70			9,000	65		
										9,000	425		
										4,000	625		
60	L35	" " " " Sfbd " "	8.2	100	95	75,000	100			9,000	310		
										4,000	550		
61	L36	" " " Ford. Port " "	17.4	100	90	75,000	200			9,000	185		
										4,000	395		
18	L37	" " " " Sfbd. " "	16.5	200	110	75,000	225			9,000	215		
										4,000	145		
19	L38	" " " Aft. Port "B" "	10.0	200	125	75,000	150			2,000	540		
										4,000	330		
20	L39	" " " " Stb'd " "	10.0	200	125	75,000	170			9,000	540		
										4,000	400		
53	L40	" " " Midship " " "	18.3	30	25			9,000	125	4,000	2200		
50	L41	" " " Ford. Port " "	33.2	60	45			23,000	170	4,000	475		
21	L42	" " " " Stbd " "	4.1	60	50			23,000	200	4,000	520		
10				60	35			11,000	115				
	1L40	Bracket Fans "C" Deck	1.5					9,000	10	4,000	1170		
		Generator Leads		4,600		8 Circuits	150	4000	150				
						5-250,000	400						
	J	Officers Telephone System						3cc	75	14cc	Tel. Cable		550
	K	Shaft Rev. Indicator "								4,000	720		
	W	Whistle Control								4,000	165	3cc	160
	G	General Alarm								4,000	950		
	E	Call Bell System						4,000	830	3cc	105	#16 Bell Wire-Main	4800
		Mechanical Eng. Teleg.						Casing		4" I.P.S.	27	#10 Brass	
										3" I.P.S.	45	Wire	2280
		Mechanical Docking Teleg.						"		2½" I.P.S.	50	"	1735
		Whistle Pull								1½" I.P.S.	187	"	235
	X	Fuel Oil Alarm								4,000	130	3cc	140

Fixtures

| Switch No. | Feeder No. | | Ceiling Office ○ | Deck S.T.G. ⊗ | Bulkhead S.T.G. ◑ | H.Light Ceiling ◓ | H.Light Ceiling ◓ | 2-Light Ceiling ◑ | 3-Light Ceiling ◑ | 9-Light Ceiling ◑ | Ceil. Plain Rolling ○ | Ceil. Frosted Globe ⊖ | Ceil. Beaded Globe ⊖ | 1-Light Desk Light ♀ | Desk Bkt. Fixt. 1 Lt. Shield & Switch ♀ | Candle Bkt. Fixture-1 Light ♀ | Candle Bkt. Fixt. 2 Lt. & Shield ♀ | Bracket Fixture ⊣ | Bracket Fixture with Switch ⊣ | Bracket Switch Candelabra Bracket for Flame Glass ⊣ | Bulkhead, Opaque Shade & Switch ◑ | Bulkhead, Opaque Shade ◑ | Berth Light ⊟ | 3-Light Ceiling Cluster ◑ | 6-Light Cargo Reflector ◑ | Reading Light ♀ | Portable N.W.T. ♀ | Desk Light ♀ | Morse Light ♀ | Receptacle ● | 100-Watt Unit ◉ | Colored Light ◎ | Searchlight ▭ | 12" Bracket Oscillating Fan ⊙ | 12" Bracket Non-Oscillating Fan ⊙ | Branch Box ✧ | Branch Junc. Box ✧ | Feeder Junc. Box ✧ | Junc. Box ✧ | 5 Amp. N.W. Surface Type Receptacle ⊙ | 5 Amp. N.W. Flush Type Receptacle ⊙ | 5 Amp. W.T. Receptacle ▭ | 5 Amp. W.T. 3-Wire Receptacle ▭ | 5 Amp. W.T. Switch and Receptacle ▭ | 5 Amp. N.W.T. Switch ✶ | 5 Amp. N.W.T. Switch-Fancy ✶ | 5 Amp. W.T. Switch ✉ | 60 Amp. D.P.S.T. Switch ✉ | Morse Key ⌨ | 7-Cell Storage Battery B | 3" Vibr. Bell ③ | 6" Vibr. Bell ⑥ | Annunciator-Drop as Noted ▦ | 5 Wire Conn. Box ○⁵ | 10-Wire Conn. Box ⑩ | 20-Wire Conn. Box ㉑ | Gen. Alarm Gong ⓖ | W.T. Telephone ☎ | Gen. Alarm Contact Maker ◎ | 1000-Watt Heater with Switch ▭ | 500-Watt Heater with Switch ▭ | Thermo Ventilating Fan ✲ | Supply Vent Fan, no Tank Connection | Exhaust Vent. Fan | W.T. Shaft Rev. Ind. ⑤ | Shaft Rev. Trans. Ⓚ | Engine Rev. Trans. Ⓜ | Engine Rev. Indicator Ⓜ | Helm Transmitter Ⓗ | Helm Indicator Ⓗ | Push Button Flush Type ◉ | Fire Alarm Annunciator ▦ | N.W.T. Push Button ○ | Single Pear Push Button ◉ | Oil Light Brass Bulkhead ㉓ | Oil Light Brass Bracket Ⓑ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---



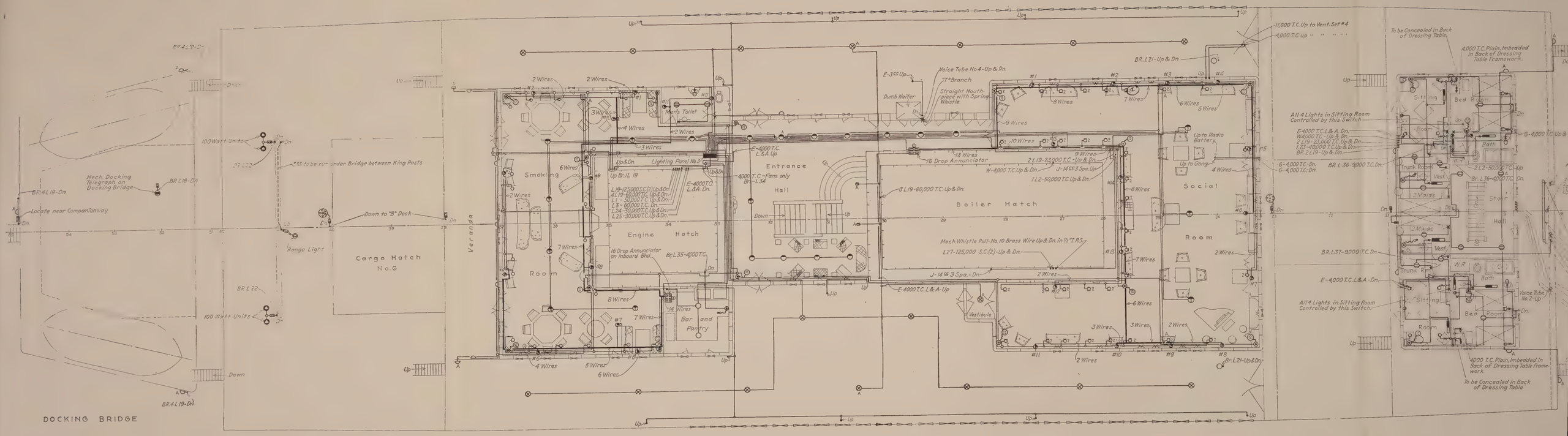
BOAT DECK

ELECTRICAL INSTALLATIONS

13,000-TON D. W. COMBINED PASSENGER AND FREIGHTER

Builders, Bethlehem Shipbuilding Corp.

New York Shipbuilding Corp.


DOCKING BRIDGE
Mech. Docking Telegraph on Docking Bridge
BR. L16-Dn
BR. 4 L19-Dn
Locate near Companionway
100 Watt Units
BR. L22
3 ft to be run under Bridge between King Posts
Down to "B" Deck
Range Light
Cargo Hatch No. 6
Veranda
Smoking Room
Men's Toilet
Lighting Panel No. 3
Engine Hatch
Br. L35-4000 T.C.
16 Drop Annunciator on Inboard Bhd.
Bar and Pantry
Entrance Hall
Dumb Waiter
Voice Tube No. 4 - Up & Dn.
"T" Branch
Straight Mouth-piece with Spring Whistle.
E-4000 T.C. L&A Up
4000 T.C. - Fans only Br. - L34
Boiler Hatch
Mech. Whistle Pull-No. 10 Brass Wire Up & Dn. in ½" T.P.S.
L27-125,000 S.C.(2)-Up & Dn.
Vestibule
Social Room
Up to Radio Battery
Up to Gong
BR. L21-Up & Dn
11,000 T.C. Up to Vent. Set #4
4,000 T.C. up " " " "
To be Concealed in Back of Dressing Table
4,000 T.C. Plain, Imbedded in Back of Dressing Table Framework.
All 4 Lights in Sitting Room Controlled by this Switch
E-4000 T.C. L & A. Dn.
W-4000 T.C. - Up & Dn.
2 L19 - 23,000 T.C. Up & Dn.
L23-40,000 T.C. Up & Dn.
BR. 2 L19 - Up & Dn.
6-4,000 T.C.-Dn.
6-4,000 T.C.-Dn.
BR. L-36-9,000 T.C. Dn.
BR. L37-9,000 T.C. Dn.
E-4,000 T.C. L&A-Dn.
Voice Tube No. 2 Up
Sitting Room
Bed Room
Trunk Room
Vest.
Stair
Hall
W.R.
Bath
Maids
Valets
Br. L21-Up & Dn.
4000 T.C. Plain, Imbedded in Back of Dressing Table Framework.
To be Concealed in Back of Dressing Table

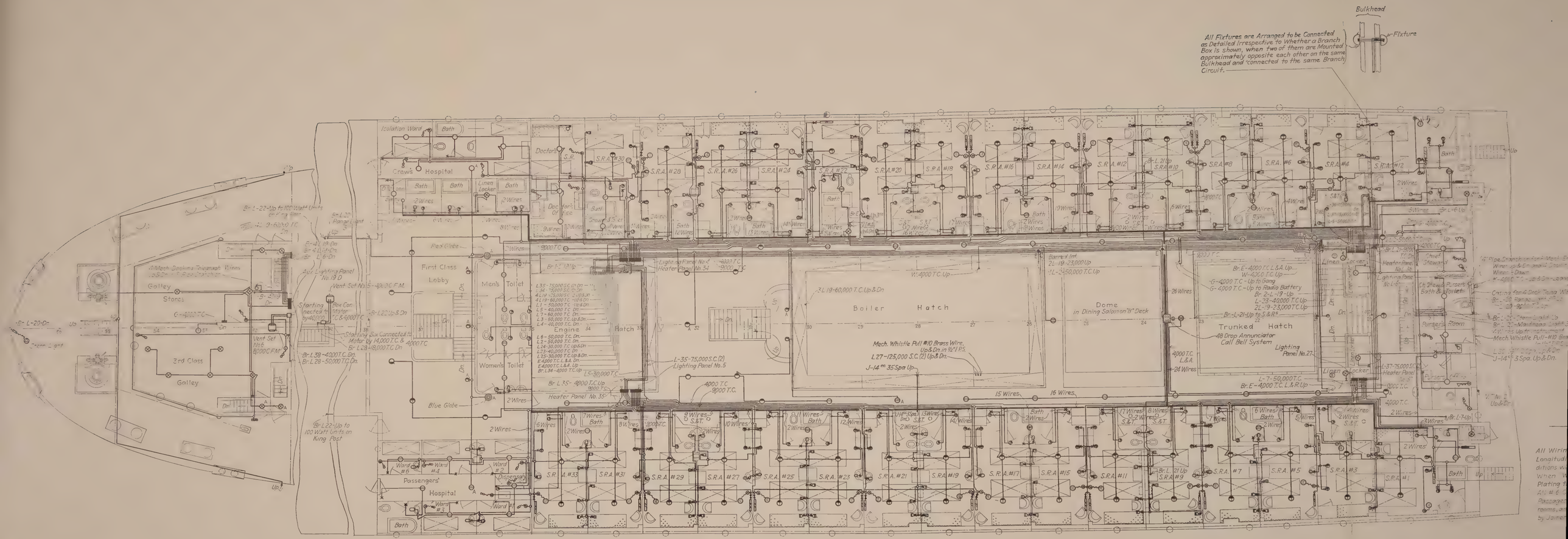
BRIDGE DECK

ELECTRICAL INSTALLATIONS

13,000-TON D. W. COMBINED PASSENGER AND FREIGHTER

Builders, Bethlehem Shipbuilding Corp.

New York Shipbuilding Corp.



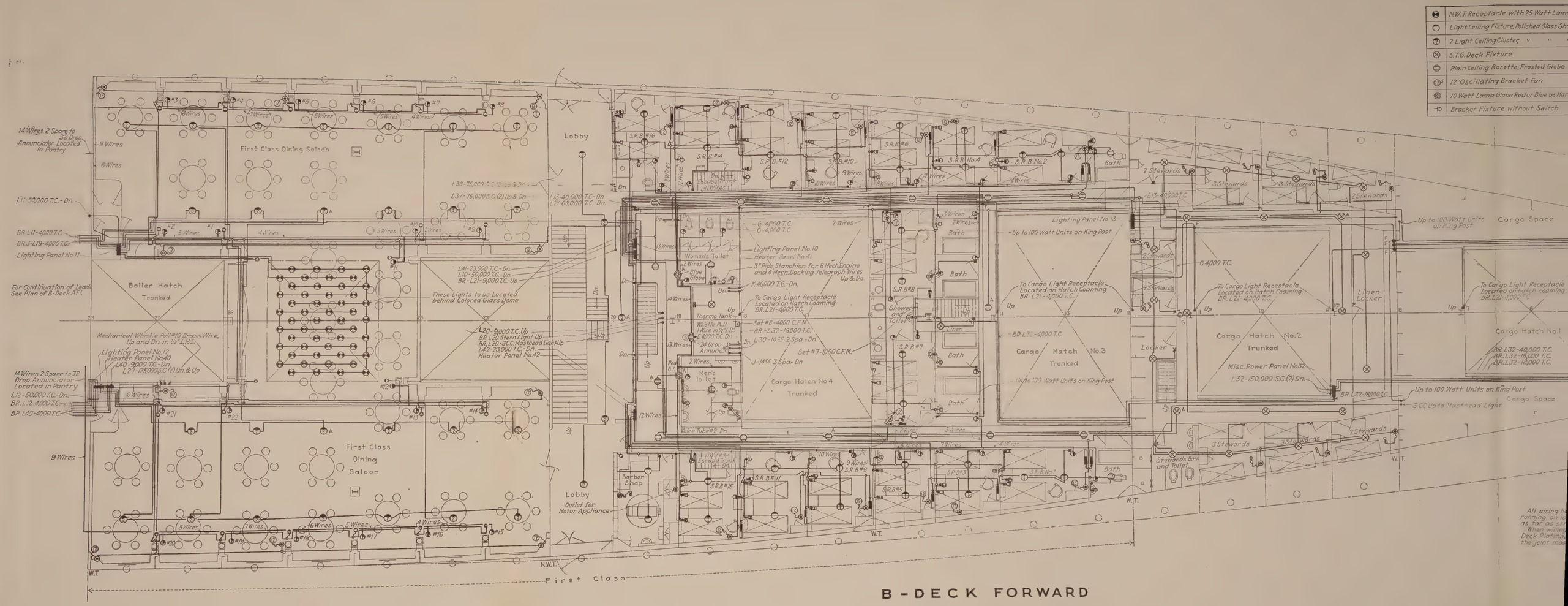
A-DECK

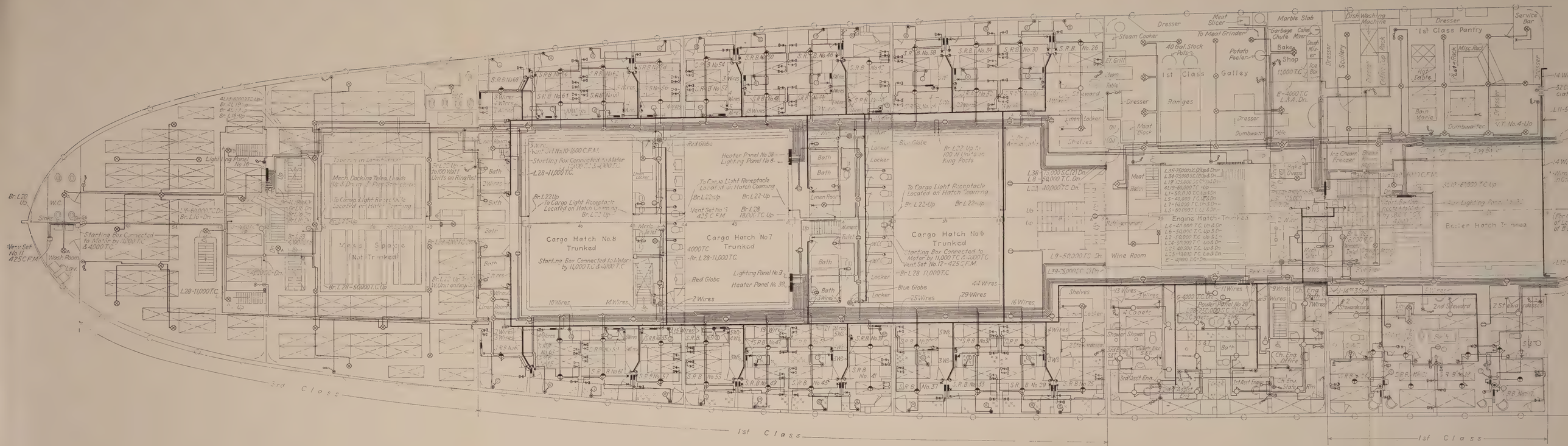
ELECTRICAL INSTALLATIONS

13,000-TON D. W. COMBINED PASSENGER AND FREIGHTER

Builders, Bethlehem Shipbuilding Corp.

New York Shipbuilding Corp.


N.W.T. Receptacle with 25 Watt Lamp
Light Ceiling Fixture, Polished Glass Shade
2 Light Ceiling Cluster, " "
S.T.G. Deck Fixture
Plain Ceiling Rosette; Frosted Globe
12" Oscillating Bracket Fan
10 Watt Lamp Globe Red or Blue as Mar
Bracket Fixture without Switch
14 Wires 2 Spare to 33 Drop Annunciator Located in Pantry
First Class Dining Saloon
Lobby
Boiler Hatch Trunked
Cargo Hatch No.4 Trunked
Cargo Hatch No.3 Trunked
Cargo Hatch No.2 Trunked
Cargo Hatch No.1
Cargo Space
Linen Locker
Locker
Bath
Shower and Toilet
Women's Toilet
Men's Toilet
Barber Shop
Stewards Bath and Toilet
Lighting Panel No.10 Heater Panel No.41
Lighting Panel No.12 Heater Panel No.40
Lighting Panel No.13
Misc. Power Panel No.32
Mechanical Whistle Pull #10 Brass Wire, Up and Dn. in 1/2" I.P.S.
Escape Trunk
Voice Tube #2-Dn.
Outlet for Motor Appliance
Steam Whistle
Masthead Light
W.T.
N.W.T.
First Class
B-DECK FORWARD
ELECTRICAL INSTALLATIONS
13,000-TON D. W. COMBINED PASSENGER AND FREIGHTER
Builders, Bethlehem Shipbuilding Corp.
New York Shipbuilding Corp.



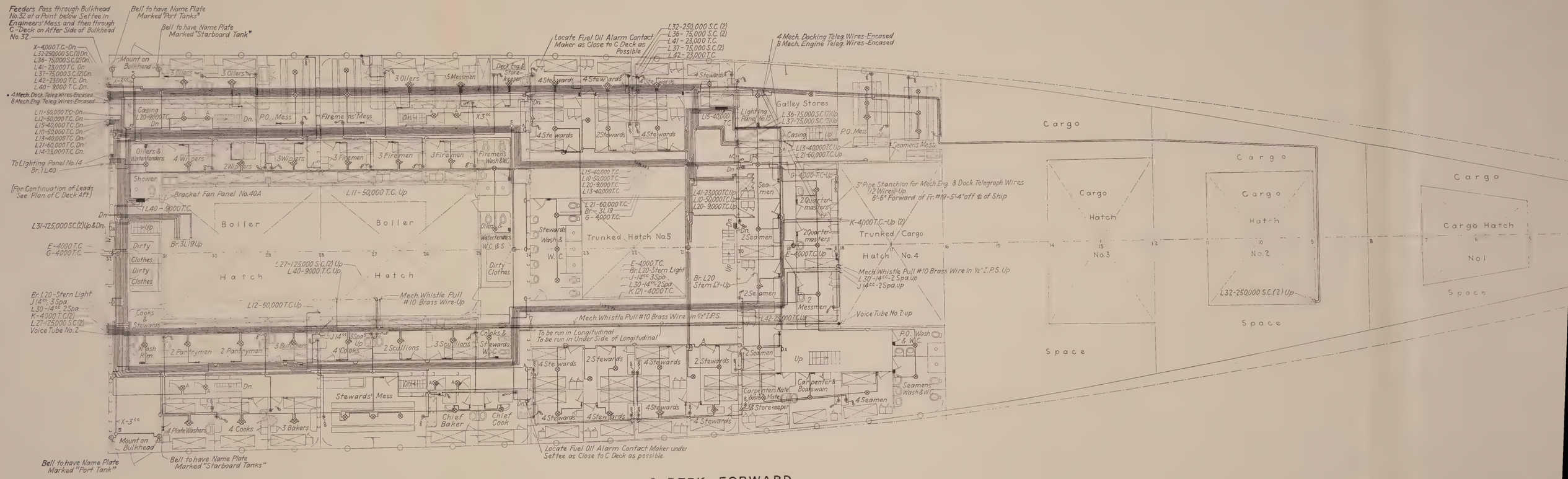
B - DECK AFT

ELECTRICAL INSTALLATIONS

13,000-TON D. W. COMBINED PASSENGER AND FREIGHTER

Builders, Bethlehem Shipbuilding Corp.

New York Shipbuilding Corp.



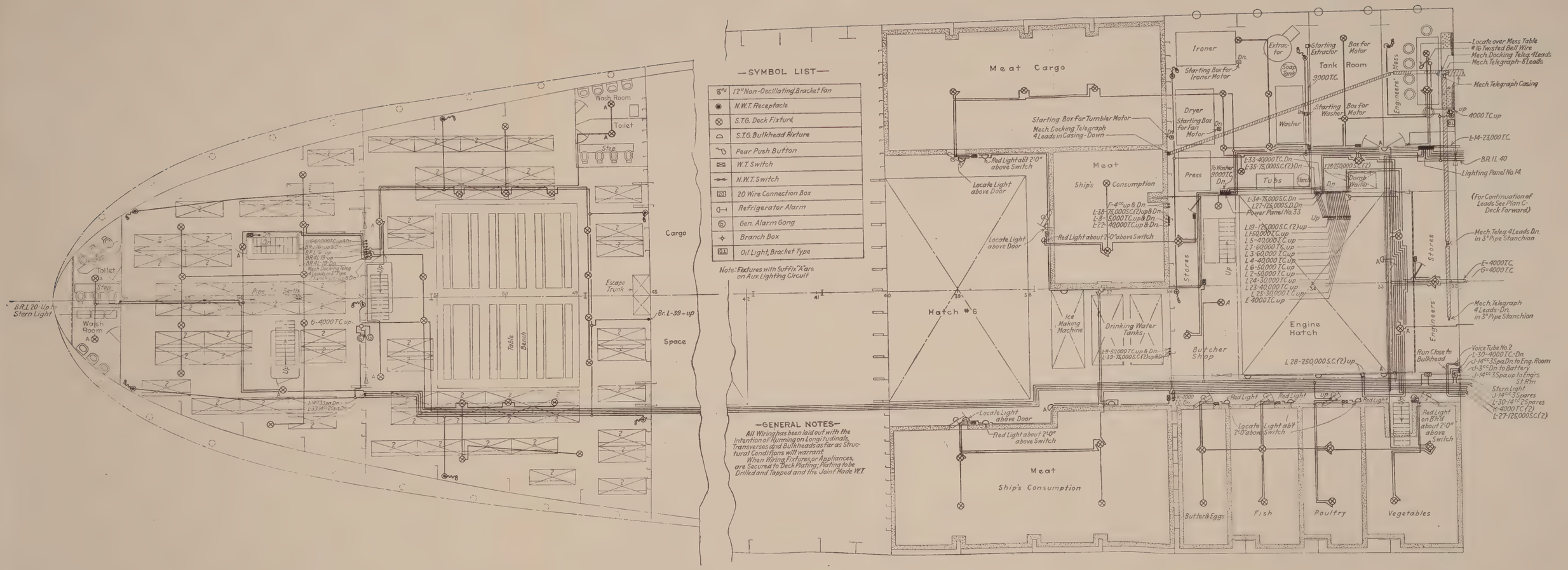
C. DECK FORWARD

ELECTRICAL INSTALLATIONS

13,000-TON D. W. COMBINED PASSENGER AND FREIGHTER

Builders, Bethlehem Shipbuilding Corp.

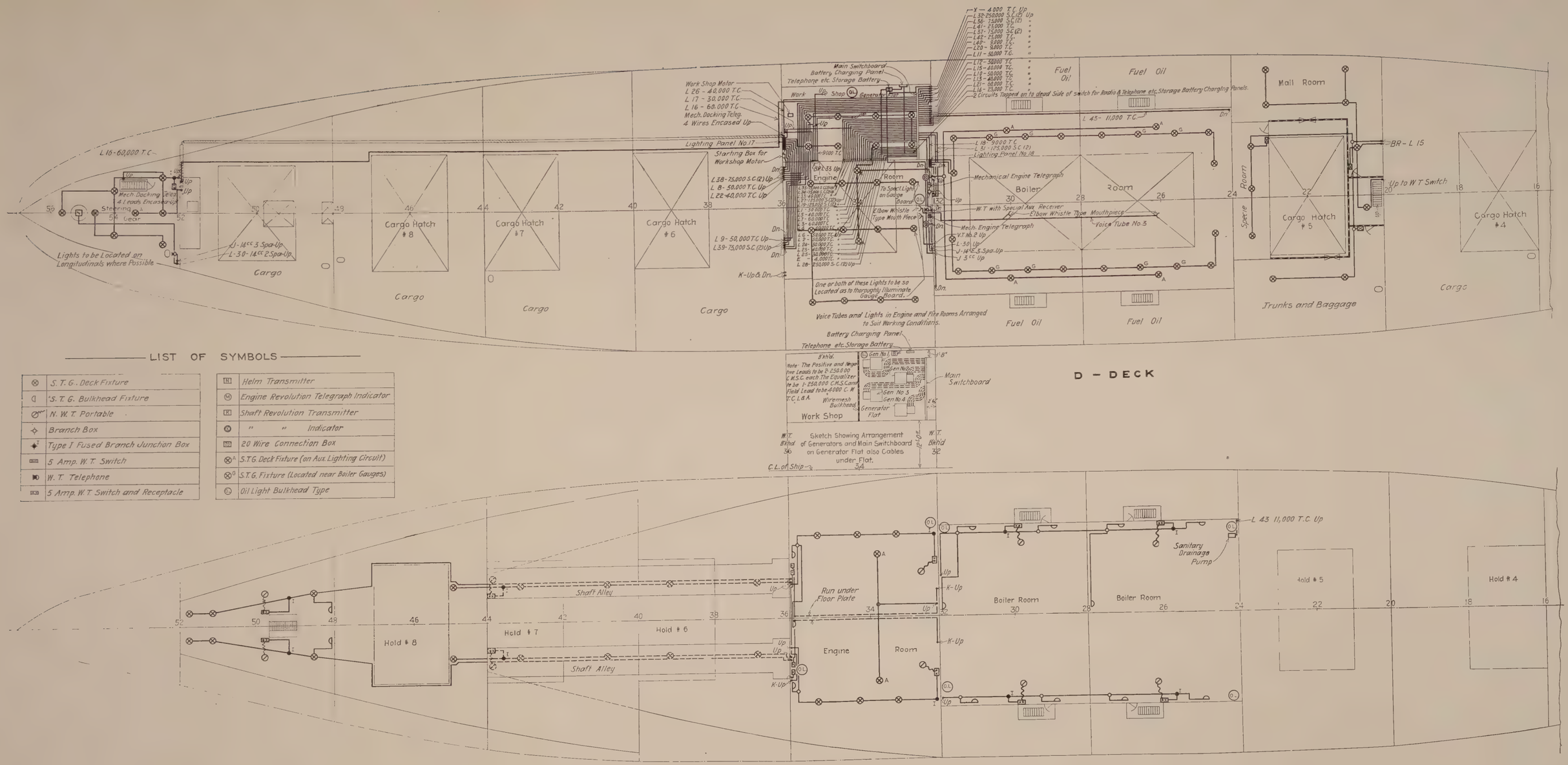
New York Shipbuilding Corp.



C-DECK AFT

ELECTRICAL INSTALLATIONS
13,000-TON D. W. COMBINED PASSENGER AND FREIGHTER
Builders, Bethlehem Shipbuilding Corp.
New York Shipbuilding Corp.

PLATE LIX



LIST OF SYMBOLS

⊗	S. T. G. Deck Fixture
◐	S. T. G. Bulkhead Fixture
⊗	N. W. T. Portable
✧	Branch Box
✦ T	Type I Fused Branch Junction Box
▭	5 Amp. W. T. Switch
◙	W. T. Telephone
▭	5 Amp. W. T. Switch and Receptacle

H	Helm Transmitter
M	Engine Revolution Telegraph Indicator
K	Shaft Revolution Transmitter
M	" " Indicator
20	20 Wire Connection Box
⊗A	S.T.G. Deck Fixture (on Aux. Lighting Circuit)
⊗G	S.T.G. Fixture (Located near Boiler Gauges)
○	Oil Light Bulkhead Type

D - DECK

HOLD

ELECTRICAL INSTALLATIONS
13,000-TON D. W. COMBINED PASSENGER AND FREIGHTER
Builders, Bethlehem Shipbuilding Corp.
New York Shipbuilding Corp.

PLATE LX

13,000-TON D. W. COMBINED PASSENGER AND FREIGHTER

For Remainder of Schedule See Plate LII.
For Arrangement Plans See Plates LIII to LX.

LIST OF LAMP BULBS REQUIRED

Size in Watts	Type of Bulbs	Where Used
50	Standard Clear	In all Places except as Follows
100	"	Cargo Light Fixtures on King Posts
50	Round Frosted	Ceiling Rosette Fixtures of Tea Room, Public Baths, Toilets and 1st Cl Passages
25	Std Clear	Domes of 1st Cl Lobby Boat Dk and 1st Cl Dining Saloon, Bracket Fixtures having Glass Shades in 1st Cl Dining Saloon, Writing Room, Entrance Hall, Offrs Quarts, 1st Cl State Rooms, and Companion Ways; All Desk Lights, Bulkhead Fixtures over Lavatories in Showers and Toilets and Baths not having a Ceiling Light
25	Rd. Frosted	Ceiling Rosette Fixtures of Private Baths and Bulkhead Fixtures of Tea Room
15	Standard Clear	Bulkhead Fixtures over Lavatories in State Rooms, Private Baths, Public Toilets and Compartments having also a Ceiling Light; and in Berth Light Fixtures
15	Rd. Frosted Candel. Base	In 1 & 2 Lt Candle Bracket Fixtures in Tea Room, Social Hall, Smoking Hall and Sitting Rooms of 1st Cl. Suites
15	Taprd Frosted Candel. Base	Candelabra Fixtures at Dressing Tables in 1st Cl. Suites
10	Standard Clear	Colored Globe Fixtures at Public Toilets, S.T.G. Bulkhead Signal Lts. at Refrigerator Doors; Compasses and Tell Tale Board
5	Clear	Helm Indicator
	Tubular Clear	Engine Revolution Telegraph, on Gauge Board

LIST OF PORTABLES

Item	Quantity	Length of Cable in Feet: Length Each	Plain	Silk	3cc
Cargo Reflector	12	50	600		
Stern Light	1	3	3		
Side "	2	3	6		
Morse "	1	10	10		
Mech. Teleg. Light.	6	3	18		
Binnacle Light	2	3	6		
N.W.T. Portable	11	35	385		
Range Light	1	3			3
Mast Head Light	1	3			3
Fan	7 Ft. Silk Cord Complete with Plug				
Desk Light	9 " "	"	"	"	"
Totals			1028		6

LIST OF VOICE TUBES

No	From	To	To	Sketch	Length 1½" V.T.	Elbows	Branch	Sleeve
V.T.1	Bridge	Wheel House			6'			
V.T.2	Wheel House	Engine Room			200'	6		7'
V.T.3	Engine Room	Fire Room Aft	Fire Room Fore		75'	3	Y	2'
V.T.4	Pantry (Boat Dk.)	Entrance (Bridge Dk.)	Pantry (B' Deck)		30'		T	1'

LIST OF FUSES (Not on Main Switchboard)

	No.	Amp Size	Dist. Panel No.	Location: Deck	Btwn Frms	Side	Circt. No.	Remarks
Plug Fuses	24	10	1	Boat	30-31	Port	L1	
	8	10	2-4	Boat	24	"	L12	
	12	10	2-6	"	19-20	"	L22	
	16	6	2-C	Nav Brdg	20-21	"	"	
	28	10	3	Brdg	33-34	"	L3	
	6	10	4	"	"	"	L4	Enclosed with Panel #34
	16	10	5	A	"	Stbd	L5	" " " " 36
	8	10	6	A	20	Port	L6	" " " " 36
	8	10	7	A	"	Stbd	L7	" " " " 37
	8	10	8	B	31-32	Port	L8	" " " " 38
	8	10	9	"	"	Stbd	L9	" " " " 39
	24	10	10	"	19-20	Port	L10	" " " " 41
	8	10	11	"	27-28	"	L11	
	6	10	12	"	"	Stbd	L12	Enclosed with Panel #40
	8	10	13	"	2	Port	L13	
	24	10	14	C	32-33	"	L14	
	20	10	15	"	20	"	L15	
	6	10	16	B	32	"	L16	
	6	10	17	D	36	"	L17	
	8	10	18	"	32	"	L18	
	4	10	19	A Boat	33-34	"	L19	
	8	10	21	"	20-21	"	L21	
	24	10	19-20	B	30-31	"	L19	
	8	10	19-20	A	51-52	"	L19	
	12	20	34	"	33-34	"	L24	Enclosed with Panel #4
	12	20	35	"	"	Stbd	L35	" " " " 5
	12	20	36	"	20	Port	L36	" " " " 6
	12	20	37	"	"	Stbd	L37	" " " " 7
	12	20	38	A	31-32	Port	L38	" " " " 8
	12	20	39	"	"	Stbd	L39	" " " " 9
	8	15	40	"	27-28	"	L40	" " " " 2
	8	15	41	"	19-20	Port	L41	" " " " 10
	8	15	42	"	"	Stbd	L42	
	8	10	40-A	"	31-32	Port	L40	
Enclosed Fuses	2	20	19	Boat	24-25	Port	L19	Aux Lighting Circt
	10	10	Transf	"	"	"	L19	" " "
	2	30	40	"	"	"	L19	" " "
	2	15	Panel	"	"	"	L19	" " "
	2	40	2	"	27	Stbd	L27	Vent. Set No. 4
	6	50	"	"	"	"	"	" #1, 2, 3
	4	20	28	B	33-34	"	L28	Vent. Sets #10, 11, 12, 13
	2	40	"	"	"	"	"	" #5
	2	50	"	"	"	"	"	" #9
	2	80	"	"	"	"	"	" #6
	8	10	31	"	32	Port	L31	Meat Grinder; Slicer; Dish Washer; Spare
	8	15	"	"	"	"	"	Cake Mixer; Egg Boiler Grill; Potato Peeler
	4	20	"	"	"	"	"	Ice Cream Freezer; Spare
	4	40	"	"	"	"	"	Toaster; Dough Mixer
	4	15	32	"	9	Stbd	L32	Vent. Set #7; Spare

	No.	Amp Size	Dist. Panel No.	Location: Deck	Btwn Frms	Side	Circt. No.	Remarks
Enclosed Fuses	4	25	32	"B"	9	Stbd	L32	Grinder; Drill
	2	40	"	"	"	"	"	Vent. Set No. 8
	2	60	"	"	"	"	"	Saw
	6	10	33	"C"	35-36	Port	L33	Tumbler Fan; Tumbler Cyl Spare
	2	15	"	"	"	"	"	Ironer
	4	40	"	"	"	"	"	Washer; Extractor
			Radio Panel	Boat		"	L24	
	2	10	Chara Panel	"D"	32-33	Port	L25	Telephone etc.
			Chara Panel	Boat		"	"	Radio
Link Fuses	2	10	E-Box	Boat	19-20	Port	2L2	Whistle
	2	15	"	"A"	22	"	L21	Cargo Lights
	2	15	"	"	23-24	"	"	"
	2	15	F-Box	B	8-9	"	"	"
	2	15	"	"	"	"	"	"
	2	15	"	"	"	"	"	"
	2	15	"	"	11-12	"	"	"
	2	15	"	"	14-15	"	"	"
	2	15	"	"	15-16	"	"	"
	2	15	"	"	18-19	"	"	"
	2	15	"	"	19-20	"	"	"
	2	15	"	"	38	"	L22	"
	2	15	"	"	39-40	"	"	"
	2	15	"	"	42	"	"	"
	2	15	"	"	45	"	"	"
	2	15	"	"	47	"	"	"
	2	15	"	"	48	"	"	"
	2	15	"	"	51	"	"	"
	2	15	E-Box	Boat	25-26	"	G	
Glass Fuses	2	2	L-Box	Boat	24	Stbd	1L2	Portable
	2	4	"	"	20-21	"	2L2	"
	2	4	"	"B"	19-20	"	L10	Barber Shop
	2	4	"	"	2-4	Port	L18	Carpenter "
	2	4	"	"D"	52-53	"	L16	Steerg Eng. Rm.
	2	4	"	Helo	22-23	"	L17	Portable
	2	4	"	"	43-44	"	"	"
	2	4	"	"	49-50	"	"	"
	2	4	"	"	52-53	Stbd	"	"
	2	4	"	"	43-44	"	"	"
	2	4	"	"	49-50	"	"	"
	2	4	"	"	52-53	"	"	"
	2	4	"	"	55-56	Port	L18	"
	2	4	"	"	30-31	"	"	"
	2	4	"	"	25-26	Stbd	"	"
	2	4	"	"	30-31	"	"	"
	2	4	"	Nav Brdg	19-20	Port	L20	"

General Notes

Where Conductors pass through Watertight Bulkheads, they shall be made Watertight by Means of Stuffing Tubes. Conductors passing through Decks shall be Protected by Conduit and Terminal Tube, except when such Leads are installed behind Sheathing or when they are fully Protected from Mechanical injury. In such cases the Stuffing Tube only will be used.

Where Voice Tubing pierces Watertight Decks or Bulkheads the Joint shall be made Watertight by Means of Stuffing Tubes. All Wiring to be 4000 T.C. unless otherwise marked.

All Fixtures with Switch will be Controlled by that Switch only

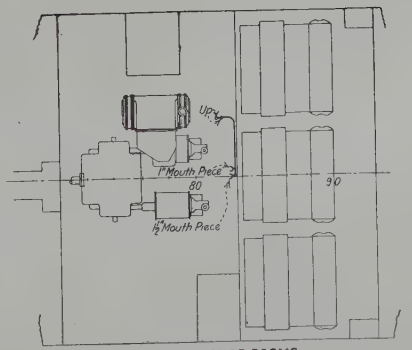
Leaded and Armored Cable to be used for Permanent Leads throughout Ship except Branch Leads in 1st Cl. Quarters, Passages and Public Rooms where Armored Cable will be used.

Permanent Leads of Armored or Leaded and Armored Cable will be given one Coat of Shellac after Installation and then Painted to Match their Surroundings Places on Cable where Original Paint has been rubbed off will first be Painted with Approved Insulating Compound.

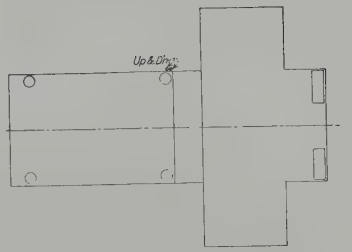
Conductors shall be Rigidly supported by Steel Strap Hangers, or Cable Clips spaced approximately 18" apart Conductors entering Watertight Appliances shall have a Terminal Tube Where Conductors enter Non-Watertight Appliances or pass through Beams or Non-Watertight Bulkheads a Clearance Hole shall be drilled and the edges rounded smooth Armor to be removed from all Cable within 15 ft. of Standard Compass.

All Fixtures and Junction Boxes to be thoroughly Painted with Insulating Paint.

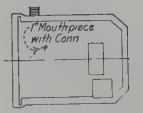
All Distribution Panels Located in 1st Cl. spaces to be concealed in Sheathing behind Paneled Door with Flush Yale Lock.



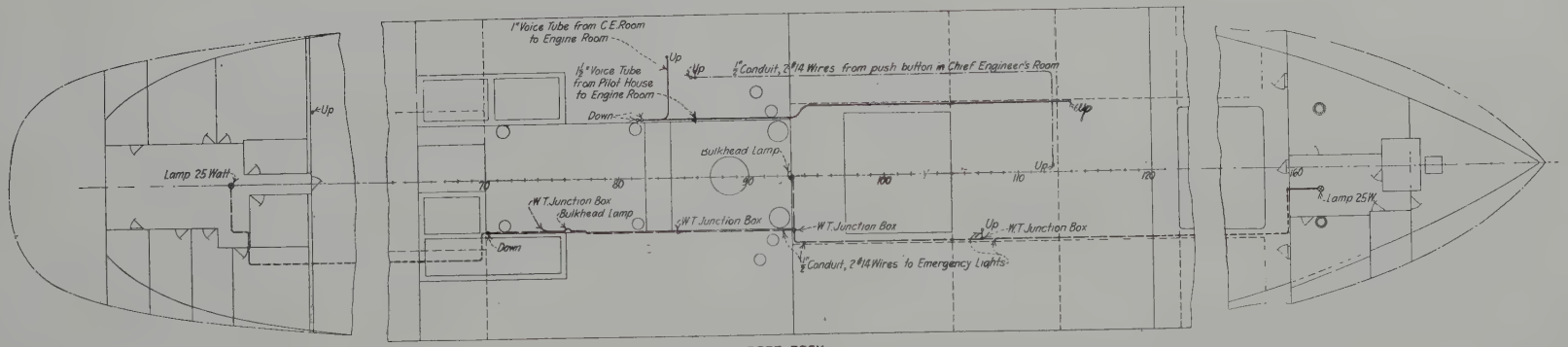
ENGINE AND BOILER ROOMS



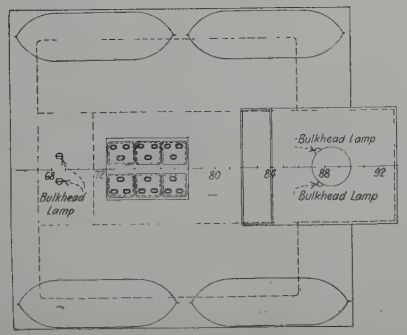
ENGINE AND BOILER CASING - SECOND DECK



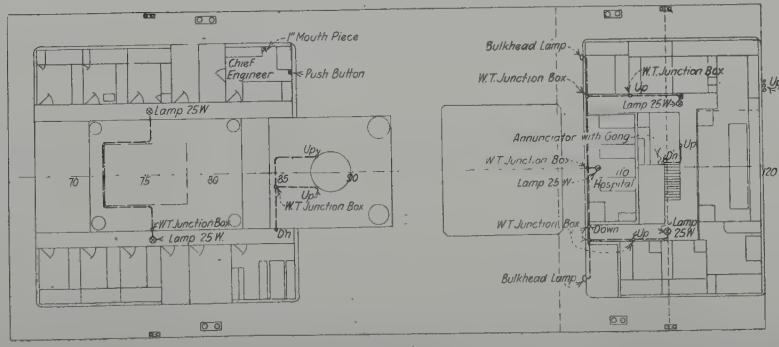
TOP OF PILOT HOUSE



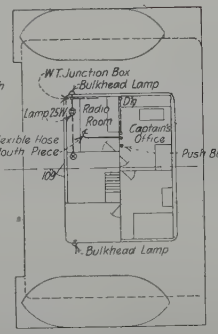
UPPER DECK



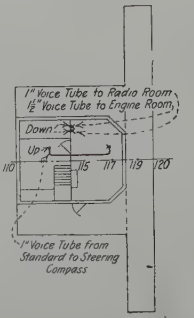
AFTER BOAT DECK



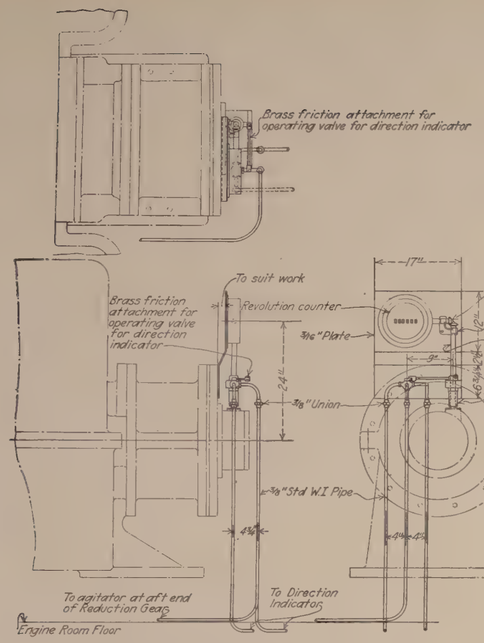
BRIDGE DECK



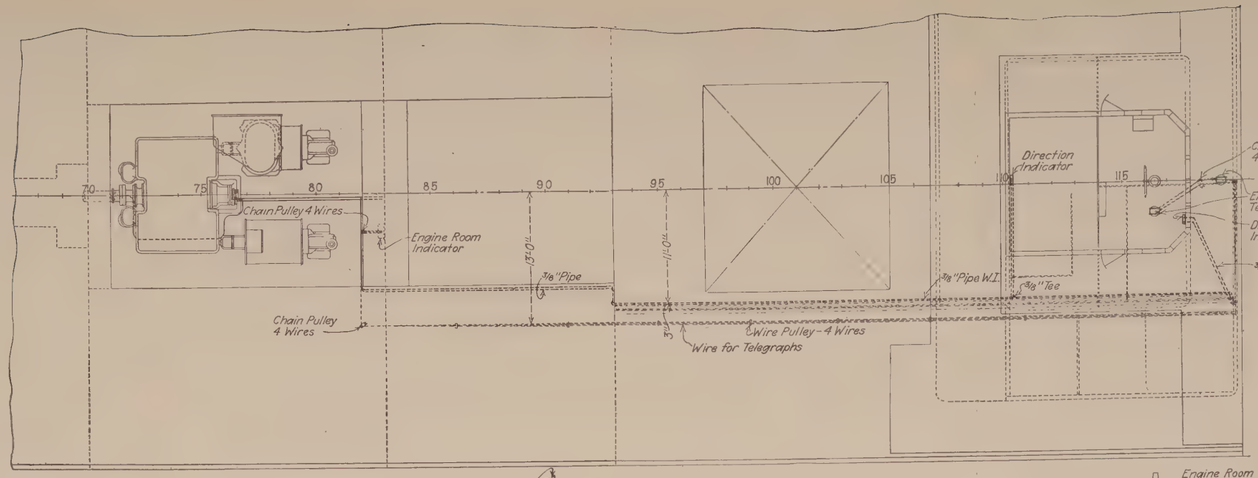
FORWARD BOAT DECK



NAV. BRIDGE


Brass friction attachment for operating valve for direction indicator
To suit work
Revolution counter
Brass friction attachment for operating valve for direction indicator
Miter Gear (Brass)
Gear Bracket (Brass)
Shaft 1" Dia. (C.R.S.)
Coupling (C.R.S.)
3/16" Plate
3/8" Union
3/8" Std W.I. Pipe
To agitator at aft end of Reduction Gear
To Direction Indicators
Engine Room Floor

ARRANGEMENT OF REVOLUTION COUNTER & OPERATING GEAR FOR VALVE CONTROLLING DIRECTION INDICATORS



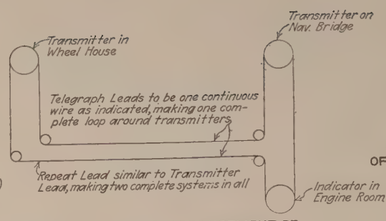
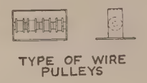

Transmitter on Nav. Bridge
Transmitter in Wheel House
Telegraph Leads to be one continuous wire as indicated, making one complete loop around transmitters
Repeat Lead similar to Transmitter Lead, making two complete systems in all
Indicator in Engine Room

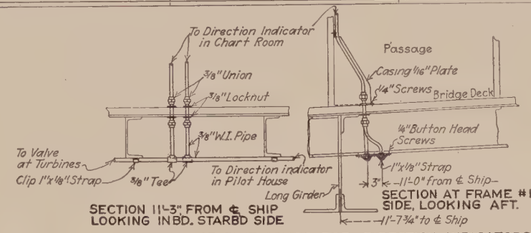
DIAGRAM SHOWING ARRANGEMENT OF MECHANICAL TELEGRAPH LEADS

SPECIAL TYPE OF CHAIN PULLEY

TYPE OF CHAIN PULLEYS



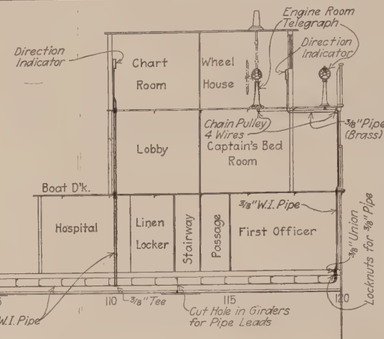
TYPE OF WIRE PULLEYS

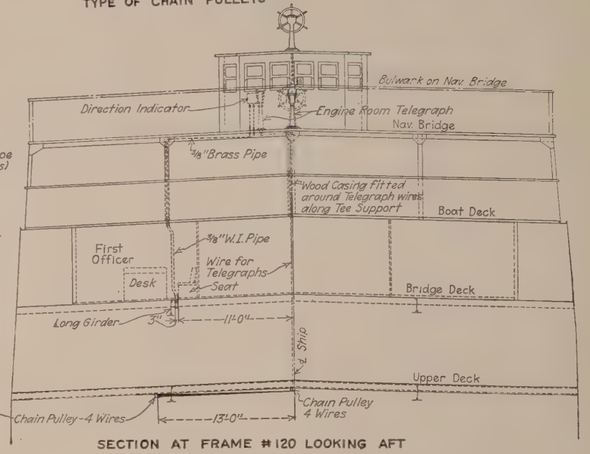


SECTION 11'-3" FROM ℄ SHIP LOOKING INBD. STARBD SIDE

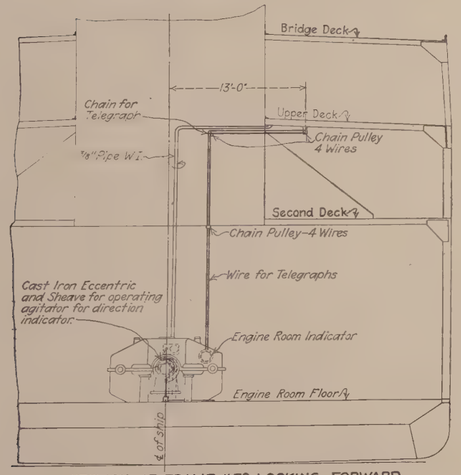
SECTION AT FRAME #111, STARBD SIDE, LOOKING AFT.

DETAIL OF PIPE LEADS FOR DIRECTION INDICATORS

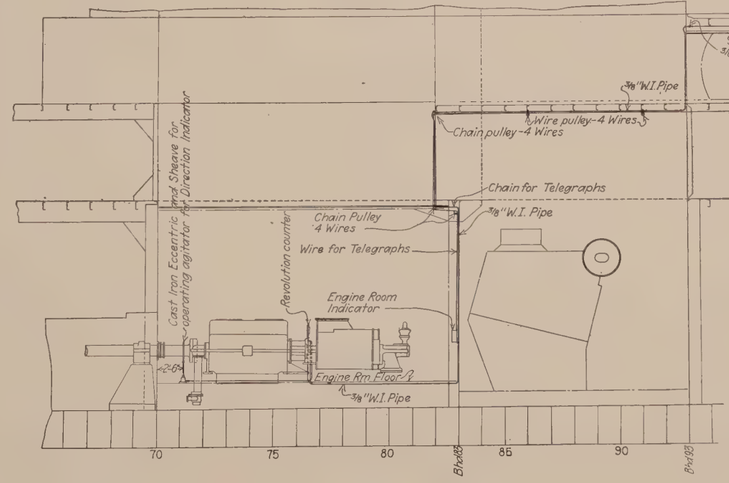


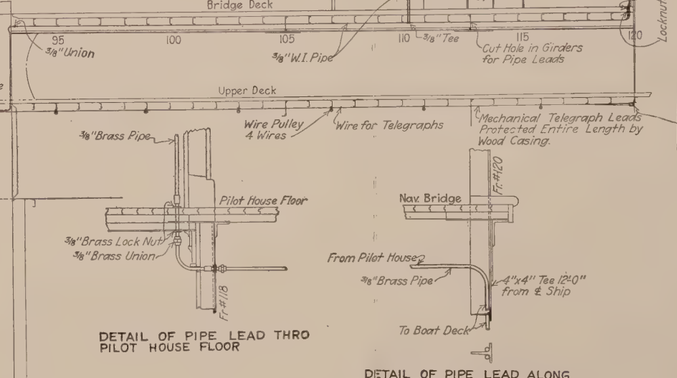


SECTION AT FRAME #120 LOOKING AFT



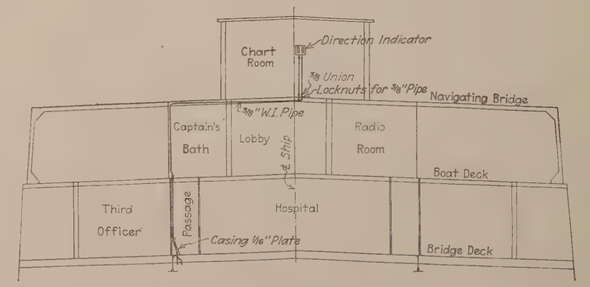
SECTION AT FRAME #70 LOOKING FORWARD





DETAIL OF PIPE LEAD THRO PILOT HOUSE FLOOR

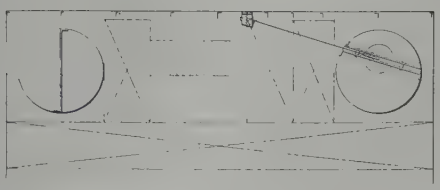
DETAIL OF PIPE LEAD ALONG STIFFENER TO BOAT DECK

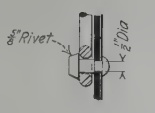


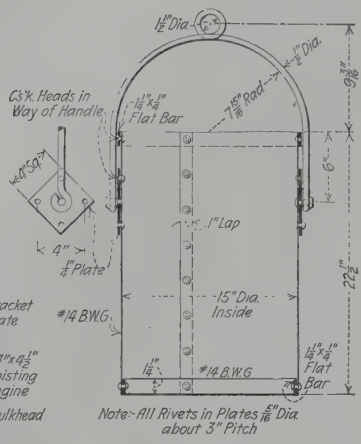
SECTION AT FRAME #112 LOOKING AFT

ARRANGEMENT OF ENGINE ROOM TELEGRAPHS, DIRECTION INDICATORS AND REVOLUTION COUNTER
9,000-TON D. W. FREIGHTER

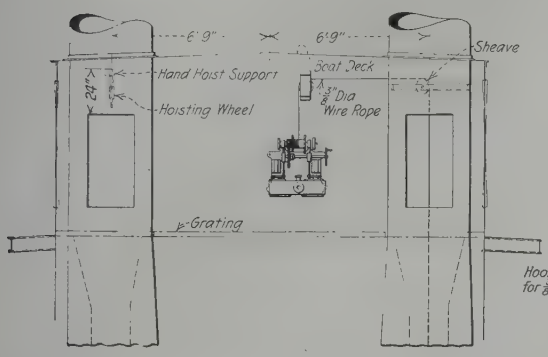
PLATE LXI

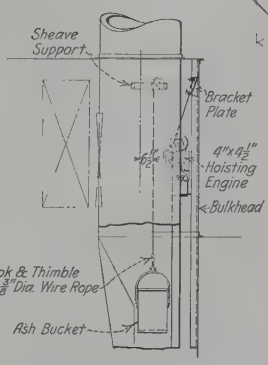




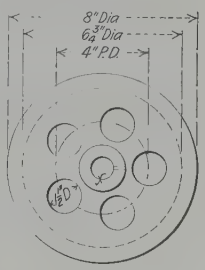


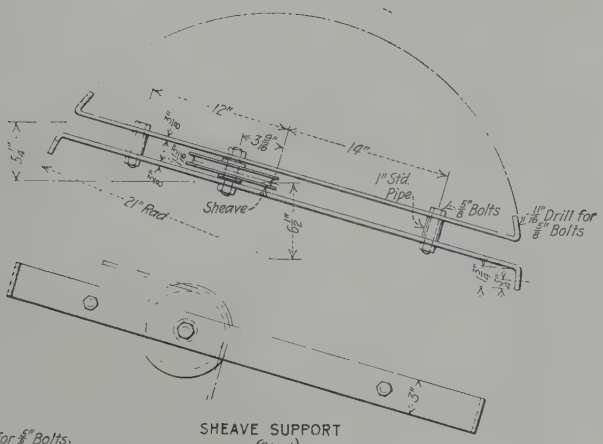
ASH BUCKET
(Steel)



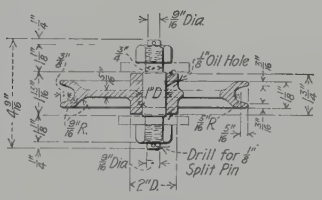


ARRANGEMENT OF ASH HOISTS

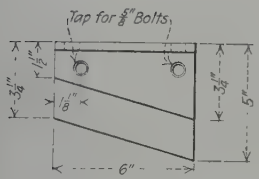


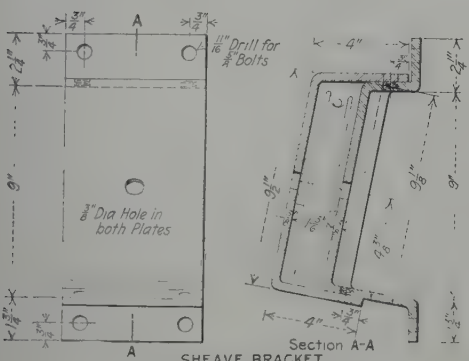


SHEAVE SUPPORT
(Steel)

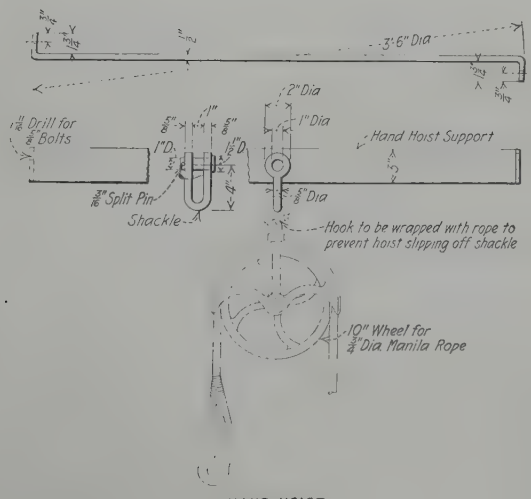


SHEAVE
(Cast Iron)

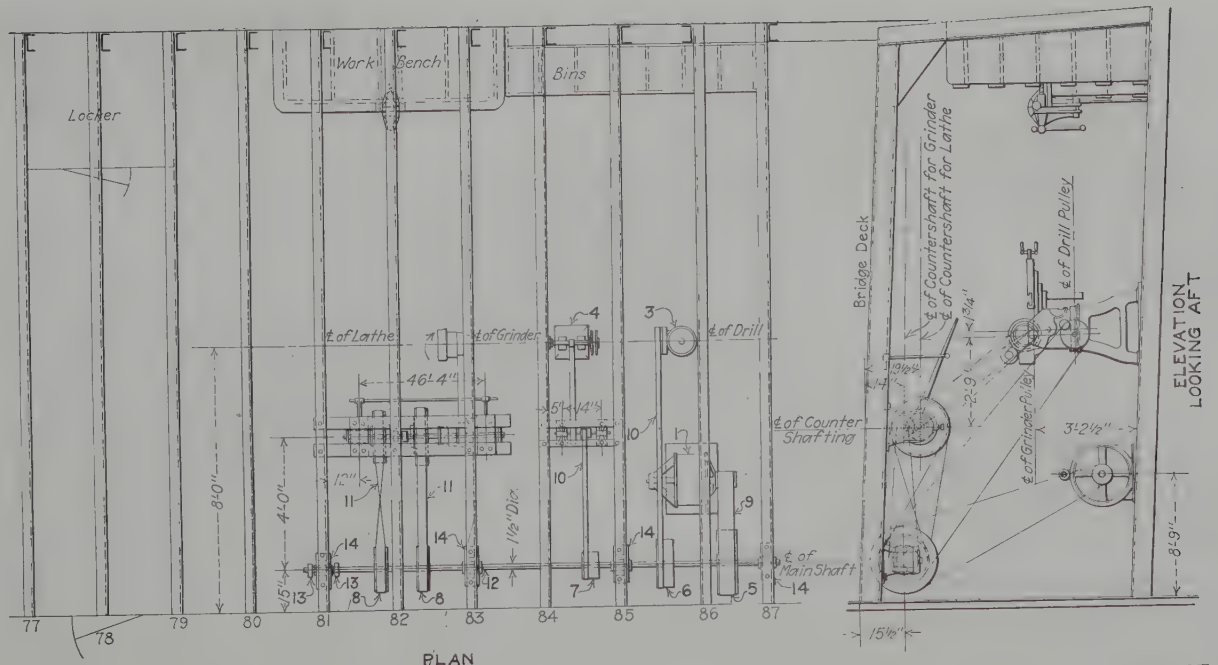




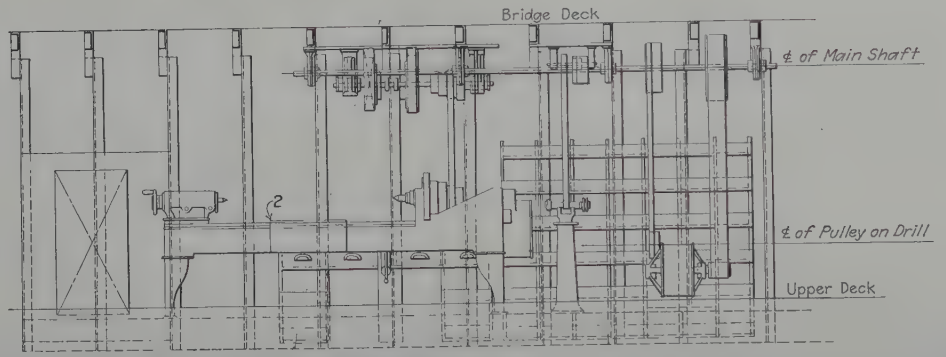
SHEAVE BRACKET
(Steel)



HAND HOIST



PLAN



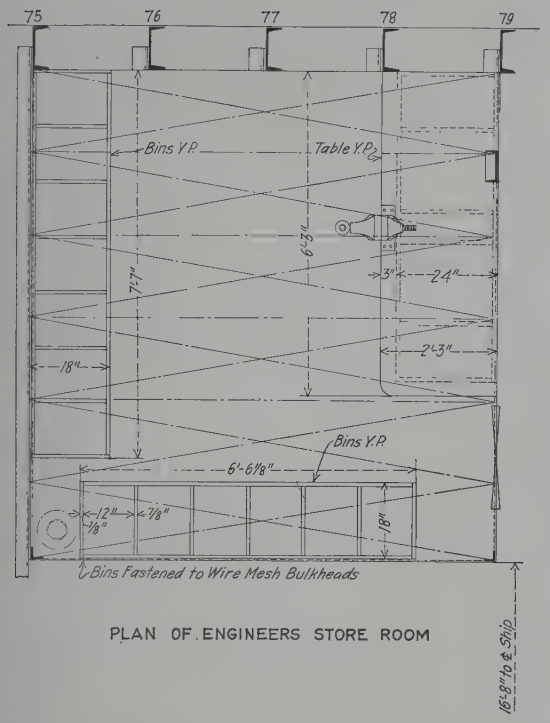
ELEVATION LOOKING OUTBOARD

BILL OF MATERIAL

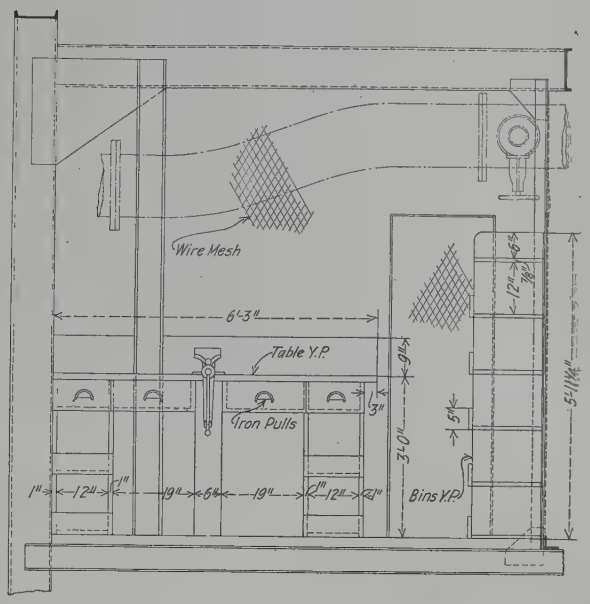
Pc. No.	Am't.	Name	Material
1	1	7½" H. P. motor, 850 r. p. m.	.....
2	1	16" 10" Engine lathe	.....
..	1	Set 12 lathe tools	.....
3	1	Drill	.....
4	1	No. 2 double grinder	.....
..	3	Emery wheels 8" x 1" x ½"	.....
5	1	Pulley 24" dia. x 7" f., 1½" bore	.....
6	1	Pulley 18" dia. x 6" f., 1½" bore	.....
7	1	Pulley 10" dia. x 6" f., 1½" bore	.....
8	2	Pulley 17" dia. x 4" f., 1½" bore	.....
9	18 ft.	Double 6"x18 ft., belt	Leather
10	45 ft.	Single 2"x45 ft., belt	Leather
11	60 ft.	Single 3"x60 ft., belt	Leather
12	16 ft.	1½" Dia. shafting	C.R.S.
13	3	Safety collars for 1½" dia. shaft	.C.I.
14	4	Bracket bearings	C.I.

9,600-TON D. W. FREIGHTER

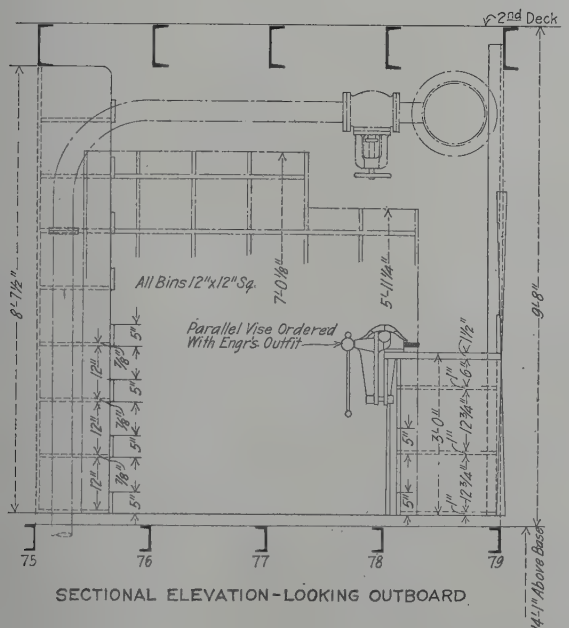
ARRANGEMENT OF ENGINEER'S STORE ROOM



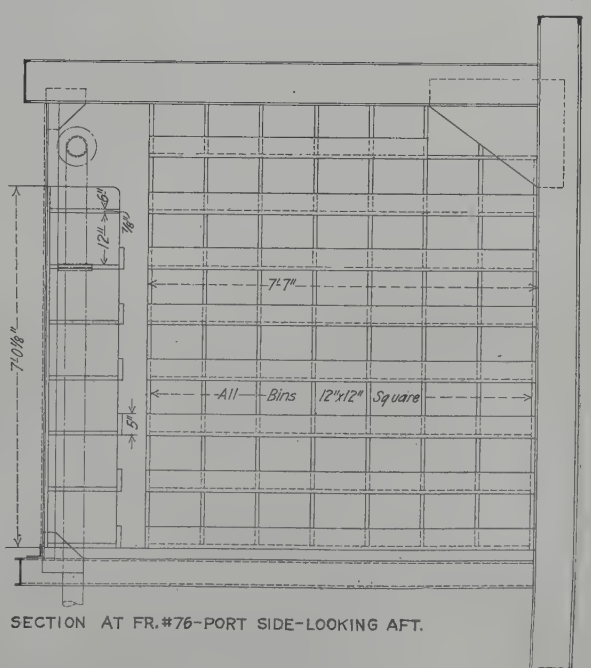
PLAN OF ENGINEERS STORE ROOM



SECTION AT FR. #78-PORT SIDE-LOOKING FORWARD



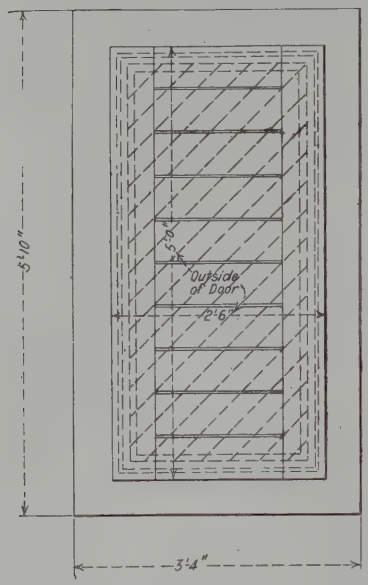
SECTIONAL ELEVATION-LOOKING OUTBOARD



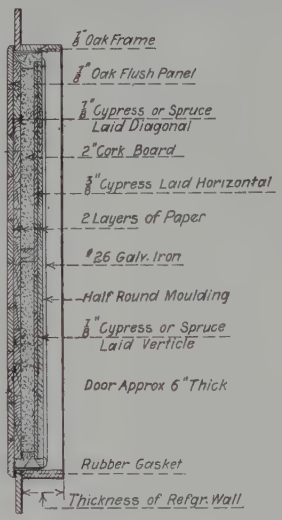
SECTION AT FR. #76-PORT SIDE-LOOKING AFT.

9,000-TON D. W. FREIGHTER

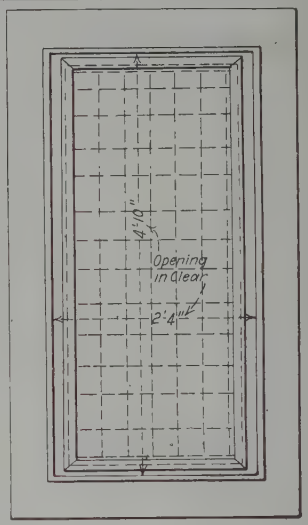
DETAILS OF REFRIGERATOR ROOM



FRONT VIEW

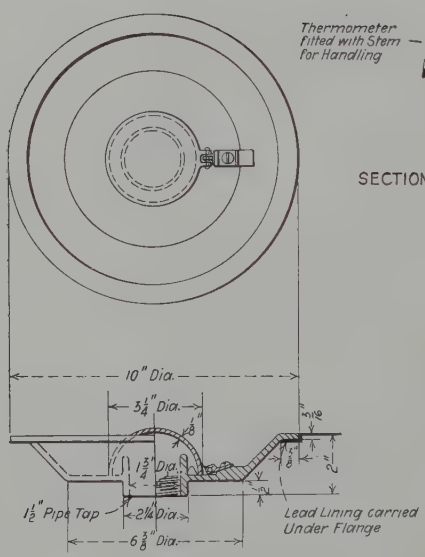

1" Oak Frame
1/4" Oak Flush Panel
1 1/8" Cypress or Spruce Laid Diagonal
2" Cork Board
3/8" Cypress Laid Horizontal
2 Layers of Paper
#26 Galv. Iron
Half Round Moulding
1 1/8" Cypress or Spruce Laid Verticle
Door Approx 6" Thick
Rubber Gasket
Thickness of Refgr. Wall

SECTION AND INSTALLATION

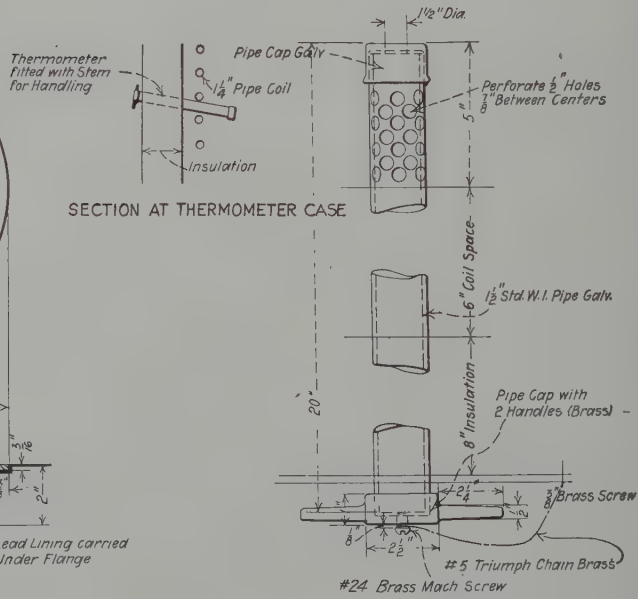


BACK VIEW

DETAIL OF REFRIGERATOR DOORS



BELL TRAP (CAST IRON.)



DETAIL OF THERMOMETER CASE

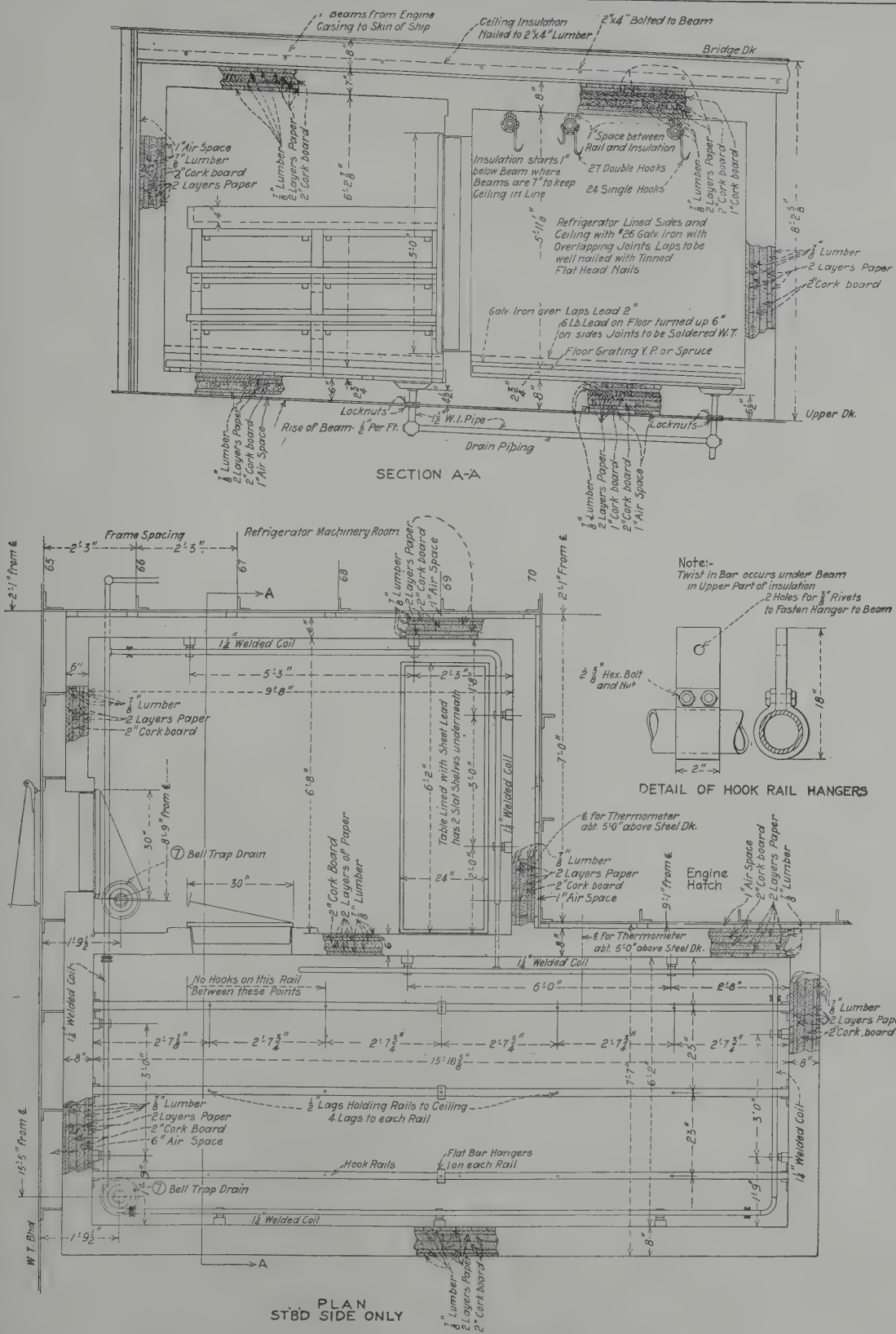
General Notes

Floor Gratings to be Yellow Pine or Spruce in Sections convenient to Handle
Door Hardware to be Extra Heavy Tinned Iron, Fasteners to be operated From both Sides of Door. Three Hinges for each Door.
Inside of Doors to be lined with #26 Galv. Iron worked around edge with Half Round Moulding Outside of Doors to be Solid Oak well filled & Varnished.
Exposed sides of Refrigerator to be painted two Coats best lead & Oil Paint Color as approved.
Bell Trap in each Compartment to be supplied
All Lumber outside of Frame work to be 1/8" T&G Spruce or Cypress. Exposed outside to be 1/8" No 1&2 Grade Yellow Pine.
All Inside Sheathing to be worked like Flooring Ploughed and Tongued.
All Frame work to be of Spruce Merchantable Grade
All Sheathing Paper to be of Waterproof Type. About 80 lbs. per thousand Square Feet
All 1" & 2" Cork Board to be of pure cork. Shelves to be of hard Wood. Top shelf to be lined with 4 Lb. Sheet Lead.
Thermometer and fittings for same to be supplied.

9,000-TON D. W. FREIGHTER

See Opposite Page

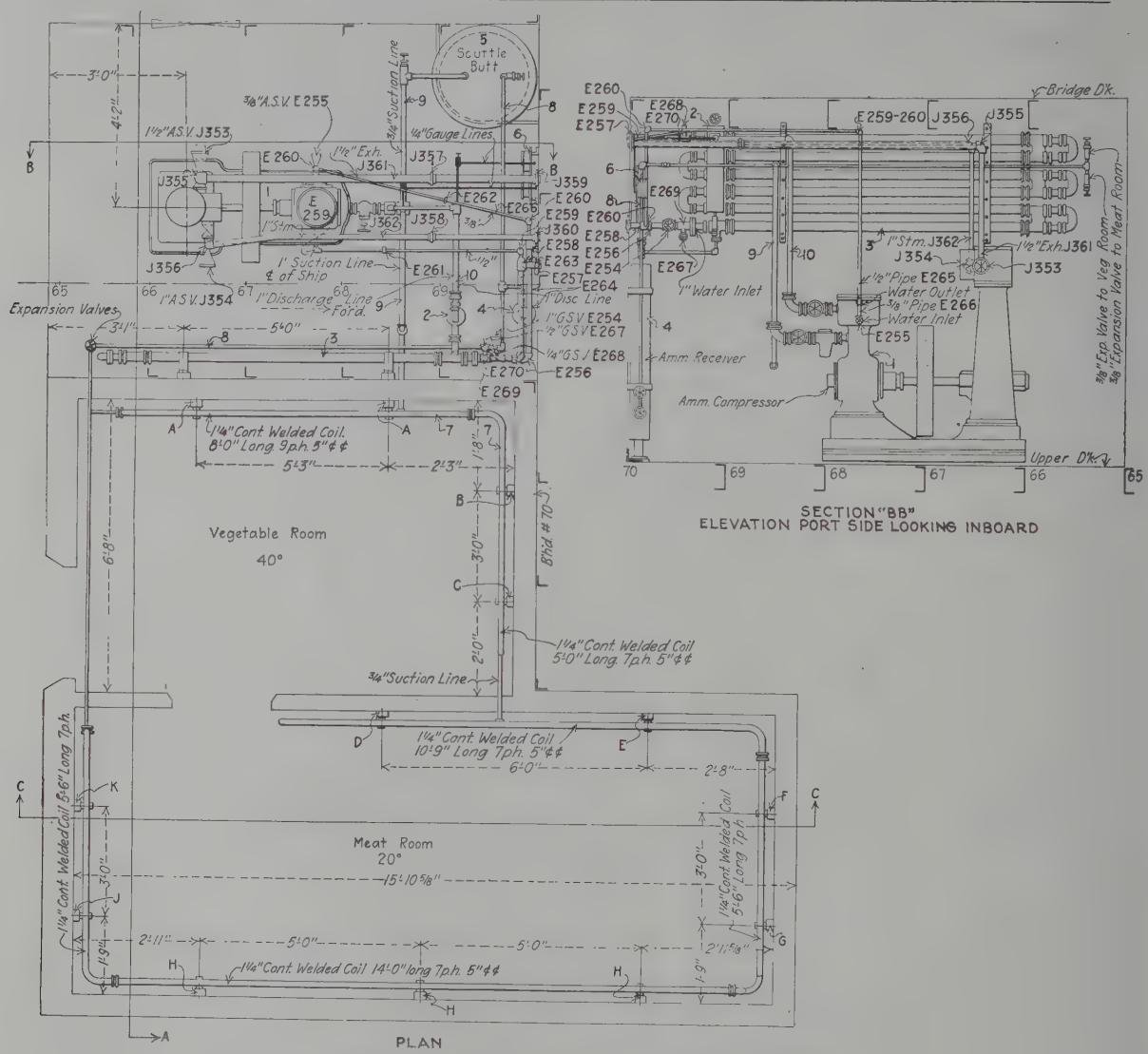
ARRANGEMENT OF REFRIGERATOR ROOM


Beams from Engine Casing to Skin of Ship
Ceiling Insulation Nailed to 2"x4" Lumber
2"x4" Bolted to Beam
Bridge Dk
1" Air Space
7/8" Lumber
2" Cork board
2 Layers Paper
7/8" Lumber
2 Layers Paper
2" Cork board
1" Space between Rail and Insulation
Insulation starts 1" below Beam where Beams are 7" to keep Ceiling in Line
27 Double Hooks
24 Single Hooks
Refrigerator Lined Sides and Ceiling with #26 Galv. Iron with Overlapping Joints Laps to be well nailed with Tinned Flat Head Nails
Galv. Iron over Laps Lead 2"
6 Lb. Lead on Floor turned up 6" on sides Joints to be Soldered W.T.
Floor Grating Y.P. or Spruce
Locknuts
1/2" W.I. Pipe
Rise of Beam 1/2" Per Ft.
Drain Piping
Upper Dk.
SECTION A-A
Frame Spacing
Refrigerator Machinery Room
1 1/4" Welded Coil
Table Lined with Sheet Lead has 2 Slat Shelves underneath
Bell Trap Drain
2" Cork Board
2 Layers of Paper
7/8" Lumber
Engine Hatch
1" Air Space
No Hooks on this Rail Between these Points
1/2" Lags Holding Rails to Ceiling 4 Lags to each Rail
Hook Rails
Flat Bar Hangers 1 on each Rail
W.T. Bhd
PLAN
ST'BD SIDE ONLY
Note:- Twist in Bar occurs under Beam in Upper Part of insulation
2 Holes for 3/4" Rivets to Fasten Hanger to Beam
2 3/8" Hex. Bolt and Nut
DETAIL OF HOOK RAIL HANGERS

9,000-TON D. W. FREIGHTER

See Opposite Page

ARRANGEMENT OF REFRIGERATOR PLANT



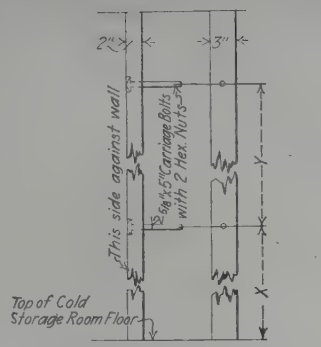
MATERIAL FOR ONE 9,000-TON D. W. FREIGHTER

Pc. No.	No. Pcs.	Name	Mat'l	Remarks
J353	1	1½" Angle stop valve, sc'r'd..	Brass.	Exh. fr. refr. eng.
J354	1	1" Angle stop valve, ex. h'vy, sc'r'd.	Brass.	St. to refr. eng.
J355	1	1½" St'd ell, sc'r'd.....	C.I.	Exh. fr. refr. eng.
J356	1	1" St'd ell, ex. h'vy, sc'r'd..	C.I.	St. to refr. eng.
J357	1	1½" Union	M.I.	Exh. fr. refr. eng.
J358	1	1" Union, ex. hv'y.....	M.I.	St. to refr. eng.
J359	1	1½" Double boss flange.....	C.I.	Exh. fr. refr. eng.
J360	1	1" Double boss flange.....	C.I.	St. to refr. eng.
J361	11 ft.	1½" St'd pipe.....	W.I.	Exh. fr. refr. eng.
J362	11 ft.	1" St.'d pipe, ex. h'vy.....	W.I.	St. to refr. eng.
E254	1	1" Globe stop valve, sc'r'd...	Brass.	Cool. water disch. to amm. cond.
E267	1	¼" Globe stop valve, sc'r'd..	Brass.	Amm. cond. cool. water drain.
E255	1	⅜" Angle stop valve, sc'r'd..	Brass.	Cool. water disch. to amm. comp.
E268	1	¼" Globe stop valve, sc'r'd..	Brass.	Amm. cond. cool. water air valve.
E256	2	1" St'd ell, sc'r'd.....	C.I.	Cool. wat. disch. to & fr. amm. cond.
E257	1	1"x½"x¼" Tee, sc'r'd.....	C.I.	Cool. wat. disch. fr. amm. cond.
E258	1	1"x⅜"x1" Tee, sc'r'd.....	C.I.	Cool. wat. disch. to amm. cond.
E269	1	1"x1"x½" Tee, sc'r'd.....	C.I.	Amm. cond. cool. water drain.
E270	1	1"x1"x¼" Tee, sc'r'd.....	C.I.	Amm. cond. cool. water air disch.
E259	3	½" St'd ell, sc'r'd.....	C.I.	Cool. wat. disch. fr. amm. comp.
E260	3	⅜" St'd ell, sc'r'd.....	C.I.	Cool. wat. disch. to amm. comp.
E261	1	½" Union	M.I.	Cool. wat. disch. fr. amm. comp.
E262	1	⅜" Union	M.I.	Cool. wat. disch. to amm. comp.
E263	1 ft.	1¼" St'd pipe	W.I.	Cool. wat. disch. fr. amm. cond.
E264	6 ft.	1" St'd pipe	W.I.	Cool. wat. disch. to & fr. amm. cond.
E265	11 ft.	½" St'd pipe	W.I.	Cool. wat. disch. fr. amm. comp.
E266	12 ft.	⅜" St'd pipe	W.I.	Cool. wat. disch. to amm. comp.

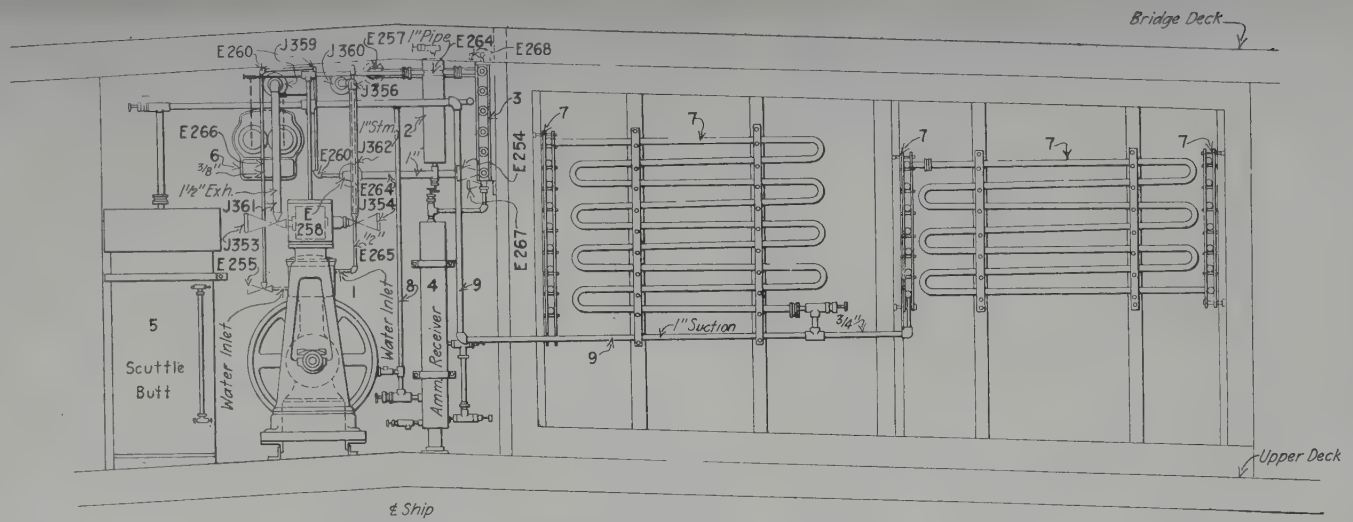
1	1	4"x4"x5"x5" Vert. sing. act. amm. comp.
2	1	5"x24" Oil separator.
3	1	1¼"x2" D. P. amm. cond., 6 P. H., 9 ft. long.
4	1	6" x 4' 0" Vert. amm. receiver.
5	1	18" diam. x 4' 0" Scuttle butt, coil & insulation.
6	1	Gauge board with 5" H. P. and 5" L. P. amm. gauges.
7	6	1¼" Cont. welded evap. coils for cold storage rooms.
8		Liquid connect. from amm. receiver to coils and scuttle butt.
9		Suction connect. from coils and scuttle butt to amm. comp.
10		Discharge connect. from amm. comp. to oil sep. and cond.

9,000-TON D. W. FREIGHTER

See Opposite Page



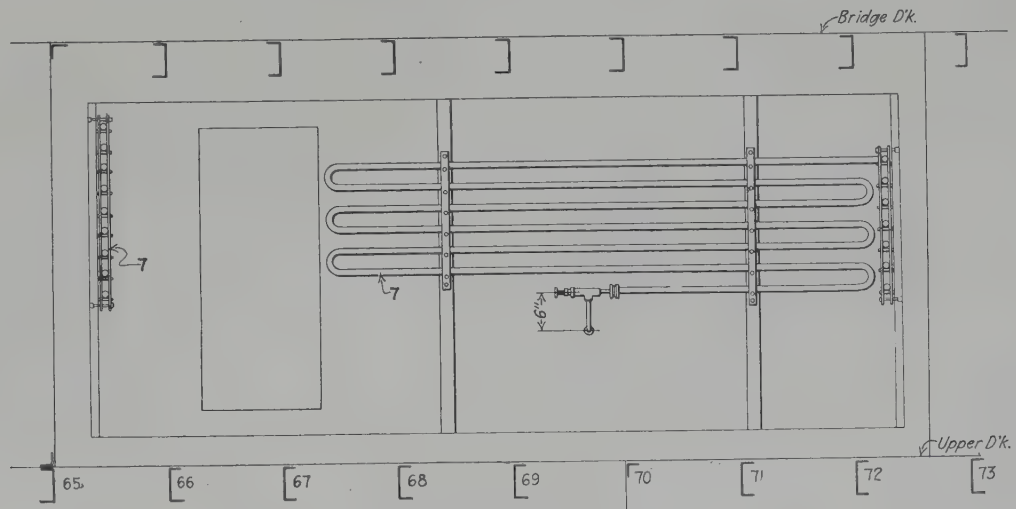
DETAIL OF COIL SUPPORTS



SECTION "AA"
AT FR. #66 LOOKING FOR'D.

COIL SUPPORTS

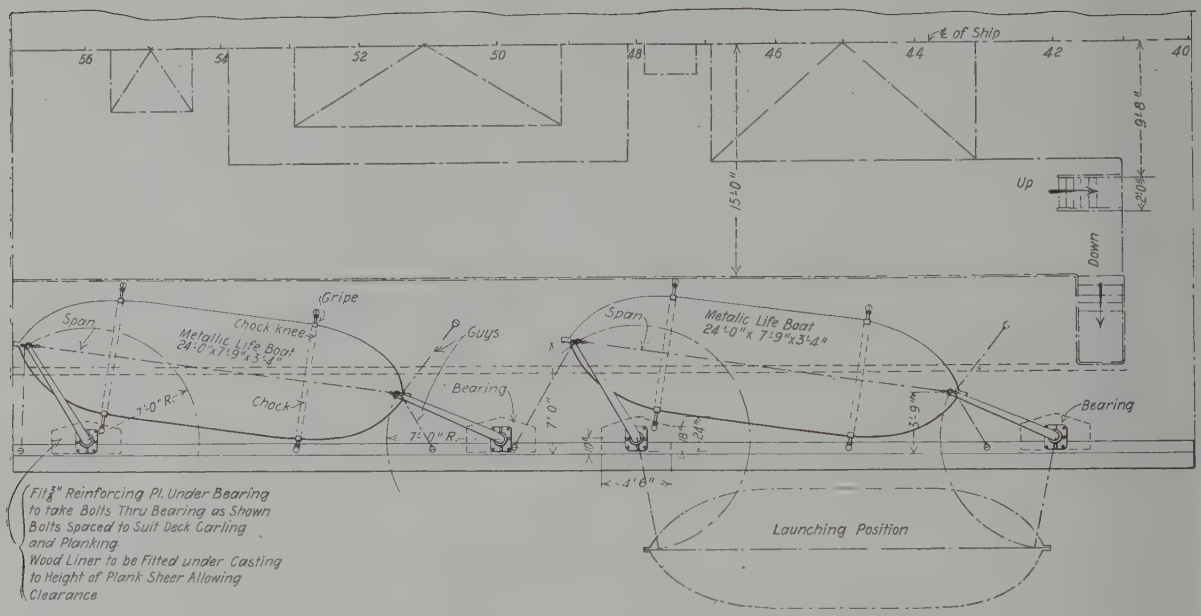
Support	No. Req'd.	Dimension X	Dimension Y
A	2	2'-2½"	3'-9"
B	1	2'-3¼"	3'-9"
C	1	2'-4¾"	3'-9"
D	1	2'-11¾"	2'-6"
E	1	2'-6"	2'-11"
F	1	2'-6⅞"	2'-11"
G	1	2'-8⅜"	2'-11"
H	3	2'-9¼"	2'-11"
J	1	2'-2⅜"	3'-5"
K	1	2'-0⅞"	3'-5"



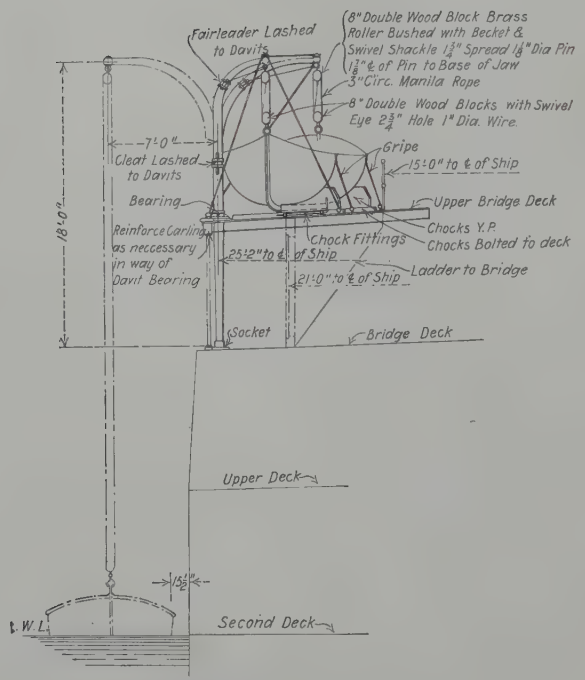
SECTION "CC"
ELEVATION ST'B'D. SIDE LOOKING INBOARD

9,000-TON D. W. FREIGHTER

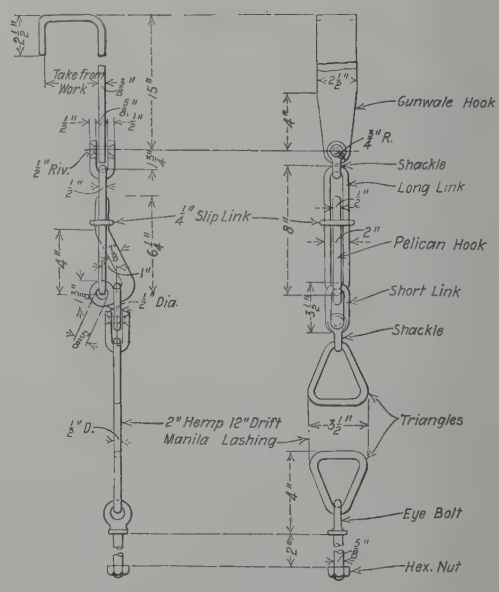
See Opposite Page



PLAN OF BOAT STOWAGE
ON UPPER BRIDGE DECK

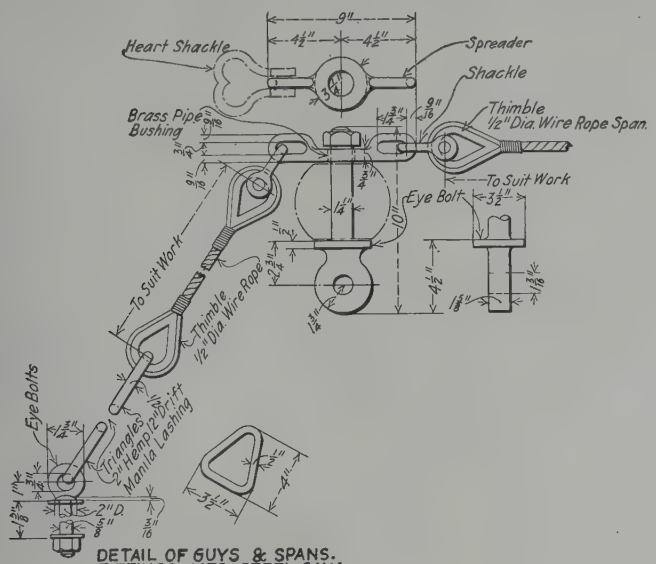

Fairleader Lashed to Davits
8" Double Wood Block Brass Roller Bushed with Becket & Swivel Shackle 1 3/4" Spread 1 1/4" Dia Pin
1 7/8" ℄ of Pin to Base of Jaw
3" Circ. Manila Rope
8" Double Wood Blocks with Swivel Eye 2 3/4" Hole 1" Dia. Wire.
7'-0"
Cleat Lashed to Davits
Gripe
15'-0" to ℄ of Ship
Bearing
Upper Bridge Deck
Chocks Y.P.
Chocks Bolted to deck
Reinforce Carling as neccessary in way of Davit Bearing
Chock Fittings
25'-2" to ℄ of Ship
Ladder to Bridge
21'-0" to ℄ of Ship
18'-0"
Socket
Bridge Deck
Upper Deck
15 1/2"
L.W.L.
Second Deck

ELEVATION OF BOAT STOWAGE
LOOKING AFT. AT FR. 41

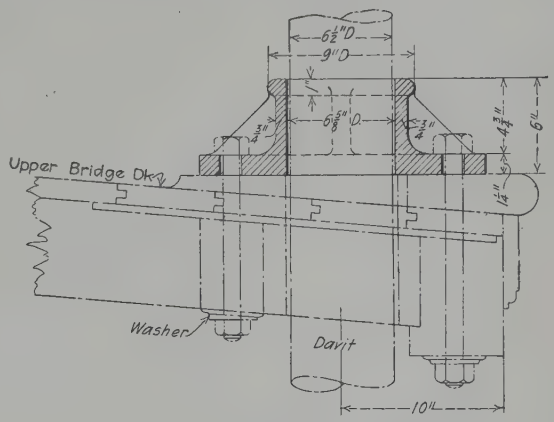


DETAIL OF BOAT GRIPE
MED. STEEL GALV.

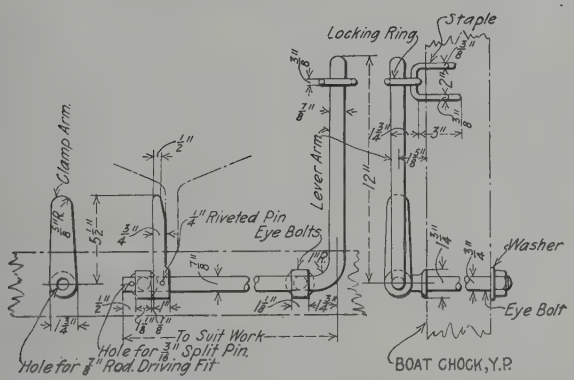
See Opposite Page



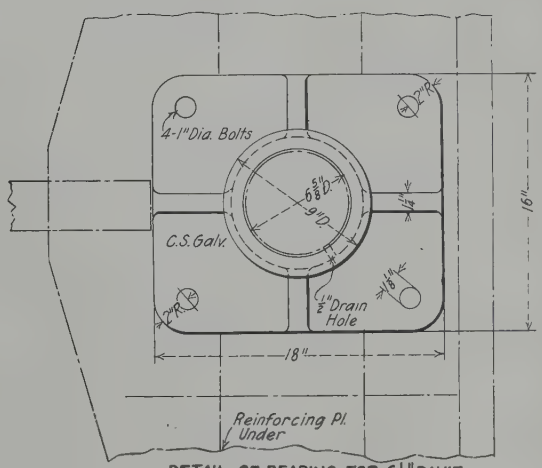
DETAIL OF GUYS & SPANS.
FITTINGS MED. STEEL GALV.
FOR 24'-0" LIFE BOATS



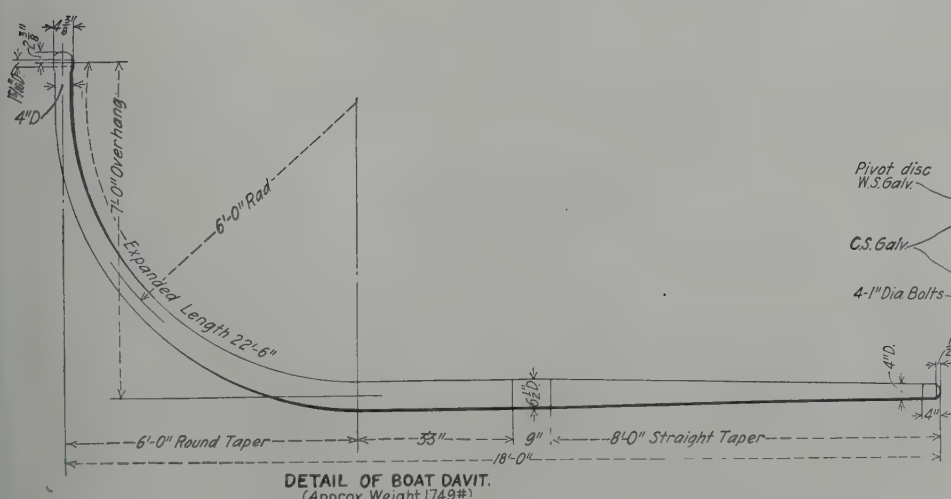
ELEVATION OF BEARING
(Looking Forward)



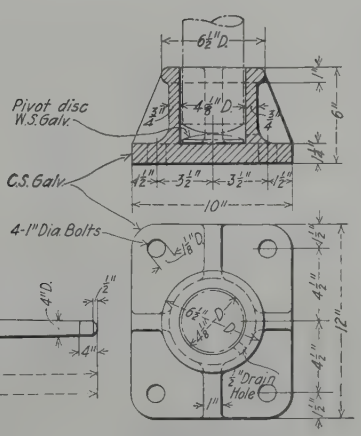
DETAIL OF CHOCK FITTINGS.
MED. STEEL GALV.



DETAIL OF BEARING FOR 6 1/2" DAVIT
(At Upper Bridge Deck)



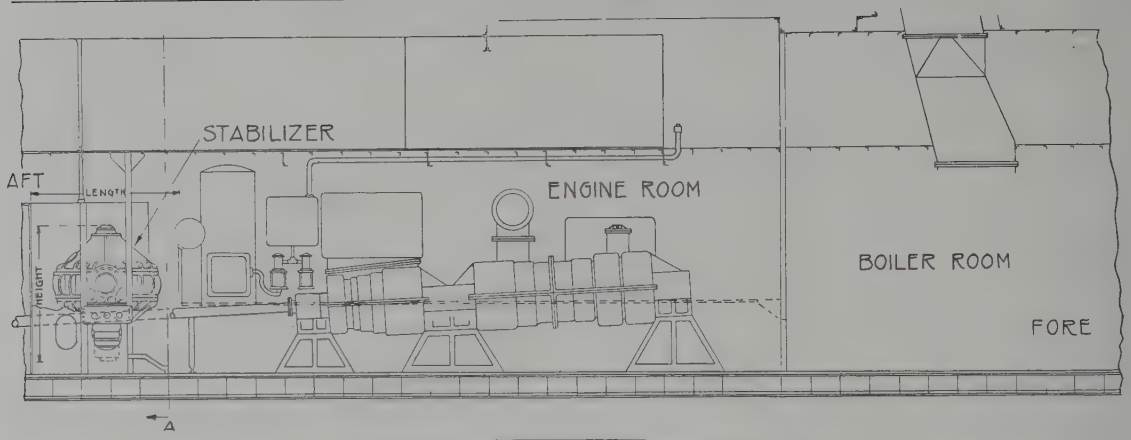
DETAIL OF BOAT DAVIT.
(Approx. Weight 1749#)

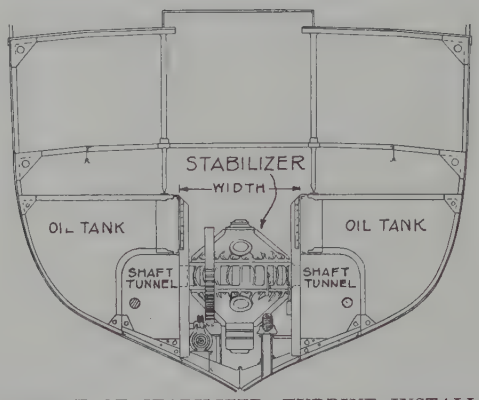


DETAIL OF SOCKET
(On Bridge Dk.)

See Opposite Page

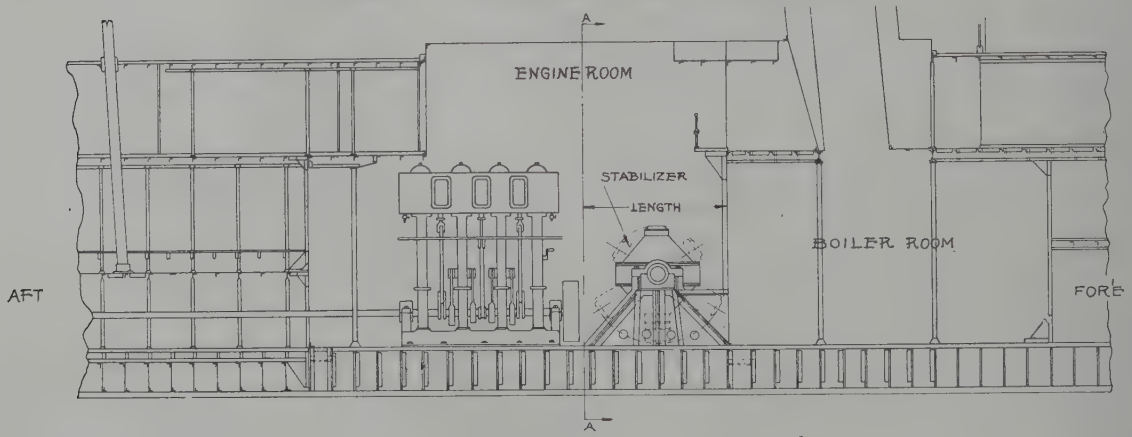
ARRANGEMENT OF GYRO-STABILIZER

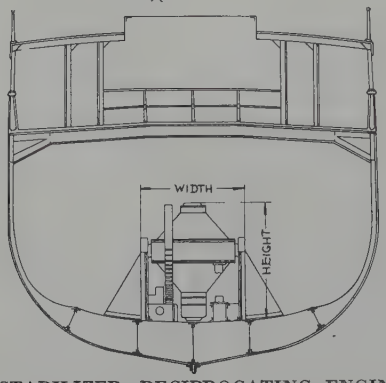




VIEW LOOKING AFT FROM "A-A"

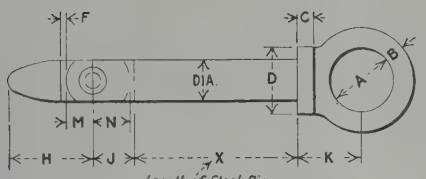
ARRANGEMENT OF STABILIZER, TURBINE INSTALLATION

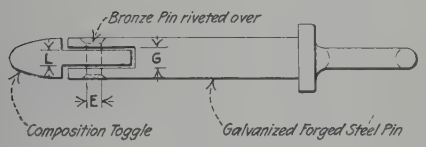




VIEW LOOKING FORWARD FROM "A-A"

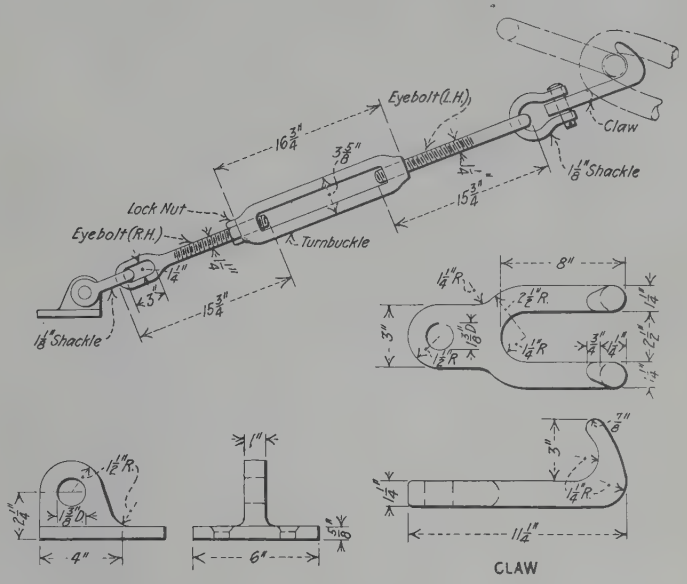
ARRANGEMENT OF STABILIZER, RECIPROCATING ENGINE INSTALLATION

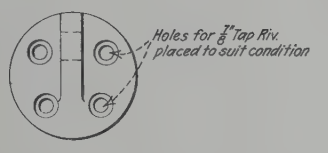




TOGGLE PIN

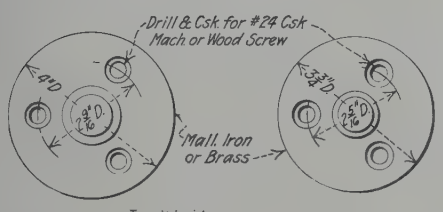
DIA.	A	B	C	D	E	F	G	H	J	K	L	M	N	X
1"	3/4	1/4	3/16	13/16	3/16	1/16	7/32	1	1/2	3/4	3/16	5/16	7/16	3
7/8"	3/4	1/4	3/16	1	3/16	1/16	9/32	1/4	5/8	3/4	1/4	3/8	9/16	3
3/4"	3/4	1/4	3/16	1 3/16	3/16	1/16	9/32	1 1/2	11/16	3/4	1/4	7/16	9/16	3
7/8"	3/4	1/4	1/4	1 3/8	3/4	1/16	9/32	1 3/4	13/16	13/16	1/4	1/2	3/4	3

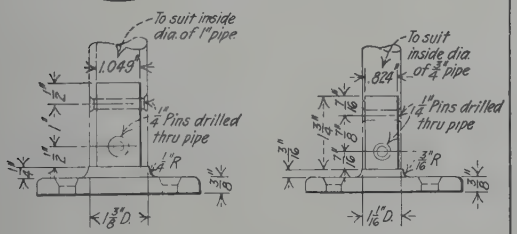


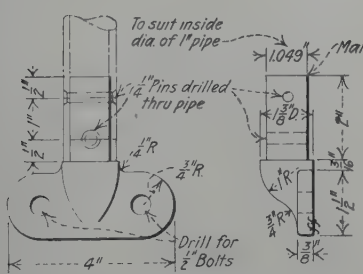


PAD

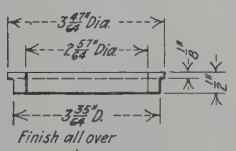
DEVILS CLAW



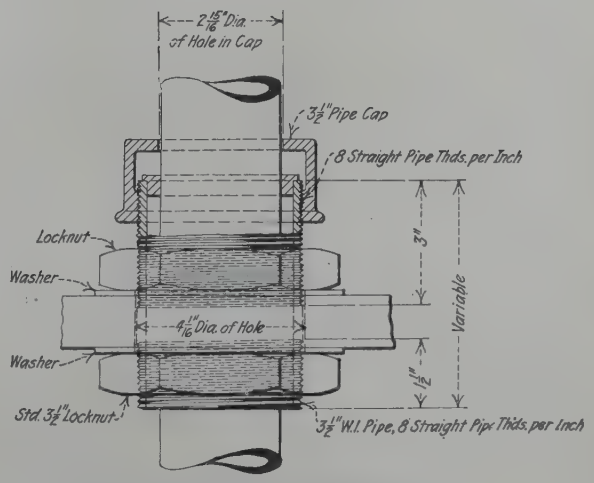




PIPE END SOCKETS



DETAIL OF GLAND



STANDARD 2 1/2" DECK STUFFING BOX

Shipbuilding Cyclopedia Service

Fund of Data Available

The Editorial Staff of the Shipbuilding Cyclopedia is made up of men with many years experience in Merchant Ship design and construction. The composite experience of the staff covers every phase of shipbuilding. It couples specialists in design and in shipyard operation with the practical shipbuilder and marine engineer.

Through the co-operation of many manufacturers of ship and shipyard equipment, a most complete Catalog File has been built up. It covers practically every conceivable product required in the building or operating of vessels. The Catalogs are thoroughly indexed and cross-indexed making any desired information immediately available. Such details as the names of all leading manufacturers of any specific equipment or material, the locations of their branch offices, etc., is also available.

These facilities are at the service of shipbuilders and ship operators, without cost.

Woolworth Building, New York
Main Office of the Shipbuilding Cyclopedia

To the Ship Designer

The Catalog Section presents, almost invariably, details regarding any desired equipment or material. If sufficient data regarding any product cannot be found there, an inquiry to the Shipbuilding Cyclopedia will bring prompt response. Shipbuilding Cyclopedia Service is prepared, at all times, to aid in the selection of the equipment best adapted for any particular work and to recommend reliable manufacturers who can supply that equipment. Naval Architects, Marine Engineers and Designers are invited to avail themselves fully of this service.

To the Shipbuilder

Upon the shipyard executive, perhaps more than any other individual, depends the future of the Shipbuilding Industry in the United States. To keep step always with progress in methods and machinery—to maintain and operate the yards upon the most efficient basis—is essential for prosperity in the years to come.

Shipbuilding Cyclopedia Service is prepared to co-operate fully with shipbuilders in the selection of equipment. In the Catalog Section are given the essential facts regarding the machinery, tools and materials of many leading manufacturers. Should any desired data not appear, however, an inquiry to the Shipbuilding Cyclopedia will receive immediate attention.

To the Ship Operator

In the maintenance and replacement of ship machinery the Catalog Section will prove invaluable. Frequently Shipbuilding Cyclopedia Service has been called on to supply the name and address of the manufacturer of some piece of equipment on which repair parts were required—to advise the best sources from which certain types of equipment or materials can be secured.

The Catalog Section now makes unnecessary a large part of these inquiries. But should any detailed information desired not be found, a request addressed to the Shipbuilding Cyclopedia will bring prompt response.

Our lists of yards equipped to handle repair and alteration work are most complete. We are therefore in a position to aid the ship operator in locating such yards, should this information be required.

To the Manufacturer

The practical experience of the Shipbuilding Cyclopedia Staff—their intimate knowledge of the equipment, materials and supplies used both on ships and in shipyards—is at the service of manufacturers. Coupled with this are large resources in data enabling the staff to view the entire field in its broadest aspect.

Analyses of the possible market in these industries for any product are readily compiled. Advice as to the adaptability and use of any specific product—concrete suggestions as to the best methods of selling to the field—these suggest the type of service which the Shipbuilding Cyclopedia is prepared to render.

Manufacturers are invited to make full use of these resources.

The House of Transportation

For many years the Simmons-Boardman Publishing Company has been giving just such service to the Railway Industry. Five technical magazines and several books similar to the Shipbuilding Cyclopedia are published for this field.

With the addition of the Shipbuilding Cyclopedia Simmons-Boardman becomes still more truly "The House of Transportation."

LIST OF OFFICES

Chicago—Transportation Building
Cincinnati—First National Bank Building
Cleveland—Citizens Building
Washington—Home Life Building
London, England—34, Victoria St., Westminster, S. W. I.

SIMMONS-BOARDMAN PUBLISHING COMPANY

WOOLWORTH BUILDING, NEW YORK

THE CATALOG SECTION

One of the greatest needs of the Shipbuilding Industry has been a Composite Catalog, giving reliable and detailed information about the various materials, machinery and equipment required by the shipyard and for the ship. The Composite Catalog Section of the SHIPBUILDING CYCLOPEDIA fills this want for the first time, with over 400 pages covering the products of representative manufacturers.

Every effort has been made to induce manufacturers to present those details which are necessary for selecting proper equipment and for planning its installation. By binding in a single volume the essential engineering facts regarding specific types of ship and shipyard equipment, the SHIPBUILDING CYCLOPEDIA becomes invaluable as a ready-reference book. It eliminates, to a large extent, the necessity in the shipyard and office for the elaborate and systematic collection of data—for searching through large files of catalogs, blueprints, etc. —for correspondence regarding many details which must be ascertained regarding desired equipment.

Moreover, the Composite Catalog Section is greatly enhanced in value by its co-ordination with the practical data in the preceding sections. Page references, given after the definition of each product, to practical planning data on ships and yards and to the Catalog Section, provide a quick means of securing complete information on the details and installation of the desired equipment. Three additional indices—the Directory of Products, the Trade Name Index and the Alphabetical Index of Manufacturers—follow the Catalog Section and make the fund of information which it contains easily accessible. For still further convenience, similar products are, as far as possible, grouped together throughout.

With full confidence in its practical value, this Composite Catalog Section is presented to the Shipbuilding Industry.

Drawing Room Equipment and Supplies

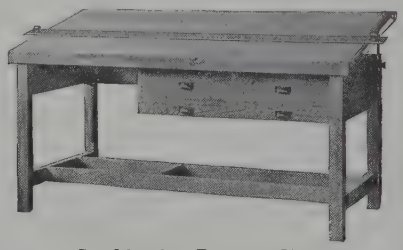
Complete Drawing Room Equipment

The Electro-Sun Company is prepared to furnish all the equipment required to completely outfit an up-to-date drawing room. The materials which this company furnishes are all of the most improved design and highest quality and include all the special instruments desirable for ship construction drafting work. A large range of types and sizes of equipment permits exact meeting of any requirement, and large stocks, particularly of drawing instruments and supplies, assure prompt service and quick deliveries. Complete catalog of drawing materials, and drawing room equipment and supplies furnished on request.

Sectional Filing Cabinet

Filing Cases

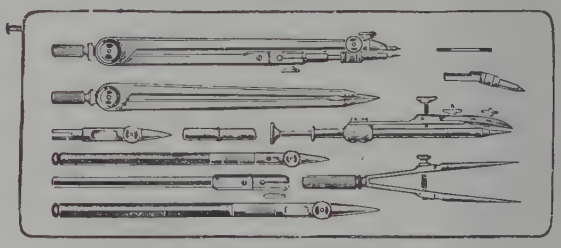
Filing Cases of all types and sizes can be furnished, arranged for convenient filing and ready reference to drawings, blue prints, tracings, maps, photographs, specifications, etc. These filing cases are built of first class materials and are of high grade workmanship, and occupy a minimum space. The type shown above is made up of interchangeable sections conveniently permitting expansion as more cabinet space is required. These cabinets can also be furnished of special arrangement, construction, trimmings or fittings to order.



Combination Drawing Table

Drawing Tables

Drawing Tables of all types and sizes are furnished with the most improved and modern adjustments for comfort, convenience and efficiency. The drawing table illustrated above is particularly adapted for ship drafting due to its sturdy construction, large adjustable drawing board and spacious drawers. This table can be furnished with or without the parallel straight-edge. Iron Stand Drawing Tables, Folding Drawing Tables, Adjustable Drawing Tables, Revolving Top Drawing Tables, Attachable and Separate Drawing Boards, and various combinations can also be furnished in many sizes and to suit all purposes. Horses for Drawing Boards, Draftsman's Stools, and other drawing table equipment and accessories can also be supplied.

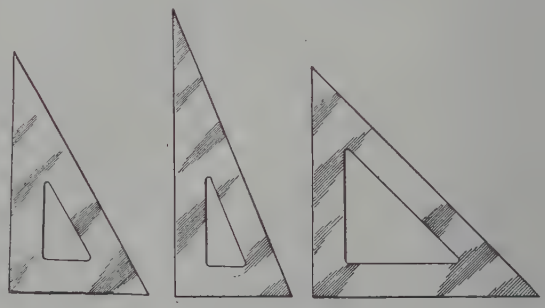


Drawing Instruments

Drawing Instruments and Drafting Tools

The Drawing Instruments furnished by the Electro-Sun Company comprise a most complete variety of all types that may be of assistance in standard work and also for special work connected with ship design. All of these instruments are of guaranteed quality and accuracy and are the best that can be obtained.

Drawing Instrument Sets as shown above are furnished in all standard and special combinations. They are of the finest German Silver and English Steel. These instruments are also supplied singly as desired.

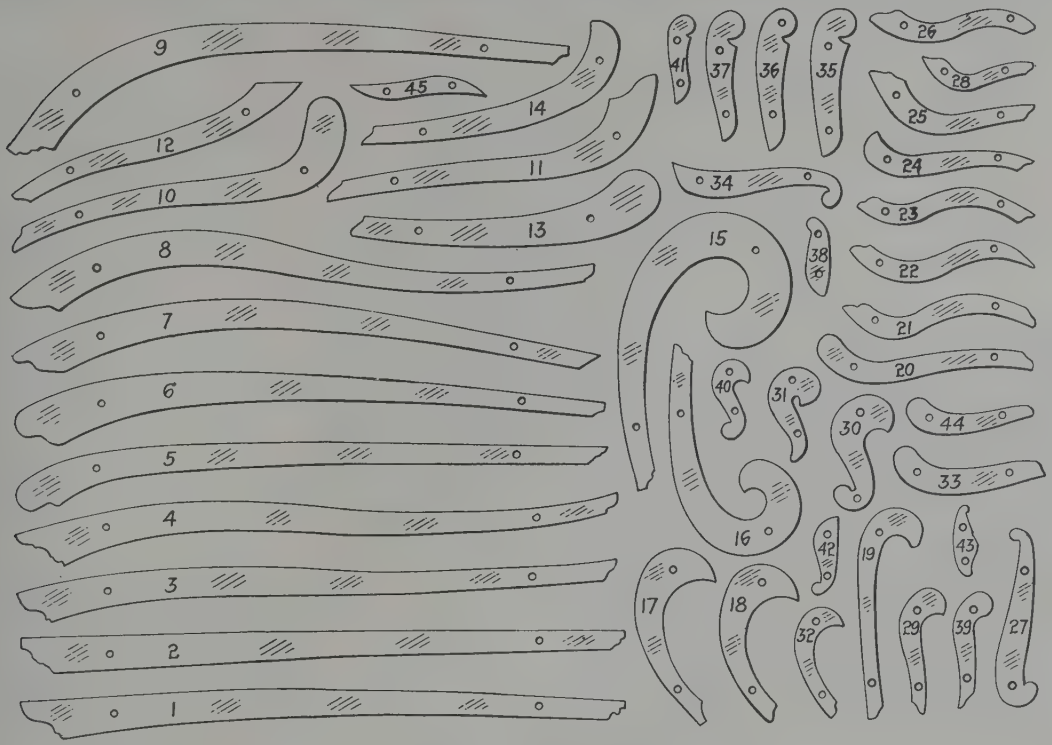


Transparent Celluloid Triangles

A number of the more important drafting tools and supplies which can be furnished are listed below:

Compasses, Beam	Pantographs
Curves, Copenhagen Ship	Protractors
Curves, French	Scales, Architects'
Dividers, Proportional	Scales, Boxwood
Edges, Straight	Scales, Engineers'
Erasers	Slide Rules
Erasing Shields	Splines
Pencils, Drawing	Spline Weights
Pens, Lettering	T Squares
Pens, Shading	T Squares, Automatic
Parallel Rules	Thumbtacks
Planimeters	Triangles

Drawing Room Equipment and Supplies

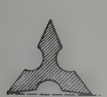


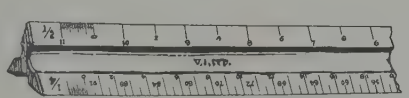
Copenhagen Ship Curves

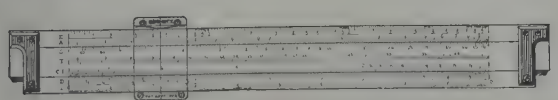
Drawing Supplies

A large stock of all drawing supplies are kept in stock, thus permitting orders to be filled and shipped promptly. Small orders receive the same prompt and careful attention given to large orders. Drawing Paper, Tracing Cloth, Cross-Section Paper, etc., of all types and grades can be furnished in rolls or sheets.

The products listed below are among the large stock of drawing supplies ready for immediate delivery:



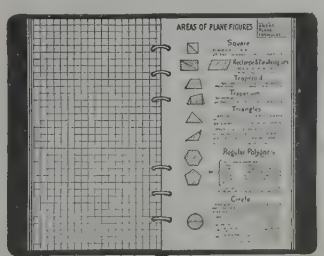




Board, Bristol
Cloth, Black Print
Cloth, Blue Print
Cloth, Brown Print
Cloth, Cross-Section
Cloth, Tracing
Covers, Loose-Leaf
Data Sheets, Marine
Data Sheets, Mechanical
Ink, Waterproof Drawing
Paper, Black Print
Paper, Blue Print
Paper, Brown Print
Paper, Cloth - Backed Drawing
Paper, Cross-Section
Paper, Detail
Paper, Drawing
Paper, Eggshell
Paper, Isometric
Paper, Metric
Paper, Strathmore
Vellum, Tracing Paper

Lefax

Every technical man has frequent need for data of his own selection, which can only be obtained by making his own reference book. Lefax supplies the "makings" for such a book in the form of loose-leaf data sheets, blank forms and pocket binders.



About 2,000 data sheets (4,000 pages) are now available. They are accurate, condensed, self-indexed and cover practically the entire technical and business field. Over 100 different blank forms are also available, for special data sheets.

Write for specimen sheets and complete information.

Prints and Photographic Reproductions

The Electro-Sun Company, through its well equipped Blue Printing and Photographic Departments, is in a position to fill orders of any size for copies of drawings, blue prints, letters, specifications, etc.

For copying drawings on transparent paper or cloth, reproductions are made by the Blue Print, Blank Print, or Sepia Print Process, as specified.

Reproductions of blue prints, specifications or drawings on non-transparent material are made by the photo-process to any specified size.

ELECTRO-SUN COMPANY, INC.

161 WASHINGTON STREET, NEW YORK, N. Y.

The Photostat

The Photostat

The Photostat is a Photographic Copying Machine with all the necessary equipment for making facsimile copies. It makes photographic reproductions, quickly and at small cost, to any specified size—the same size as the original, enlarged, or reduced. The name Photostat is registered in the U. S. Patent Office.

Shipyard Uses

The Photostat is used to copy pencil or ink drawings, sketches, tracings, blue-prints, photographs, reports, data sheets records, letters, graphs, specifications, charts, etc.

Since the Photostat can make greatly reduced reproductions, without the loss of legibility, it is particularly adapted to the copying of drawings, blue-prints, etc., as the reduced copy, being perfectly legible, becomes as good a record as the original and is more easily handled and filed.

Sizes

The Photostat is made in three models, all of which are equipped with either a book holder or engineering copy board of the sizes given in the table below. All of these models can be adjusted to copy subjects of larger sizes if desired.

Model	Largest Size of Copy	Size of Book Holder	Size of Engineering Copy Board	Floor Space
1	11½"x14"	21"x26"	23"x36"	4'x8'
2	14" x18"	21"x26"	31"x40"	5'x10'
3	18" x22"	21"x26"	39"x48"	6'x12'

Operation

The original subject is photographed directly upon a specially manufactured sensitized paper, producing a fac-simile copy which is immediately cut off, developed and fixed right in the Photostat itself.

The focusing, exposing, and developing are all controlled by simple mechanical devices, and no glass plate, film or other intermediate negative has to be made.

After fixing, the copy is removed to a tank of running water and rapidly washed free from chemicals. It is then dried and ready for use. As many copies as desired can be run off in this manner.

By a simple adjustment of the mechanical focusing device, the copy may be made at actual size, reduced or enlarged, within the size limitations of the machines.

Advantages

From the point of view of accuracy, speed, economy, convenience or quality of work done, the Photostat offers many advantages as a portion of the equipment of a modern shipyard drafting room.

Accuracy:—Its accuracy is unquestionable as it gives a fac-simile copy. Any possibility of drafting or typographical errors or omissions is entirely eliminated.

Legibility:—The lens of the Photostat is of so high a quality and may be focused so exactly that all details of the copy are as clear as the original itself. This feature is of particular importance in the reduction of drawings from an unhandy size without sacrificing clearness of detail.

Speed:—It is possible to make copies at the rate of one per minute and users have cited many instances where as many as 500 to 800 or more copies a day have been made.

Economy:—Laborious and expensive copying and checking are eliminated, and unskilled labor is enabled to reproduce work of any kind quickly, easily, and at low cost. Analyses by its users show that the cost of reproducing drawings, etc., may be reduced from that of a skilled draftsman, working several hours to several days to that of a boy working a few minutes. In one instance, in the copying of documents, etc., work previously requiring over 200 hours to perform was done by the use of the Photostat in 15 hours at a saving of over $50 a day in salaries alone.

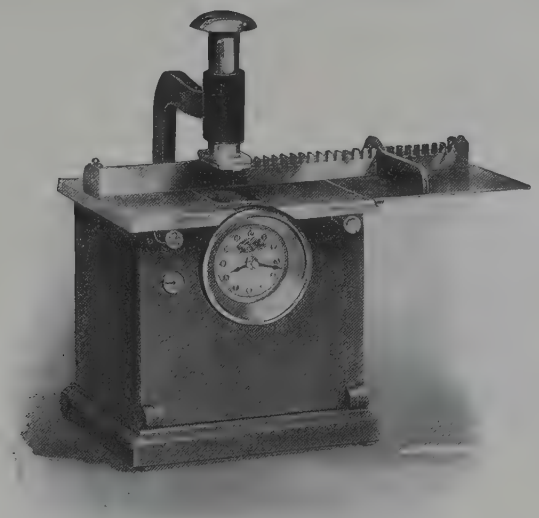
Convenience:—The Photostat is very simple in construction and very easy to operate. A boy or girl with the ability to work in an office can learn in two or three hours to operate a Photostat.

Quality of Work:—Photostat copies do not fade; they do not smut; also they are water-proof and they are erasure proof.

COMMERCIAL CAMERA CO., ROCHESTER, N. Y.

CHICAGO, NEW YORK, PHILADELPHIA, SAN FRANCISCO, WASHINGTON

Time Stamping Clocks



Follett Time Stamping Clock

Follett Time Recording Clock

The device shown is a Time Stamping clock which records every minute of the day and night automatically. It is made by the Follett Time Recording Company of 9a West Broadway, New York City.

Features and Principles of Operation

The outstanding feature of this device is the simplicity of its construction, thereby lending itself to suit almost any condition where time keeping is the important factor. It is wound and set like any ordinary watch or clock and prints the date and time in a straight line, in plain figures, tripping the date automatically at midnight.

The basic principle of operation is by means of an escapement fork which passes through an eccentric attached to the clock movement, the latter being separate from the printing mechanism which gives the time and date each time an impression is taken. The importance of this feature, that of having the clock movement separate from the printing mechanism, can be easily appreciated when it is stated that in taking impressions there is no limit to the quantity, and no amount of pounding can affect the time keeping qualities of the clock movement.

Printing Mechanism

This printing mechanism has its own motive power and is driven by the clock movement. The oscillations of the clock movement carry the eccentric horizontally from right to left and return, and upon the completion of its full turn, the fork trips the minute wheel, and thus records the time and day. Concurrently with the minute wheel, upon the completion of 60 minutes, the hour and meridian wheels trip correspondingly.

Advantages of Time Stamping Clocks

With a machine of this kind an exact result of every minute of an operation on any particular piece of work can be had at all times. From the moment the boiler is placed in the hold up to the time it is fired for steam this recording device will give the exact number of hours and minutes consumed in the entire operation. Likewise in getting rafters together, or in the assembling or putting together of hulls, decks, masts, etc., every moment can be accounted for.

Adaptability

Special work tickets and special material cards which are used by various concerns can all be used with this machine by means of proper gauges to fit the particular cards and so get all imprints uniformly. Arrangements can be made so as to eliminate all waste in so far as space and printing on the card is concerned and the resumé or compilation of the entire time so adjusted as to make computation a very speedy and accurate operation. In other words, at a glance, almost, you can tell exactly just how long one man, or fifty men, took to do a particular job.

Guarantee

By means of special wheels, special conditions are well taken care of. In cases where the decimal system is employed wheels can be made up in 10ths or 50ths of the hour all actuated in the same manner. And for night work, the 24 hour wheel running from 0 to 23, or as may be selected by the user, can also be made specially.

The entire machine is built in a solid grey iron case, and the best materials obtainable are used in its construction. A liberal guarantee is given with each and every one sold and correspondence is solicited by the sole manufacturers.

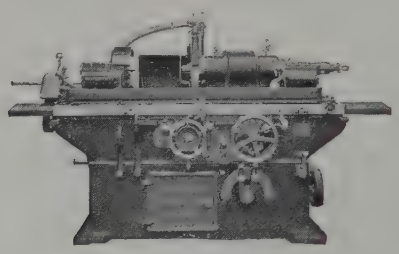
FOLLETT TIME RECORDING CO.

9A WEST BROADWAY, NEW YORK, N. Y.

"Modern" Plain Grinders

Designed for rapid manipulation, extreme accuracy, and severe duty.

Base is massive with heavy cross sections, giving exceptional rigidity. Heavy cuts may be taken without chatter.



The headstock is driven through Internal Helical Gear, insuring absolute smooth movement to the work. Work centers are over and between the guides of the table, eliminating the strains found where work centers are outside and overhanging their bearings.

All controls are placed on the front of machine to give maximum convenience.

Machines are fitted throughout with the most suitable types of anti-friction bearings. All revolving shafts, pulleys and gears completely guarded.

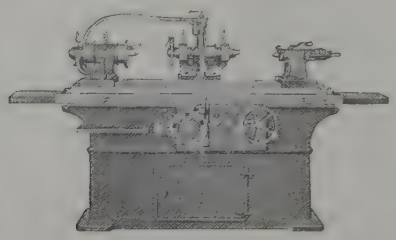
Other features include; non self-centering reversing mechanism; variable tarry device; steady rests of universal movement; positive stops for duplicating work; gears engaged with shaft by our patented ball drive clutch.

"Modern" Plain Grinders are made in eight sizes as follows:

8″ x 18″	12″ x 60″
8″ x 30″	16″ x 36″
12″ x 36″	16″ x 48″
12″ x 48″	16″ x 60″

"Modern" Universal Grinders

Weight, rigidity, stability, wide range, great adaptability and extreme accuracy are characteristics of this Modern Grinder.

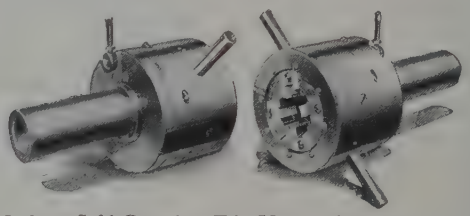


"Modern" Universal Grinders have many distinctive features, the most important of which are as follows:
—Angle sides instead of "T" slots to insure accurate alignment on Head and Foot Stock.
—Wheel spindle, exceptionally large.
—Headstock bearings, adjustable for wear.
—Counter-shaft, self-aligning and fitted with anti-friction bearings.

"Modern" Self-Opening Die Heads

Modern Self-Opening Die Heads (Adjustable) are for use on turret of any hand or automatic screw machine, and when fitted with closing device, on vertical and horizontal live spindle machines.

The success of Modern Self-Opening Die Heads is due primarily to correct mechanical design. They are as rigid as solid heads, quickly cleaned without dismounting or taking entirely apart. Also they do not clog as easily as other types.



Modern Self-Opening Die Heads eliminate the complex and troublesome adjustments and replacements of other types—practically nothing to wear out.

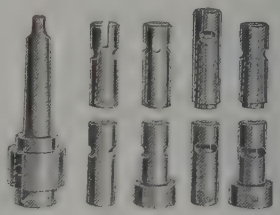
Chasers cannot change position during work. Chasers will not "rock", "cock", or "bell at the mouth." Modern construction insures clean, full size, accurate threads, true to lead.

The quick reversal saves the usual "back off" time and turns it to production.

Made in 17 sizes, each having a wide range of diameters which may be cut. It is not necessary to have a separate head for each different job.

"Modern" Magic Chuck and Collet Equipment

The "Modern" Magic Chuck and Collet Equipment converts a single, live spindle machine into a multiple with as many holes as you have tools to use. Especially valuable for successive operations without removing or resetting work.



It is used on drill presses or other revolving spindles, lathes, screw machines, etc. Made in both positive and friction drives; 5 sizes taking Morse Taper Shanks No. 0 to No. 6 inclusive.

Drills, reamers, boring bars, counter bores, and mills, taps, etc. changed almost instantly without stopping or slowing machine.

It is a real time saver and production speeder.

A special collet for reclaiming drills with broken tangs will, through the saving effected, soon return the entire initial cost.

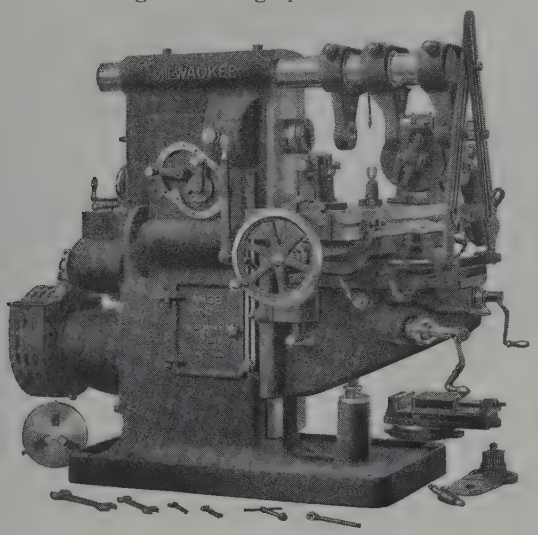
"Modern" Collapsible Taps

"Modern" Collapsible Taps are rigid and efficient. They possess all the merits of the solid taps plus the convenience and time-saving of the collapsible. The sizes for tapping are 3/4″ to 3″. Larger sizes can be made to order. For further information send for bulletin.

Milwaukee Milling Machines

Milwaukee Horizontal Milling Machines

Milwaukee Milling Machines embody many features of merit that recommend them to discriminating purchasers. They are designed and constructed to efficiently handle unusual jobs as well as the regular milling operations.



The column is a box section, semi-steel casting, having few and small openings, and is reinforced with heavy vertical and horizontal internal walls. The dovetail knee slide extends upward to the overarms, forming ample bearing surface for securely attaching the various attachments.

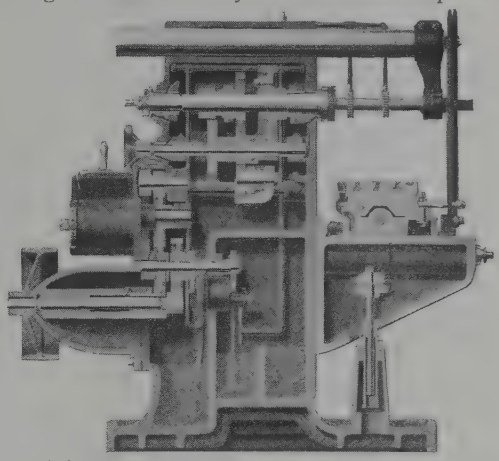
The knee is a semi-steel box section casting with solid top and extended slide, designed to secure maximum rigidity. There are no holes in the saddle slide to close under pressure and impair alignment.

The table is also a semi-steel casting and is finished both top and bottom, eliminating the possibility of distortion due to the leaving of scale on one side. The T-slots in the table are of ample depth to prevent the breaking out of metal around the holding down bolts. The bearing of the table on the saddle is at the top of the saddle. Larger bearing surfaces are thus secured.

The patented double overarm consists of two steel bars parallel with the spindle. This construction, together with the triangular arbor supports, maintains positive alignment of the arbor and prevents it from being pounded out of line when large coarse pitch cutters are used at a distance from the face of the column.

The flanged spindle of Milwaukee Milling Machines has a large diameter flange forged on the end. This flange carries well proportioned keys for driving large face milling cutters and the arbor drive collar. The arbor drive collar has recessed notches to receive the dogs on the arbor, thus removing the strain of the cut from the taper hole in the spindle which retains its original accuracy, and it also protects the face of the spindle from injury. The reverse for the spindle is self-contained in the machine; no overhead apparatus is necessary.

All bearings and gears in the main frame and feed box are flooded with lubricant by the Automatic Flooded Lubrication System which all Milwaukee Milling Machines embody. This reduces supervision

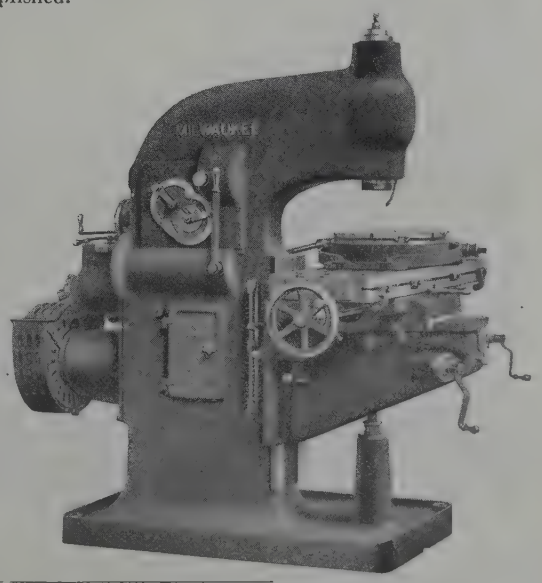


to a minimum, as there is no danger of bearings being cut, shafts sticking tight or gears wearing away.

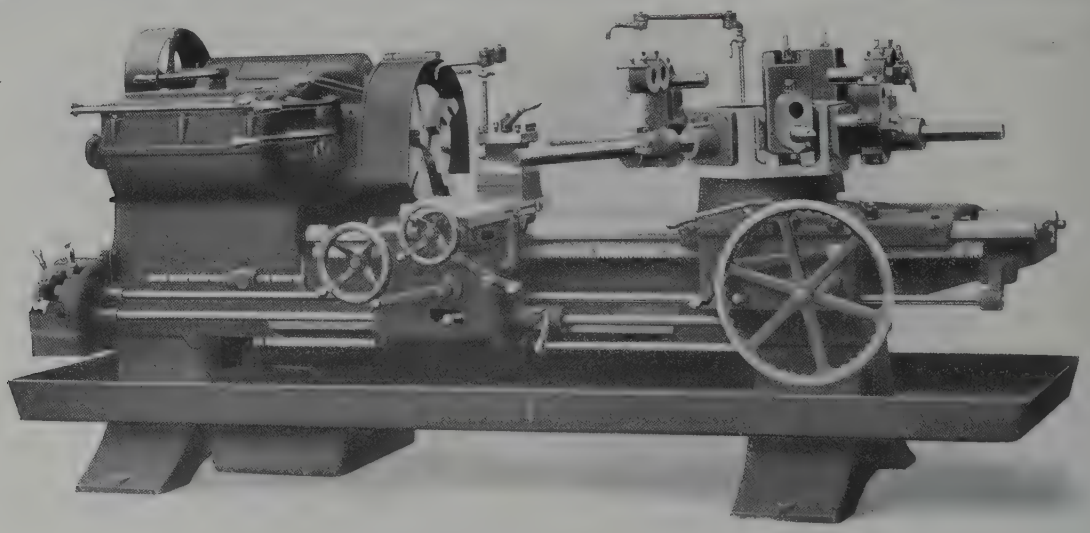
Every Milwaukee Milling Machine is equipped with pump and means for lubricating the cutters automatically.

Milwaukee Vertical Milling Machines

Milwaukee Vertical Milling Machines embody the same excellent features as the horizontal type. The vertical spindle is adjustable only for wear and this construction is decidedly rigid and can be relied upon to maintain correct alignment through years of service. Adjustment sufficient for all purposes is secured by making the knee only adjustable. The vertical type Milwaukee Milling Machines were designed primarily for the regular line of work which is best adapted to machines of this type on account of ease of chucking, but there are many parts that can be milled in connection with the rotary table by the continuous milling process whereby the cutters are always in the cut and remarkable results accomplished.



Warner and Swasey Turret Lathes



No. 3A Universal Hollow Hexagon Turret Lathe
3½" x 44" or 4½" x 44" Bar Capacity—16" Chucking Capacity

W & S Turret Lathes and Screw Machines

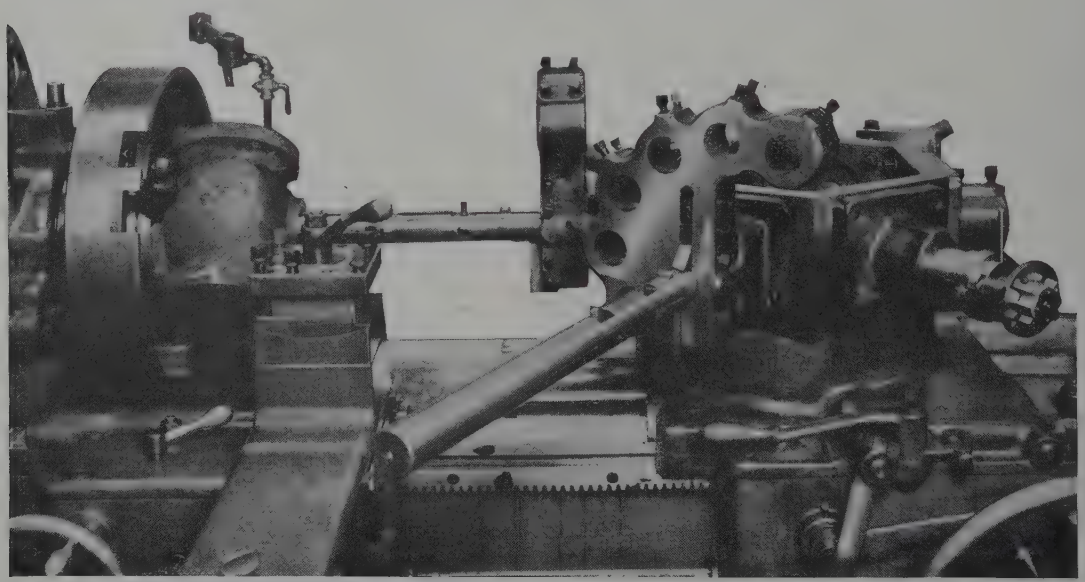
Warner & Swasey Turret Lathes and Screw Machines for rapid and accurate production of bolts, studs, pins, valve parts, rivet sets, gear blanks and similar pieces used in construction and repair in shipbuilding. The illustrations on this, and the following two pages, show some shipbuilding parts in process of being finished on W & S Turret Lathes. The majority of shipbuilding plants are just beginning to realize the importance of the turret lathe in the repair and construction of ships.

The strength, power and ease of operation of W & S turret lathes create a wide variety of demands upon them. Speed in operation is noticeable even where small lots, as few as six, are made at one time.

Built with Bar Capacities from
⅝ in. x 4 in. to 4¼ in. x 44 in.
Maximum Swing 20½ in.
Maximum Chuck Capacity 16½ in.

Universal Hollow Hexagon Turret Lathes

Universal Hollow Hexagon Turret Lathes are a highly developed type of turret lathe. They have more than enough power to take the deepest cuts and highest speeds the best high speed steel cutters will stand. Their great power aids in the resulting maximum production.

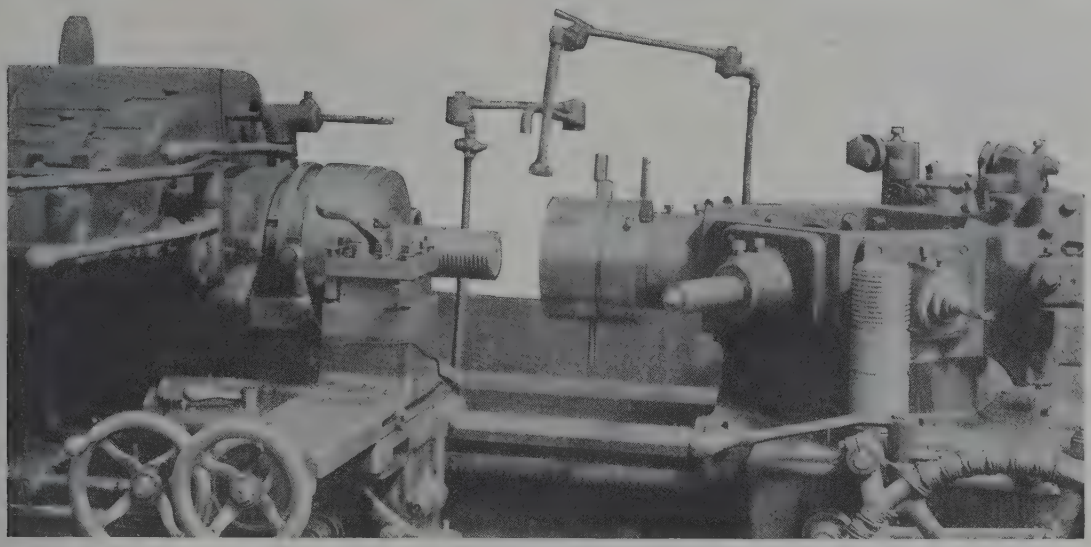


Valve Parts Are Finished on W & S Turret Lathes—This Valve Body Is 12⅛" x 11" Over All

THE WARNER & SWASEY CO., CLEVELAND, OHIO

Address Nearest Office. For List of Offices, See Third Page Following

Warner and Swasey Turret Lathes

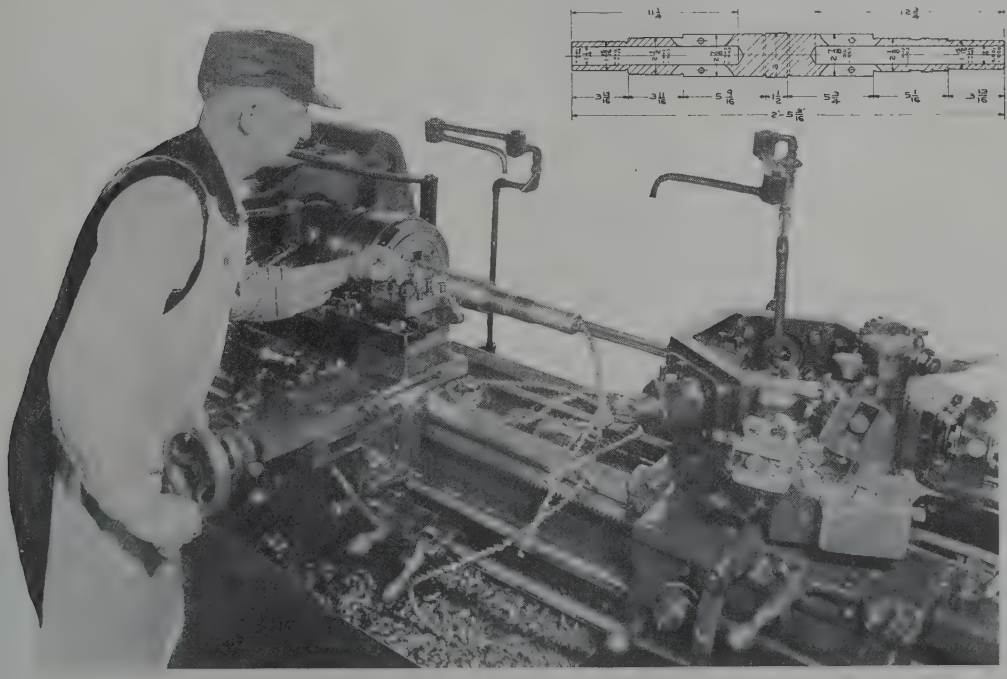


A Large Stud, 3½" Diam., Being Finished on a No. 3A Turret Lathe in a Pacific Coast Shipbuilding Plant. This Stud Is Used in the Propeller Hub, Holding the Blades, and there are 22 in Each Hub

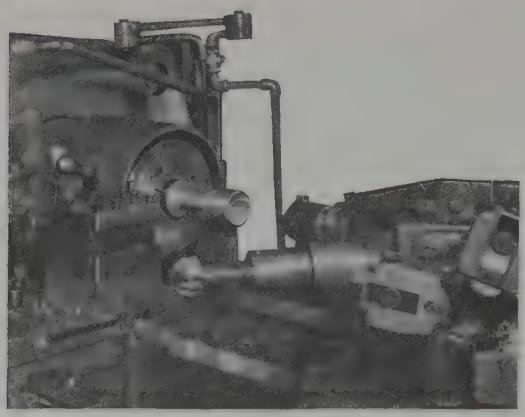
The all-geared head construction of these machines closely approaches the perfect in the rigid centering of the spindle, the number of speed changes (twelve) for the spindle, and its freedom from vibration. The lower half of the head casing is cast in one piece with the bed. All running parts of the head mechanism are immersed in oil or lubricated by the splash system.

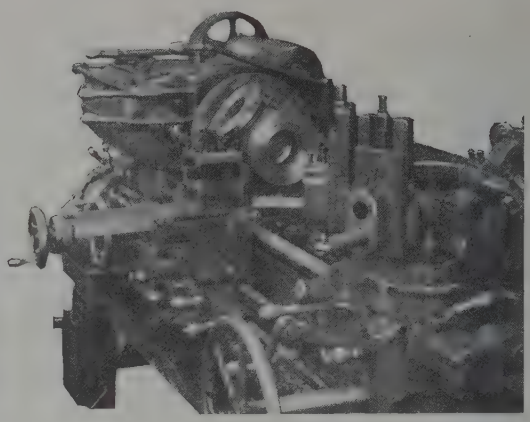
Twelve forward and reverse spindle speeds are instantly available and are very valuable when small and large diameters are to be turned, bored or threaded on the same piece.

The square turret carriage or side carriage is



A 3½" Capacity, 2A, Finishing a Shaft
The Accuracy of These Machines Was Shown on This Shaft. Note the Length and Close Limits of the Holes Bored, and Outside Limits





No. 2A Making Rivet Sets from Bar Stock

mounted on the front V of the bed so that it can be moved out of the way of the hexagon turret when not operating with it. The square turret holds four cutters.

The carriage has ten each cross and longitudinal feed changes, with six independent stop screws to regulate the longitudinal travel. Power cross feed for the cross slide can be governed by a large dial having six observation clips. The use of the square turret in connection and simultaneously with the hexagon turret has proved a time saver of no mean dimensions. On some jobs this feature alone saves as much as fifty per cent of the time necessary on other turret lathes.

The standard tool equipment, designed to accompany these machines, covers a wide range of bar and chucking work.

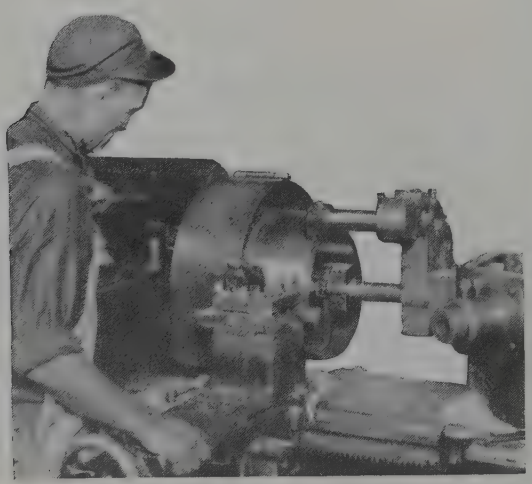
The Warner & Swasey Company will be glad to estimate the time necessary to finish your work on W & S turret lathes. Send them blue prints of your bar jobs up to 4½ in. diameter x 44 in. long and your chuck work up to 16½ in. diameter. The illustrations shown here may suggest some jobs W & S machines can do more quickly.

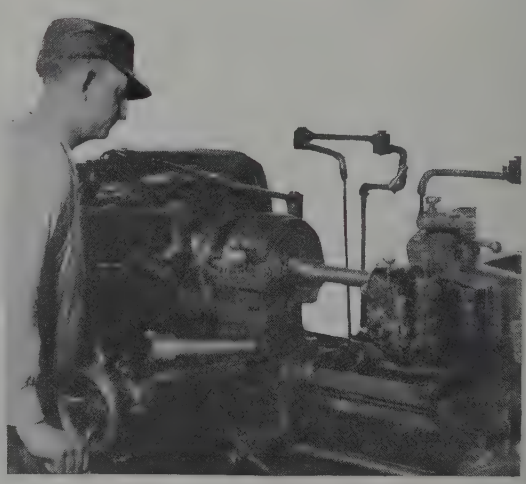
No. 4 Universal Turret Screw Machine

No. 4 Universal Turret Screw Machine for universal use in the shipbuilding machine shop, for bar work up to 1½ in. x 10 in. and chucking work to 8½ in. diameter. Like the Universal Hollow Hexagon Turret Lathes, the square and hexagon turrets operate simultaneously on a number of pieces, thereby saving a great deal of time. The square turret has power longitudinal and cross feeds each with eight changes. The hexagon turret has an independent power longitudinal feed, also with eight changes.

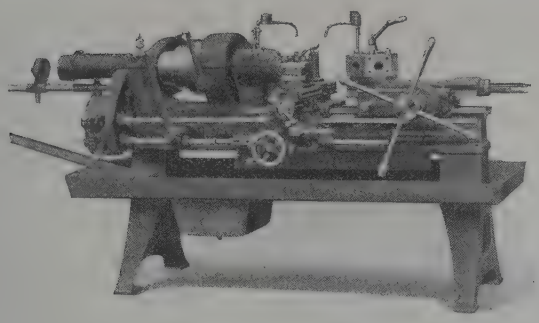
The machine can be provided with cone drive or all-geared head single pulley drive construction. The latter is for use with constant speed motor or plain countershaft. The cone of the standard machine is arranged with ratios designed for the proper spindle speeds and for transmitting maximum power.

The No. 4 Universal embodies the same high grade workmanship and careful attention to the selection of materials that enter into all the Warner & Swasey products.





Warner and Swasey Turret Lathes



No. 4 Universal Screw Machine

W & S Turret Screw Machines

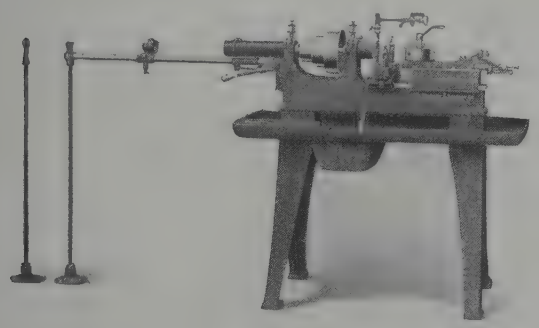
Warner & Swasey Turret Screw Machines are primarily designed for rapid manufacture of screws, bolts, nuts, and other small parts. They are also well adapted for chucking castings and forgings, and, compared with the larger universal turret lathes, are particularly suitable for use as specialized machines.

These machines are made in four sizes:

No. 1—⅝ in. (16 mm.)
No. 2—1 in. (25 mm.)
No. 4—1½ in. (38 mm.)
No. 6—2¼ in. (57 mm.)

No. 1 Turret Screw Machine is the smallest machine of this type built by The Warner & Swasey Company. It is simple, accurate and operates quickly.

It is equipped with plain head, automatic chuck and bar feed.



No. 1 Turret Lathe

The cut-off is lever operated and is regularly furnished with two tool posts of different heights.

No. 2 Turret Screw Machine is an enlarged No. 1 in every respect except for the points mentioned below. It is a larger and stronger machine throughout, with an automatic chuck capacity of 1 in. (25 mm.)

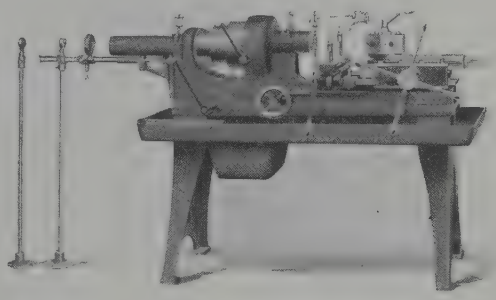
The machine is furnished with either plain or geared-friction head. The geared-friction head machine has been added to this series to accomodate heavier turning operations on steel and to make possible the cutting of larger threads by the use of a die head in the turret. The friction gears give two spindle speeds for each speed of the driving cone. In other respects the design is similar to that of the plain head machine.

No. 4 geared-friction head screw machine is similar in design to the No. 2 Geared-Friction Head Machine and will admit 1½ in. (38 mm.) round bar stock through the automatic chuck and will chuck work requiring a height of centers of 8 in. (203 mm.) over the bed. This machine is generally used for quantity production.

No. 6 Double Friction Back Geared Turret Screw Machine is the largest and heaviest machine of the series and like the No. 4 machine is very largely used in quantity production.

The automatic chuck will accommodate 2¼ in. (57 mm.) round bars and the turret slide has a turning movement of 12 in. (305 mm.)

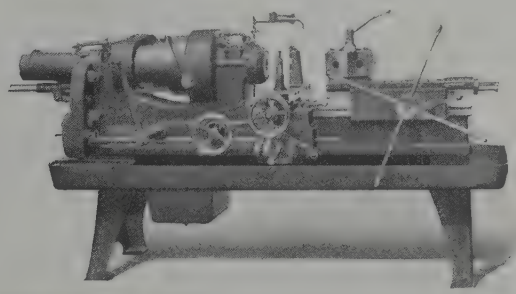
With its double friction back gears it has almost double the power of the single back geared machine.



It has three spindle speeds instead of two for every shift of the belt.

The heavy duty carriage with six power cross feeds, together with the double friction back gears, make possible greater production on this No. 6 than on any other machine of its size.

In addition to greater output, this No. 6 will finish parts in its size range which require strength and excess power just as well as the heavier and more expensive machines. This new No. 6 finishes at lower gear blanks, forgings and tough alloy steel parts.



Branch Offices

In addition to the main office and works at Cleveland, Ohio, The Warner & Swasey Company maintains the following Branch Offices:

New York Office—Singer Building.
Boston Office—Oliver Building.
Buffalo Office—Iroquois Building.
Detroit Office—Ford Building.
Chicago Office and Display Rooms—618-622 Washington Boulevard.

Address Nearest Office. For List of Offices See Above

THE WARNER & SWASEY CO., CLEVELAND, OHIO

Double Mushet High Speed Steel

Double Mushet

The complex demands on modern tool steels have led us to perfect an extra quality of High-Speed Steel, a combination which has been formed by a higher percentage of costly alloys thus resulting in a greater endurance under severe usage. This steel we call Double Mushet High Speed Steel and it is meeting successfully some of the most exacting demands, both in tests and in shop work, that modern steel is expected to accomplish.

For milling cutters, for reamers and drills, for formed and other tools which should keep exact shape and size for the longest possible time, it will be found especially valuable. Double Mushet is the steel to use for heavy cuts, heavy feeds and high speeds. The officials of any machine or engineering shops, who are determined to get the utmost output from their plant will find Double Mushet justifies its reputation, and offers a practical and economical solution to the tool cutting problem. A stock is carried in the usual sizes and special sizes will be imported promptly.

Titanic Carbon Tool Steel

Experience has proved that it is is impossible to produce one steel that can be successfully used for all kinds of tools. Different tempers of tool steel are therefore produced: i. e., steels containing different percentages of carbon, according to the kind of tools to be made.

The higher the carbon contents, the harder the steel becomes.

Titanic Carbon Tool Steels are recommended for stamping and pressing dies, chisels, smiths' tools, shear blades, taps, dies,, reamers, and other tools. The proper temper containing the correct carbon will be supplied upon stating the nature or class of work when ordering.

C. P. I. Pneumatic Tool Steel

In order to supply a steel to meet successfully the abnormal demands caused by the introduction of pneumatic tools, we are the pioneers in introducing C. P. I. Pneumatic Tool Steel. For rivet snaps, button sets and other tools, either special or regular, it will be found to combine the qualities of toughness and elasticity so as to retain shape and insure usage with the minimum amount of breakage.

Treated Double Mushet Bits

Bits can be supplied, made from Double Mushet High Speed Steel Bar stock. These are carefully treated and hardened by experts and cut to standard tool holder lengths. By cutting on an angle, waste when grinding to shape is eliminated. This is a most economical way of buying high speed steel in small quantities.

Mushet High Speed Sheets

These are rolled close to size and annealed thoroughly, so that they may be easily machined or worked. They are free from scale and easy to treat or harden. Mushet High Speed Sheets are particularly adapted for the making of Slitting Saws, Dies, Discs, and Parting Tools.

Mushet Special Original Self-Hardening

This is the original air or self-hardening steel. It has long been a favorite with many for use in tool holders when the work does not warrant the use of high grade Double Mushet. It is a fact also that the peculiar nature of this steel fits it especially for work on brass and we recommend it for this. There are many other uses for this steel about the shop and it will be found to render good service for such jobs as come within its range.

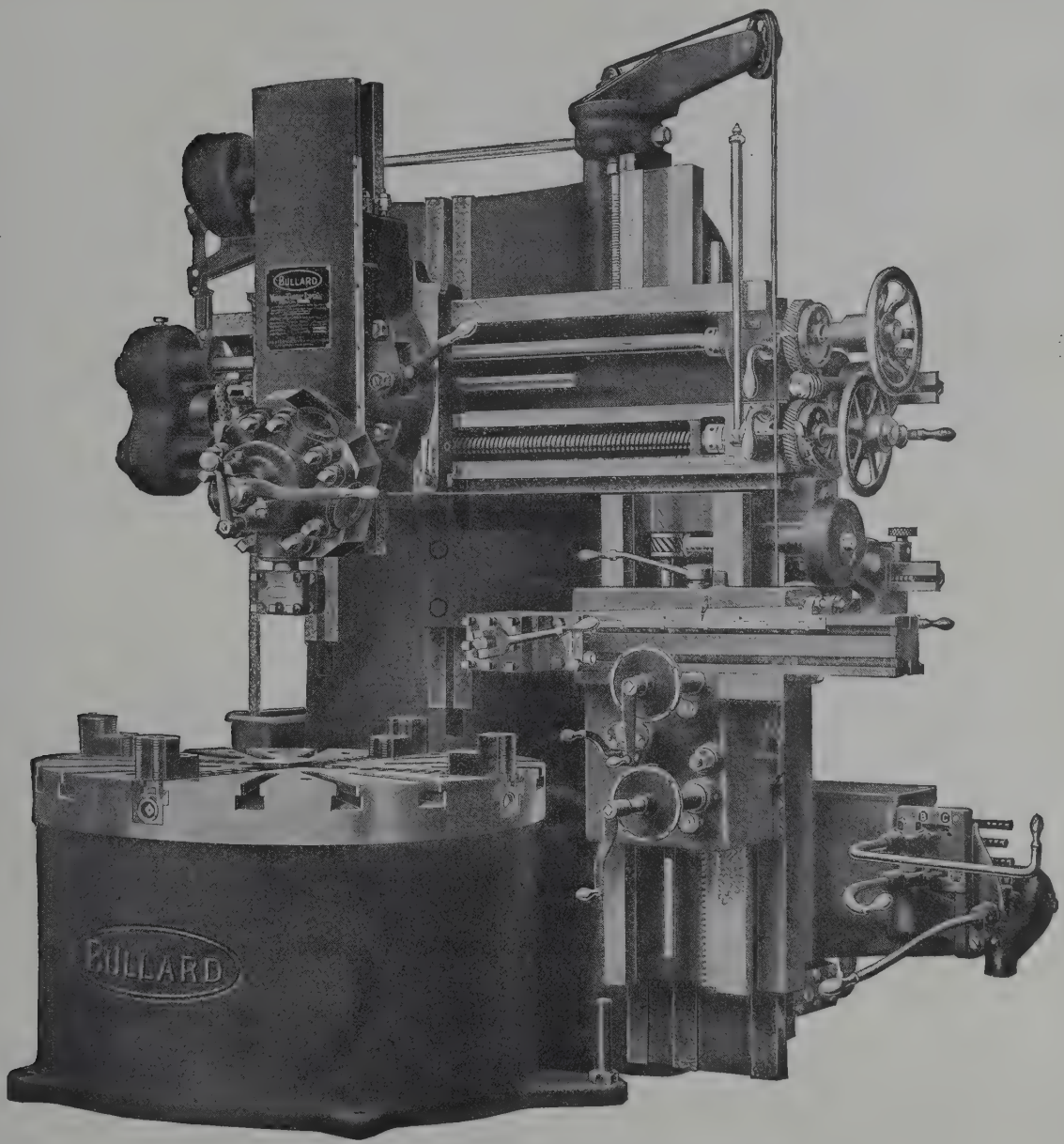
Taylor's Best Yorkshire Iron

Taylor's Best Yorkshire Iron is manufactured from Yorkshire and Swedish ore. No scrap material enters into its manufacture, thus an even and regular grade of finished iron is the result. During the process of manufacture it is piled and hammered several times before the product is considered as finished thus giving it a fibrous toughness with elasticity.

It will meet the most exacting specifications for users of high grade wrought iron. Taylor's Best Yorkshire Iron is tough, ductile, fibrous, and of uniform quality. It is smooth, free from cinder pockets, flaws, buckles, blisters and cracks along the edges. It can be easily welded.

For piston rods, shafts, thrust arms and other parts subjected to shocks, strains and vibration, Taylor's Best Yorkshire Iron will render maximum length of service. It is less liable to sudden fracture or breakage, and due to the care in manufacture plus the use of the best ores, it will give a wearing surface of extreme smoothness.

Applications of pure iron are constantly being developed. Not only for rivets, chain and staybolts, but for other points where a tough and reliable material is demanded, Taylor's Best Yorkshire Iron will prove its merit.



Vertical Turret Lathes—Sizes 24, 36, 42 and 54 Inches

Sizes

The Bullard Vertical Turret Lathe is made in four sizes—24-inch, 36-inch, 42-inch and 54-inch. The general specifications of these machines are given below.

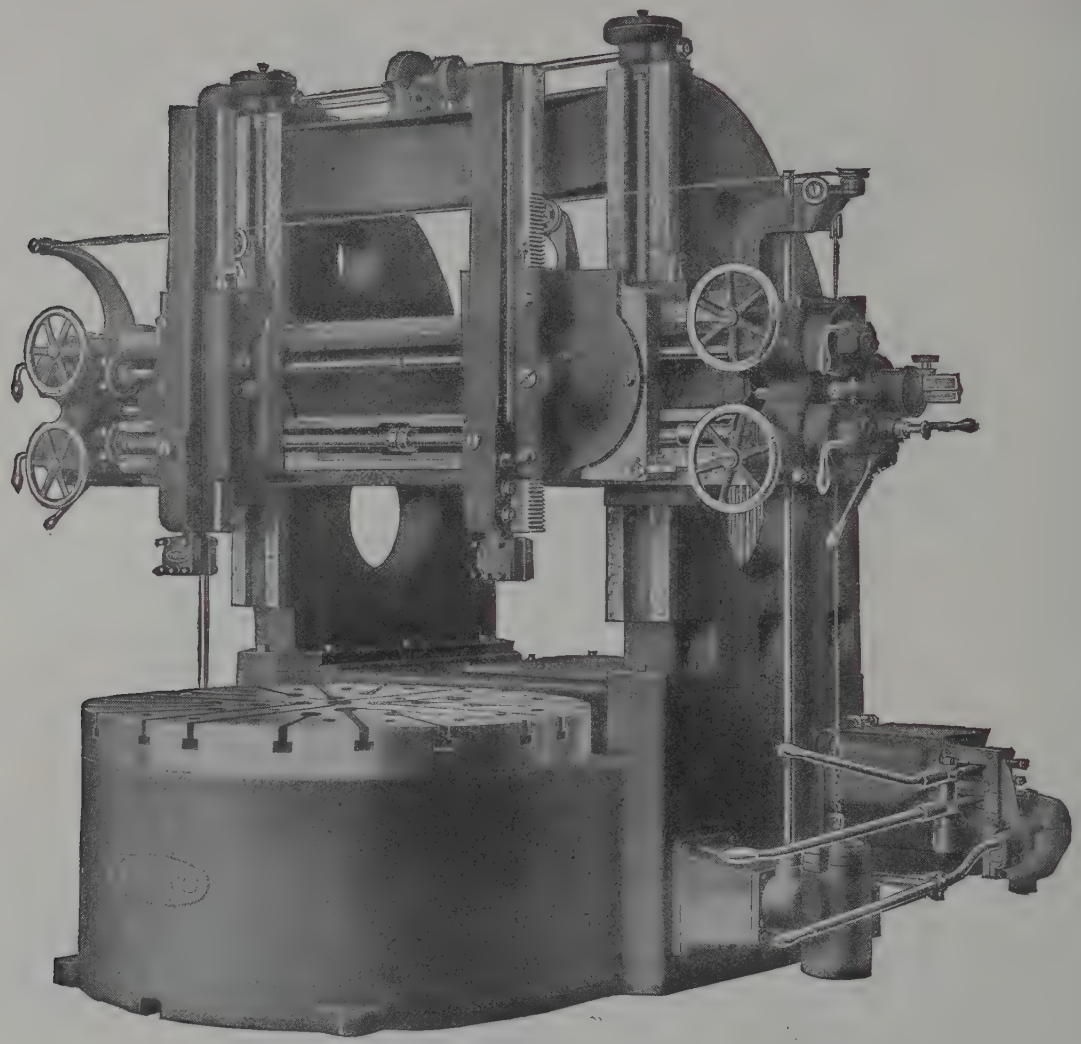
Machine	24-Inch	36-Inch	42-Inch	54-Inch
Capacity—Diameter	26″	38″	44″	56″
Under Crossrail	20″	24″	34″	38″
Under Tur. Face	28½	35″	43½	49″
Table Diameter	24¼	34″	42⅜	50″
Table Speeds	8	12	12	12
Feed Changes—Both Heads	8	8	8	8
Main Head—Vert. Movement	18″	26″	27″	27″
Mill Face	26″	38″	44″	56″
Main Turret—Diameter	14″	15¼	16¾	16¾
Side Head—Vert. Movement	11½	20	28″	31″
Horiz. Movement	18″	19	21″	21″
Weight—Net	8500	14000	18500	23000
Motor	7½HP	10HP	15HP	15HP

Adaptability

Widely adaptable and extremely durable, the Bullard Vertical Turret Lathe may be kept in continuous operation—in continuous production.

Two tool heads, one main and one side, are universal in their movement and adjustment throughout the entire range of the machine, thus simplifying the tool equipment required for a wide range and variety of work:—the same tools, excepting reamers, etc., are equally adaptable to the smallest and largest pieces of the same class.

By means of accurately graduated scales and micrometer dials, and adjustable "Observation Stops"



Bullard Maxi-Mill—Sizes, 44, 54 and 61 Inches

mounted thereon, tools are readily set and sizes obtained and maintained.

Convenient, certain and positive control, without complication, with each unit developed for the maximum service required thereof, and with a due and intelligent regard for the completed whole, results in quality intensive production.

The Bullard Maxi-Mill is made in three sizes—44-inch, 54-inch and 61-inch. The general specifications of these machines are given below.

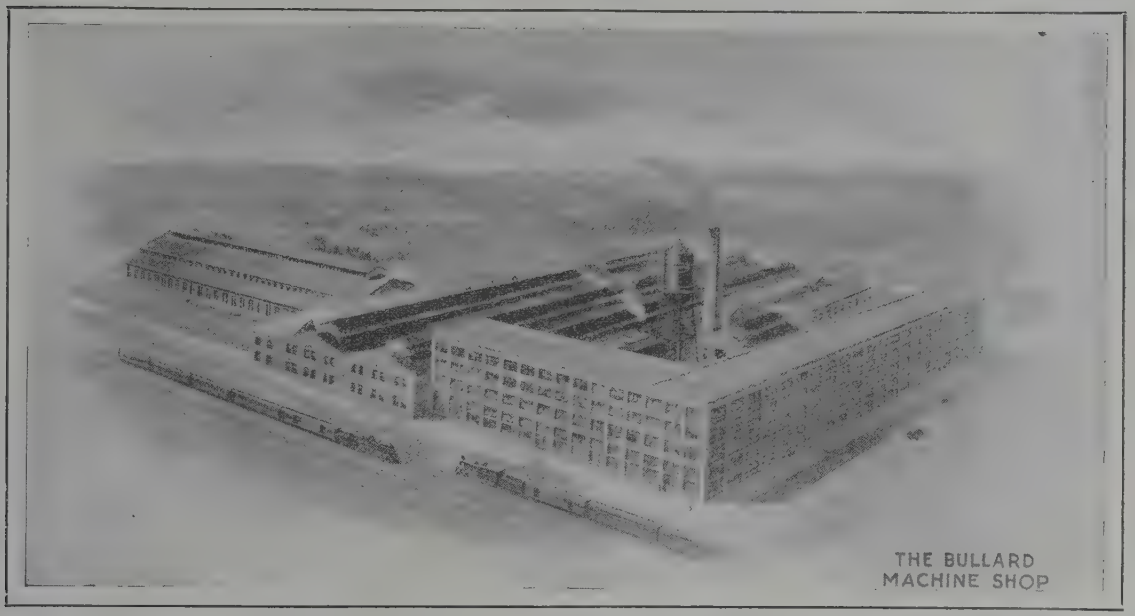
Machine	44-Inch	54-Inch	61-Inch
Capacity—Diameter	48″	56″	63″
Under Crossrail	34″	43″	52″
Under Toolholders	34″	43″	52″
Table Diameter	42⅜	50″	61″
Table Speeds	12	12	12
Feed Changes—Both Heads	8	8	8
Tool Slides—Vertical Movement	36″	36	36
Weight—Net	20000	23000	28000
Motor Drive	15 HP	15 HP	15 HP

Adaptability

This machine represents the maximum possibilities of the Vertical Boring and Turning Mill based upon a knowledge of the requirements gained by extensive observation and a specialized experience as makers and users thereof. In design and materials of construction this machine is purposed to withstand the most severe usage continuously with a minimum of maintenance cost.

Like the Bullard Vertical Turret Lathe, it is equipped with certain, positive and convenient control, hammer hand wheels, continuous flow lubrication, graduated scales, micrometer dials, observation stops for the duplication of sizes, and the table may be started and stopped from either side of the machine.

Vertical Turret Lathes and Maxi-Mills

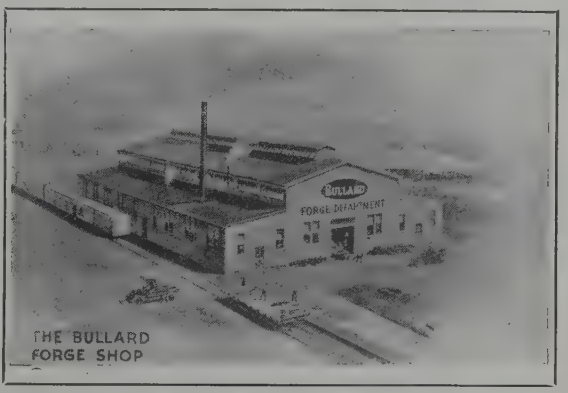


THE BULLARD MACHINE SHOP

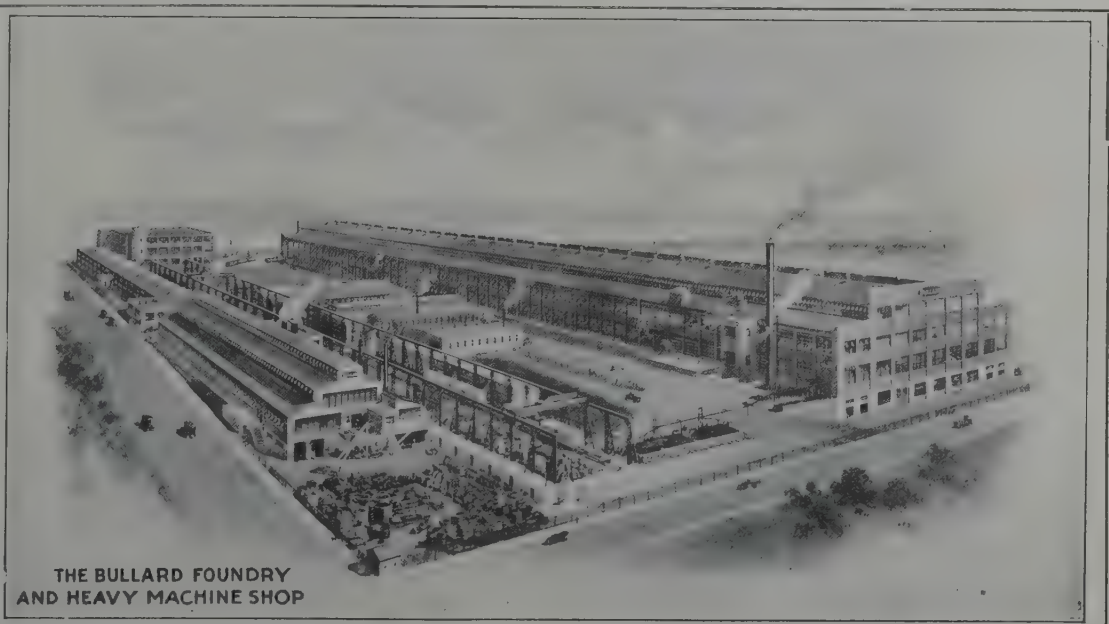
Manufacturing Facilities

Established in 1880 as the Bridgeport Machine Tool Works, and incorporated in 1894 as The Bullard Machine Tool Co., this organization has enjoyed an ever increasing demand for its product. Thoroughly modern facilities have been provided to meet this demand. Foundry, Forge and Machine Shops, models of their kind, under one ownership, control and supervision, together with chemical and physical laboratories, insure the use of quality materials only and their proper handling in the construction of Bullard Machines.

Designed by masters of machine construction and built by expert mechanics of long standing with the



THE BULLARD FORGE SHOP

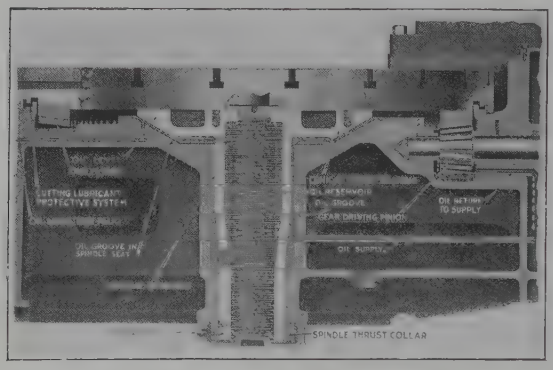


THE BULLARD FOUNDRY AND HEAVY MACHINE SHOP

THE BULLARD MACHINE TOOL CO., BRIDGEPORT, CONN.

Organization, working under ideal conditions, Bullard Machines have a superiority of design and workmanship which is recognized wherever machine tools are used.

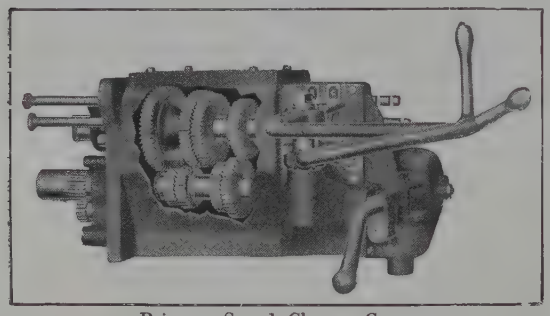
Situated in Bridgeport, Conn., on a main trunk railway, most excellent shipping facilities are enjoyed.



Bullard Table Spindle Construction

Standardized Parts

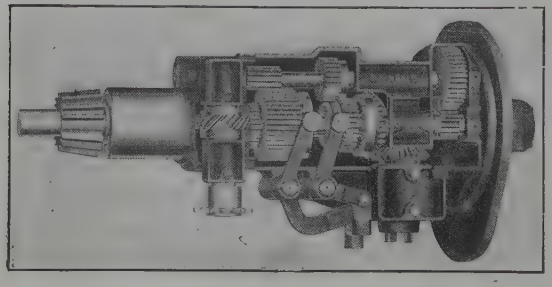
An important feature in Bullard design and construction is the standardization of parts. In their design the Bullard Vertical Turret Lathes and Maxi-Mills represent the culmination of forty years in machine-tool building. The principles they embody have been tried and tested in more than ten thousand machines. Materials of construction have been selected and adopted after a demonstration of superior merit in actual and continued service.



Primary Speed Change Case

Mechanical Speed Changes

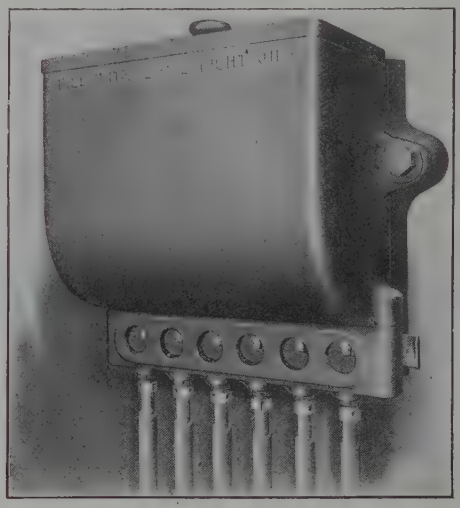
Table speed changes are mechanically obtained through two systems of selective sliding gears and positive clutches. Speeds may be selectively changed without disengaging either cuts or feeds, or stopping the main driving pulley. Change from highest to lowest, and vice versa, or to any intermediate speed, may be instantly made. No power is consumed by idle running gears—only those actually transmitting power are in mesh. These members are protected by a system of positive interlocking which makes it impossible to release brake and engage clutch until gears for any speed are fully in mesh.



Secondary Speed Change Case

Constant Flow Lubrication

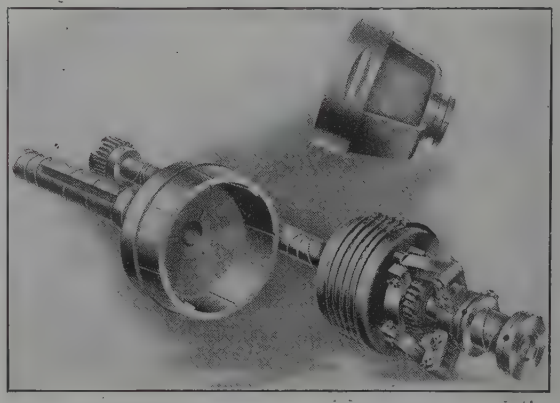
A large percentage of machine breakdowns, are the direct result of insufficient and improper lubrication of gears and bearings. To guard against burned bearings and worn gears, and to secure a maximum power efficiency, Bullard Vertical Turret Lathes and Maxi-Mills have an automatic system of lubrication. Table spindle, table driving gear, primary and secondary speed change mechanism, clutch and brake, and main driving shaft journals are lubricated by a flow of oil that is constant and positive so long as the main driving pulley is in motion.



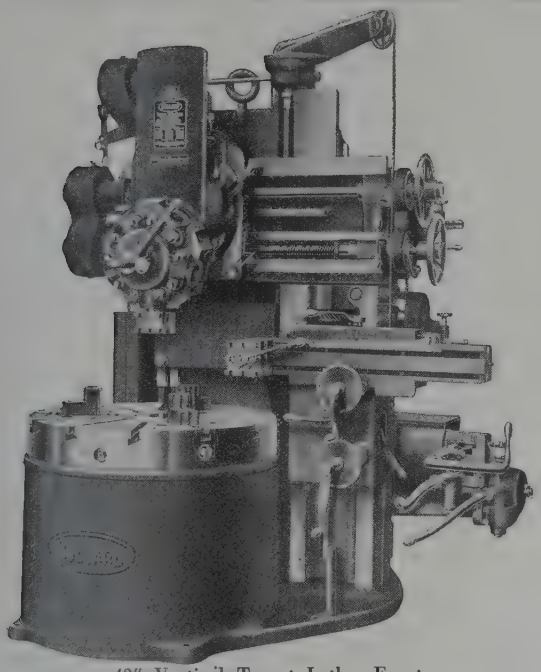
Oil Distributing Reservoir

Multiple Disc Clutch

The friction clutch and brake is mounted on the main driving shaft and is used only as a means of starting and stopping the machine. Running



Multiple Disc Clutch and Brake Drum



42″ Vertical Turret Lathe, Front

at constant speed in a bath of oil, wear is reduced to a minimum and a maximum unvarying efficiency secured.

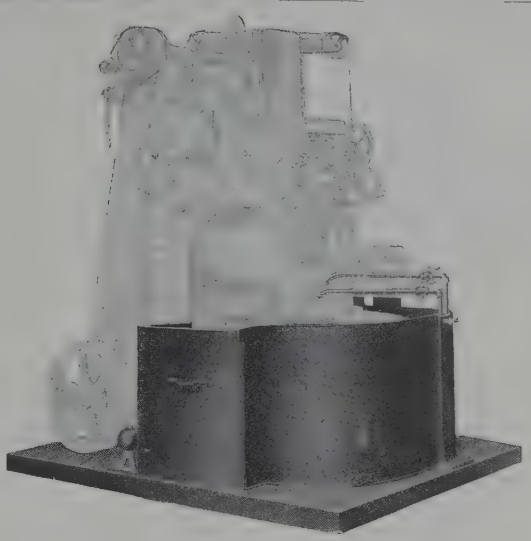
The engaging pressure is applied evenly throughout the entire surface of the discs by a three-point toggle motion acting directly on a spherical seat in the pressure plate. Both brake and clutch are operated by one lever—the engagement of one disengaging the other, and vice versa.

General Construction

The Bullard Vertical Turret Lathe is original and distinctive in type. It represents, in combination, an advanced development of the engine lathe, horizontal turret lathe, and the vertical boring and turning mill, in the design, manufacture and use of which we have enjoyed a broad experience extending over a period of thirty years.

Retaining the inherently good features of the types in which it had its origin, it has, since its conception in 1900, been the subject of continuous constructive analysis, which has resulted in a rapid development along lines essentially original and having a direct bearing on productive capacity.

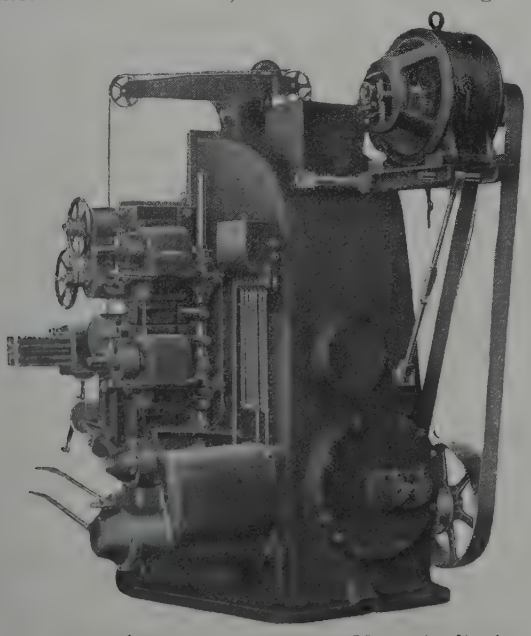
Rigidly constructed, with bearings amply proportioned and specially selected material of maximum shock- and wear-resisting qualities used throughout the gears in both driving and feed trains; lubricated continuously and automatically with filtered oil; safety devices incorporated in feed mechanism and all operative levers interlocked—this machine marks a "New Era" in machine design and is one in which implicit confidence may be placed by both manager and operator.



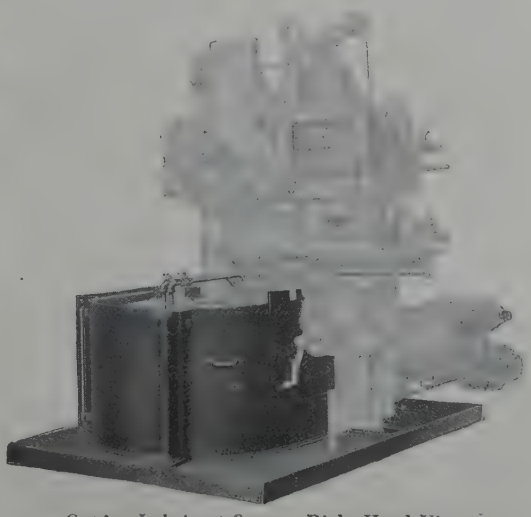
Cutting Lubricant System, Left Hand View

Cutting Lubricant System

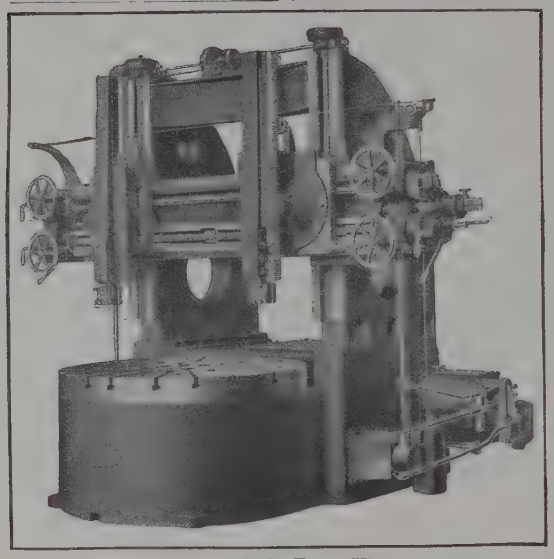
Special attention has been given to the handling of cutting lubricant. A complete equipment of pump, water guard, water pan and piping, which,



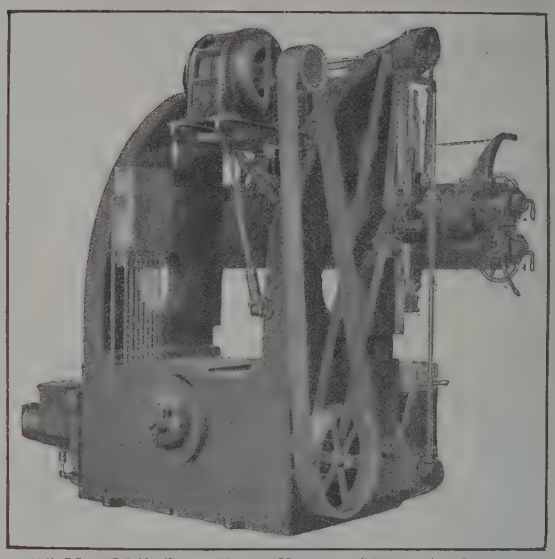
42″ Vertical Turret Lathe Showing Motor Application



Cutting Lubricant System, Right Hand View



61″ Maxi-Mill, Front View



61″ Maxi-Mill, Rear View, Showing Motor Application

competently and in a cleanly manner, will deliver a flow of coolant at the point of the cutting tools, has been designed for use with this machine in handling steel parts. This is not included in the regular equipment of the machine, but may be applied at any time after installation of the machine.

It is an established fact that, by the use of cutting lubricant, cutting speeds may be increased 40%. The life of tools is materially increased, the number of pieces produced between grinds multiplied, and a big reduction is made in the time-loss incident to grinding and tool setting. By maintaining an even temperature in the work itself, a greater accuracy is obtained, and experiments indicate a considerable saving in power consumption.

Maxi-Mill Design

In design the Bullard Maxi-Mill is a development of the maximum possibilities of the vertical boring and turning mill. The principles it embodies have, without exception, a foundation on the axiom that a machine is productive only when actually cutting, so that every effort has been centered upon reducing the time necessary to chuck the work and remove it, to make adjustments, changes of speed, and other operations which are incidental to production but only increase it as the time necessary to accomplish them is reduced. Among the features that contribute to this are the Bullard Centralized Control, Continuous Flow Lubrication, Cutting Lubricant System, Rapid Power Traverse, Hammer Hand Wheels, and the Bullard Multiple Disc Clutch and Brake.

Production

To be capable of producing the maximum amount of work within its range and to meet the exacting demands of present-day requirements, there are certain fundamentals in machine-tool design and construction which must be complied with fully. These are:

1st. A design which has been developed through years of experience with, and close observation of, the classes of work for which the machine is intended—a design which embodies convenience of operation and manipulation which reduce the physical effort required of the operator, and one which insures the possibility of maintaining the original accurate alignment of its various component factors.

Such design must be modern in the highest sense, taking into consideration the progress and change which has entered into the design and materials of the parts which it will be called upon to produce.

2nd. The use of the materials and the proportioning of machine parts by the combined process of selection and elimination based on a broad engineering knowledge and experience—all with a view of developing a construction which will withstand the most severe usage with a minimum maintenance charge.

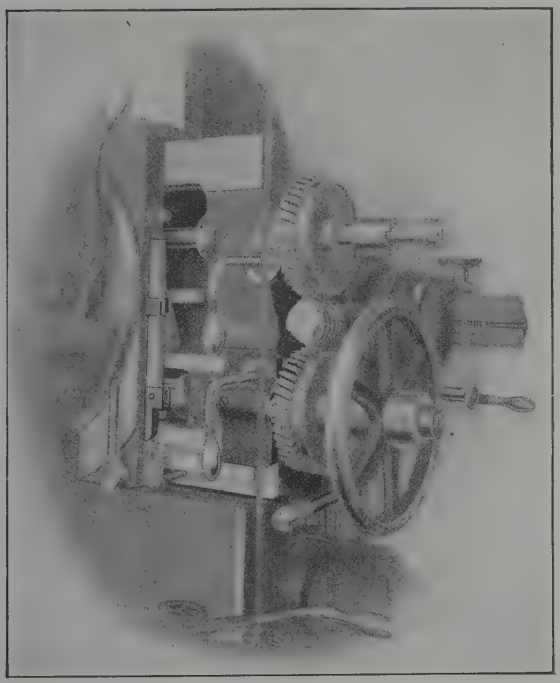
3rd. The provision of an ample and constant source of power and its application to the cut through driving units of a design and construction which are highly efficient and have, as well, a large factor of safety to sustain long and continued hard usage and shocks. Control of power is paramount in importance.

4th. A lubrication system, which, with minimum attention from the operator, will insure the continued and positive maintenance of a film of clean oil between all bearing surfaces as well as gears. This means least loss of power, longest life of parts, low maintenance charges and—increased production per day, as the operator, knowing that his machine is continually lubricated, needs but to give his entire attention to the actual production of work.

5th. An original accuracy of construction of the highest order—for no machine tool can produce work that is more accurate than itself and, in addition, original accuracy tends to continued accuracy as well as insuring easier, quicker operation; longer life of parts and economy of power.

Materials

Properly speaking, the subject of materials is a sub-division of the factor of design, i. e., the materials to be used are always specified with the latter. It is not ordinarily considered as separable from the question of design, chiefly for the reason that an amount of attention consistent



Bullard "Hammer Hand Wheels"

with its importance has not been given to the subject hitherto. With the advent of alloy steels and their common use, particularly in automobile construction, machine-tool builders were called upon to build tools that would stand the greatly increased stresses of cutting such materials. Machine tools were accordingly made heavier without any departure from the materials commonly employed.

Increased proportion of parts, with added weight, is not wholly effective, however, particularly in such items as gears, shafts and similar parts required to transmit the greater power loads and withstand the conditions of usage now imposed. Further production demands called for construction embodying the highest convenience and ease of manipulation, and this, also, indicated a change in material which would permit a reduction in size and weight of parts without sacrifice, but rather an increase, of strength.

Realizing these facts fully, the Bullard Company was accordingly a pioneer in the adoption of alloy steels of the highest grade for all parts called upon to carry the major stresses of power and feed transmission. Superior facilities for the scientific heat treatment of these materials are an important part of our plant equipment.

It is highly consistent with Bullard policy that the final selection and adoption of any material is dependent on its demonstration of superior merit in actual and continued service.

Hammer Hand Wheels

The Bullard Hammer Hand Wheels, or Safety Tool Setting Device (Patented), provide a quick and accurate means of tool setting, and eliminate the danger of rapidly revolving crank handles. Mounted on sleeves secured to the down feed rod and cross feed screw, the wheels are free to make a partial movement before becoming engaged therewith, the engagement imparting a hammer action similar to a hand tap on the end of a crank handle. By this means the finest adjustment of tools may be made.

In the illustration at the left, the hand wheel has been removed from the down feed rod, showing the notched sleeve which forms a bearing for, and is actuated by, the hand wheel.

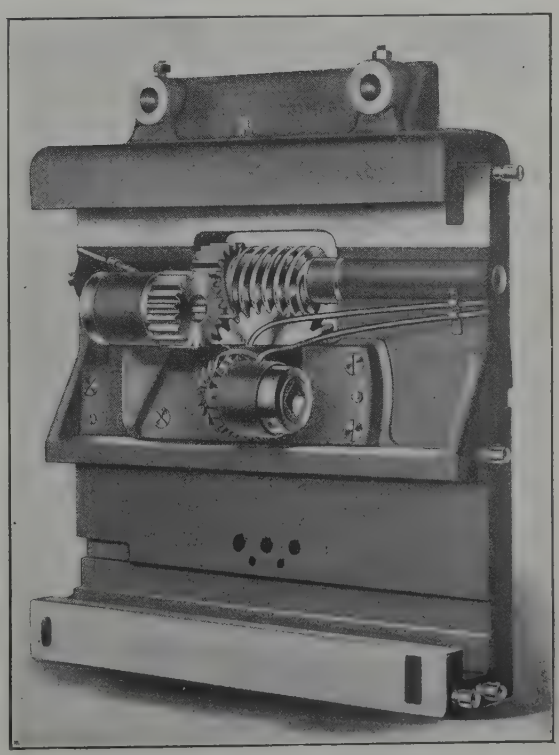
Rapid Power Traverse

The vertical head may be rapidly moved in all directions by power independent of feed works or table drive. Vertical and cross motion in either direction may be engaged singly or simultaneously, the operating mechanism for each being independent of the other. Safety device prevents damage resulting from careless handling.

This device, which is in no way connected with the feed, adds largely to the day's production—the operator's energy being conserved and a rapid pace set for all hand movements of other machine parts.

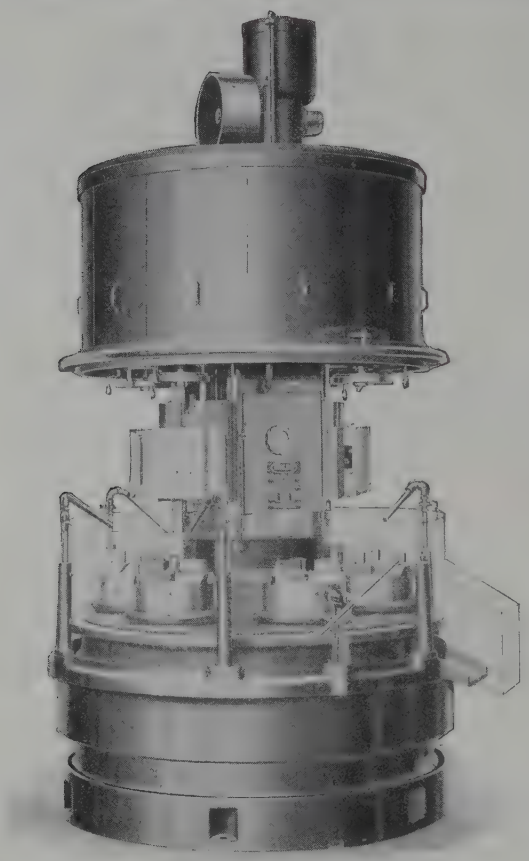
Maxi-Power Feed Mechanism (Patented)

The illustration below shows a rear view of the Main Saddle. Note the extra large worm and worm gear in the feed mechanism, also the solid square locks and narrow guide bearing. In the Maxi-Power feed mechanism the worm, with its integral pinion, is mounted in the saddle and revolves on a stud which is supported at both ends. Worm thrust is absorbed in the saddle itself and not in the bracket bolted thereto. The worm-gear is also doubly supported by bearings on either side, and revolves in an oil reservoir providing perfect lubrication. Both are hardened, and as larger diameters are possible, the efficiency is greater than in the construction usually adopted.



Bullard Maxi-Power Feed Mechanism

The Bullard Mult-Au-Matic



Bullard Mult-Au-Matic—Sizes 8 and 12 Inches

Type

The Mult-Au-Matic is essentially a manufacturing machine. In principle it is of the automatic, multiple spindle or station type—the units of which are vertically disposed for the purpose of coordinating the control and operation thereof.

In development it is radically and essentially different than other machine tools. In its design and construction are embodied many original features and combinations which have a most direct and positive bearing on productive capacity as well as on quality of output.

General Principles

Briefly, the Mult-Au-Matic comprises six independent machines automatically operated, in combination, on a series of pieces of the same form and size—all required operations in sequence, including chucking, being performed simultaneously, thereby producing a completely finished piece in the time consumed by the longest operation, plus the few seconds required for the indexing of the carrier and its spindles from one station to the next.

Advantage is thus taken of the maximum possibilities of simultaneous multi-cutting without in any way sacrificing the quality or accuracy of product.

The six independent work-holding spindles are mounted on a carrier, or turret, which revolves around a central column having six faces—the first of which, being the loading station, is blank. On the remaining five faces are mounted tool-carrying slides which are adjustably independent, each from the others, in amount, rate and direction of movement.

The action of all tool heads, as well as the indexing of the carrier from station to station, is essentially automatic the whole being coordinated and positively interlocked by a unique mechanism which provides protection for the machine, the work, and the attendant.

Scope

The field of the Mult-Au-Matic includes all classes of castings, forgings or bar-stock sections, cut to length, coming within its capacity and which require boring, facing, turning or threading operations, either singly or in combination.

Chief Characteristics

The chief characteristics and novel features of the Mult-Au-Matic are:

Six work holding spindles.

Five universal tool-carrying heads.

Widely variable and independent spindle speeds at each station.

Independent and widely variable feeds for each tool head.

Extreme simplicity of tool equipment.

Elimination of sweep cutters.

Independent in tool setting.

Accurate, positive stops.

Accurate indexing of spindle carrier.

Independent adjustment of spindles in carrier with relation to each other and to registry mechanism.

Automatic operation.

Positive coordination and interlocking of all machine movements.

Mechanically controlled rate of production.

Gearing and shafts of material (alloy steel, bronze or iron) scientifically, and in the light of experience, selected to best meet the individual service requirements thereof.

Continuous flow lubrication of all bearings and gears.

Positive and assured filtration of all lubricating oil as circulated.

Vertical construction.

Minimum floor space.

The Master Element

In comparison with any other previous type of machine tool, either hand operated or automatic, developed for the machining of work coming within the range of the Mult-Au-Matic, the productive capacity of the Mult-Au-Matic is incomparably and marvelously greater.

An analysis of the operations required in machining any given piece will indicate that under like conditions the sum total of actual cutting time (not including time required for machine movement) on the various

surfaces will, if efficiently performed, be equal, whether the work be performed in an engine lathe with single tool, in a turret lathe with group tooling and operations in sequence, or in the Mult-Au-Matic, with its multiplicity of operations carried on simultaneously, with the time of the longest operation as the controlling factor of the situation.

The master element in the greater production results of the Mult-Au-Matic lies in the principle of mechanically controlled intervals—by means of

1st. The combination in one of six individual machine units.

2nd. The coordination, mechanically, of all machine units movements, and

3rd. The refinement, without complication, of the mechanism required for this purpose.

The mechanical control of intervals reduces to a minimum the lost time usually incident to machine operation. Production is no longer dependent on the speed of the operator—a decidedly variable factor. Even the time required for chucking—the one manual operation entering into Mult-Au-Matic production—is mechanically paced by the automatic control of machine unit movements.

Compelling Facts

"Eleven men were released for other work by this machine," said the Mechanical Engineer of one of America's largest and most highly developed specialty manufacturing plants, in speaking of the Bullard Mult-Au-Matic. And, at that, they had not pushed the machine in any sense.

From an average total time of 15 minutes for a series of different machining operations on a certain piece,—each operation in a machine selected and tooled to obtain highest efficiency, to an average of 2 minutes and 15 seconds on thousand after thousand of the same piece, but of a higher and more uniform quality, is a matter of record in another plant of international renown since the installation of the Bullard Mult-Au-Matic.

Another Mult-Au-Matic saved thirty-two and one-half minutes on a thirty-six minute job originally performed in a thoroughly modern and well tooled turret machine.

Ninety-six thousand eight hundred bevel gear blanks of varying sizes, from drop forgings, is one year's production record for one Bullard Mult-Au-Matic in yet another American plant where intensive production of quality work at lowest cost is the sole aim of the management.

Men of the so-called "operator class" (supervised, of course, by skilled mechanics) made these records. And others like them, obtainable at all times, are capable of making and maintaining similar increases in production and like savings in labor-cost on an untold variety of work coming within the range and scope of the Bullard Mult-Au-Matic.

Your work can be reduced in cost, produced in shorter time and with less overhead expense on the Bullard Mult-Au-Matic because of its unique and novel design, its in-built quality and the power and durability incorporated in its construction.

As evidence of the dependableness of the Bullard Mult-Au-Matic and its capacity for maintained production at a high rate, we submit data from the shop records of a prominent user of these machines. On work in question three machines were engaged—two on identical first series operations, and the third, with two operators, on the second or finishing operations. For purposes of identification and comparison they are, in the following, indicated by number in the above order.

In a period of sixteen weeks, including two holidays, or ninety-four working days totaling a maximum possibility of 2256 hours on a basis of 24 hours per day—

Number 1 Mult-Au-Matic was run 1808 hours on first series operations, with 32 hours required for tool-setting and repairs.

Number 2 Mult-Au-Matic was run 2032 hours on first series operations, with 40 hours credited to tool-setting and over-hauling.

Number 3 Mult-Au-Matic was operated 1968 hours on second series operations and required 64 hours for tool-setting and repairs.

In this time the three machines finished in two chuckings 116,734 pieces of a total finished weight of 4,185,600 lbs., removing 950,606 lbs. of chips from 5,136,296 lbs. of rough castings.

An average hourly production of 30.4 pieces was maintained in the first series operation on machines Nos. 1 and 2. Machine No. 3 averaged 53.7 pieces per hour on the second series operations.

The same machines in a later monthly period averaged in first series operations 33.5 pieces per hour for machines Nos. 1 and 2, and 67 pieces per hour on second series operations for machine No. 3.

The following monthly period included continuous operation even on Sundays. The record shows an average for Nos. 1 and 2 increased to 36⅔ pieces per hour on first series operations, and for No. 3 an average hourly output of 73⅜ pieces on second series operations.

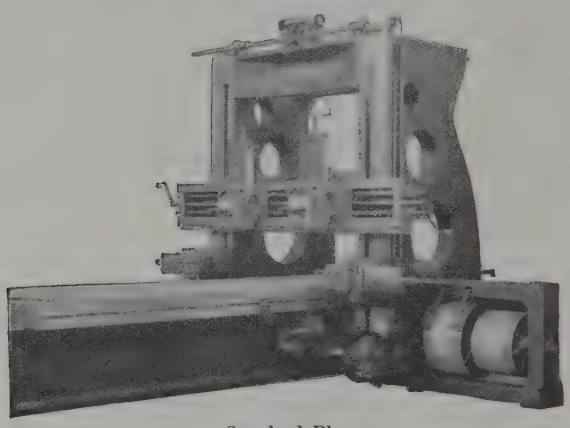
DIMENSIONS

Details	8-Inch Machine	12-Inch Machine
Capacity	8 inches diameter. 6 inches in height	12 inches diameter. 6 inches in height
Movement of Tool Heads	6 inches vertically. 3 inches in horizontal or angular directions.	6 inches vertically. 3 inches in horizontal or angular directions.
Projected Floor Space	Machine only, 67 inches in diameter	Machine only, 77 inches in diameter
Actual Height from Floor	128 inches	128 inches
Weight { Net	18,000 pounds	22,500 pounds
Weight { Domestic Shipping	18,200 pounds	22,750 pounds
Code Word	Amanda	Amazon

Cincinnati Planers and Boring Mills

Sizes and Types of Planers

The wide adaptability of the Cincinnati Planer to all classes of work is indicated by the fact it is built in 16 different sizes between 22″ and 120″ and in four different patterns — the standard, medium, heavy, and widened.



Standard Planer

Principles Governing Design

The design of the Cincinnati Planer is based on 20 years' of constant study and extremely varied experience with planer problems of increased and economical production. The three principal elements in these problems are—to provide a variation of speed which will make instantly available the correct cutting speed for all materials and conditions; to proportion all parts for maximum power, rigidity and durability; and to arrange all parts for rapid and easy manipulation.

Speed Variation

The greatest possible gain in planing comes from access to a change in cutting speeds, and the range of speeds permitted by the use of a Cincinnati Planer provides a correct cutting speed for any material and condition.

All planers from 22″ to 56″ inclusive are regularly furnished with a patent "Tu-Speed Drive belted from countershaft and giving two cutting speeds with a constant return speed to the table.

When a greater number of speeds are desired in these sizes, and in all cases for the larger sizes of planers, Reversible or Non-Reversible motor drive is furnished where direct current is used, and speed box drive where alternating current is to be used.

With the non-reversible motor drive, a two to one variable speed motor is employed, coupled to countershaft on top of planer housing and driving through belts, giving a variataion in cutting speeds with a constant or variable return speed.

With the reversible motor drive, a direct current motor is coupled direct to the driving shaft, giving a variation in cutting speeds with a constant or variable return speed.

Speed box drives are furnished with 4 speeds. The cutting speeds varying, the return speed being constant.

Plain motor drive may also be furnished, either Direct Current or Alternating Current being used. In this case only one cutting and return speed is available.

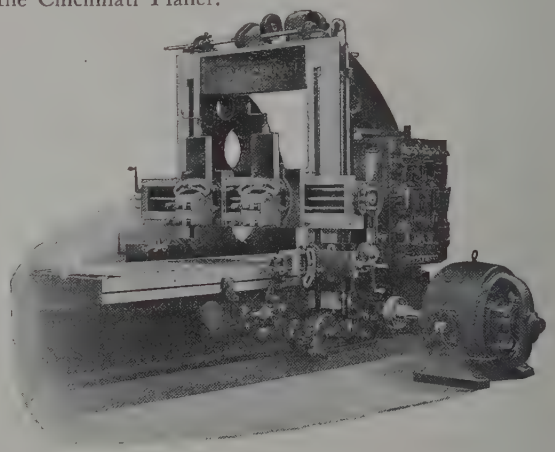
Proper Proportions

The proper proportioning of all parts of Cincinnati Planers for power, rigidity and durability has been amply proven by the many severe service requirements which have been successfully met.

Some of the features which combine to eliminate any possibility of springing at any point are the reinforced box beds, the unusually thick Double Plate Box tables, the box section housings firmly secured to bed, and the extra deep cross-rails. All parts are made of the best material and those portions of the machine such as racks, pinions and gears which are subject to greatest wear are made of steel.

Convenience in Operation

In the solution of the problem of arranging all parts for rapid and easy manipulation so as to help secure economical operation, a number of special features of construction have been evolved, which clearly demonstrate the superiority of the Cincinnati Planer.



Reversible Motor Driven Planer

Rapid Power Traverse is furnished to the Rail Heads on all machines from 28″ Standard up except the 30″ Medium and on all heads from 72″ Heavy and up. This eliminates the time consumed in moving the heads from one position to another. Besides Rapid Power Traverse, the heads have power feed in all directions.

On Planers from 36″ and up the Down Slides are hung on ball bearings to facilitate their vertical movement.

The Power Elevating Device provides a slow speed for raising and a faster speed for lowering the cross rail.

The shifting mechanism is arranged so that it can be operated from either side of the machine.

Cincinnati Planers and Boring Mills

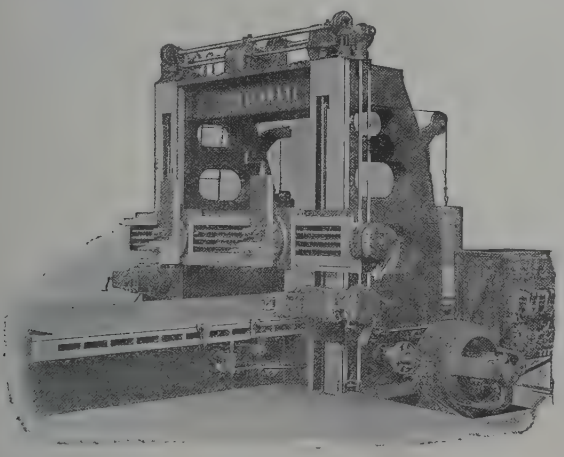
Protection from Undue Wear

Undue wear of any portion of Cincinnati Planers is effectively prevented by efficient oiling systems and protection of all parts against dirt and chips which might cut the running parts and rapidly wear out the machine.

On all machines from 30" Heavy pattern and above, the Bed and Table vees are oiled by a system of Forced Lubrication. Oil is pumped into the vees directly under the tool point and is carried over the sliding surface by large oil grooves in the Table Vee.

All shaft bearings are provided with ample lubricating arrangements, and proper lubrication of loose pulleys is assured by a new and improved self-oiling bronze bushing large enough to hold 6 weeks supply. Patent Oil Cups are placed at all important oil hole channels.

The Double Plate Box Table is constructed so that the entire bottom side is made solid, this strengthens it very materially and prevents chips and dirt from falling into the ways of the bed. The cam and rollers of the shifting mechanism are protected from dirt by a cover which entirely encloses the mechanism. A drip pan is also provided to catch the surplus oil, preventing it from getting on the belts.



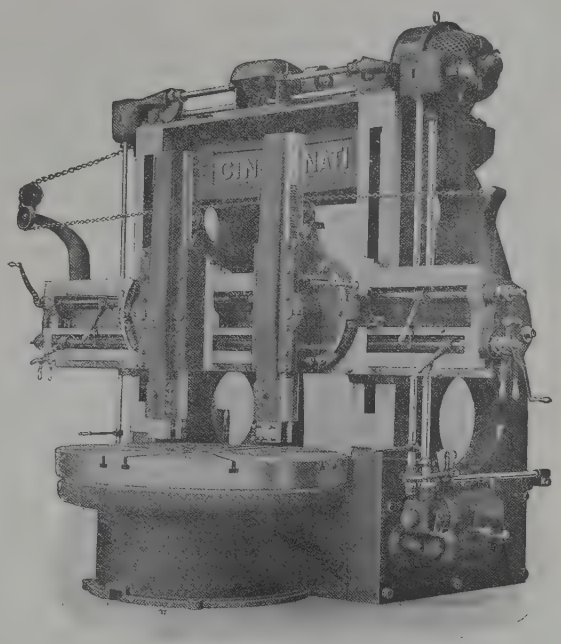
Heavy Pattern Planer

Other Features

Saving of power is assisted by the Aluminum Quick Reverse Pulleys by reason of their extreme lightness and small inertia. Actual tests show a reduction of power by their use of 25% in reversing; with a 13% increase in strokes per hour.

Extra capacity of 6" to 10" in planing is provided beyond the rated capacity of the machine by drilling extra holes at each corner and by carrying the center Tee slot the entire length of the table.

Particular attention has been given to arrange all parts to safeguard the operator from accidents. To assist this purpose the bed has been cast entirely closed between the vees, which beside its safety factor, adds great strength to the bed. A safety locking device prevents the table from starting except at the will of the operator, and all gears are placed inside of the bed.



Standard Boring Mill

Sizes and Types of Boring Mills

Cincinnati Boring Mills are are made in sizes 42", 48", 5', 6' 7', 8', 10', 12', 14' and 16' with the extension type Mills in 10'-16' and 14'-20' sizes. These machines can be arranged for either motor or belt drive.

For Motor Drive, a variable speed motor is used which in connection with the speed box gives a wide range of speeds. For Belted Drive or constant speed Motor Drive on smaller machines a cone pulley is used in connection with the speed box which will give a variety of speed changes to the table.

A large number of feeds are provided, which can be changed instantly by means of moving the handle in the feed box at the side of the Housing. A separate feed box is attached to each housing, thus giving an independent feed for each head in all directions, and eliminating complicated feed arrangements on the back of the rail.

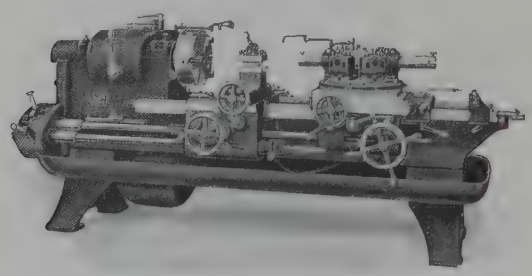
Features of Construction

The bed is of deep box form throughout. All parts are thoroughly ribbed and braced, and the entire mechanism of the mill is supported on the bed. The table is large in diameter and supported on a broad bearing near its outer edge. The main driving gear on 8' mill and above is an internal spur gear cut from the solid. Smaller sizes are driven by bevel gear and pinion. The housings are of massive box form, a wide and long seat insuring rigidity under the most severe duty. The cross rail is of box form and has a deep arch on the back. The heads have the narrow guide bearing at the bottom of the rail.

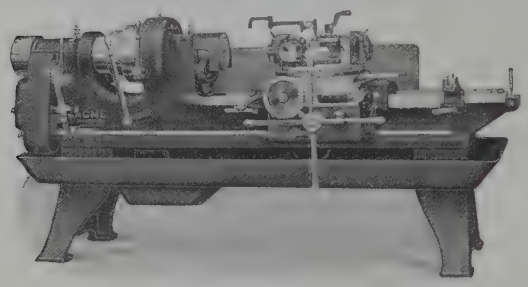
Turret Lathes and Screw Machines

Turret Lathes

The No. 3 Cincinnati Acme Flat Turret Lathe is shown in the illustration equipped for chucking work. Simplicity, accuracy and rigidity are insured by casting the head solid with the bed, thereby maintaining constant and perfect alignment of the spindle with the vees upon which the turret carriage travels.

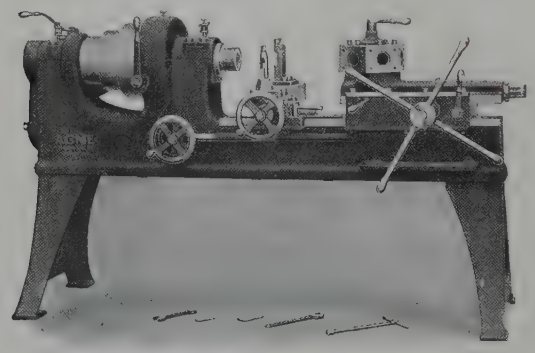


No. 3 Cincinnati Acme Universal Flat Turret Lathe Chucking Equipment



2¼" x 26" Cincinnati Acme Flat Turret Lathe Bar Equipment

The 2 1/4" x 26" Cincinnati Acme Flat Turret Lathe is shown with Bar Equipment. Taper gibs are furnished throughout to take up wear. Centralized Control is one of the important features of this machine.



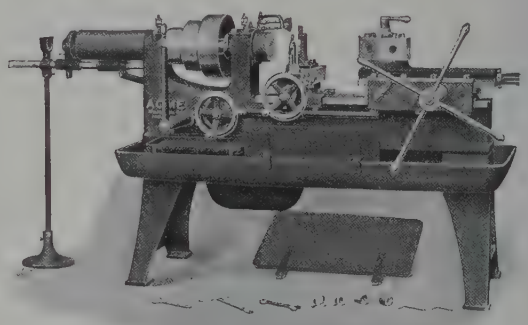
18" Cincinnati Acme Turret Lathe, Friction Back Gears

The 18" Cincinnati Acme Turret Lathe, with Friction Back Gears, is designed especially for rapid production. The Spindle is made of High Carbon Hammered Crucible Steel.

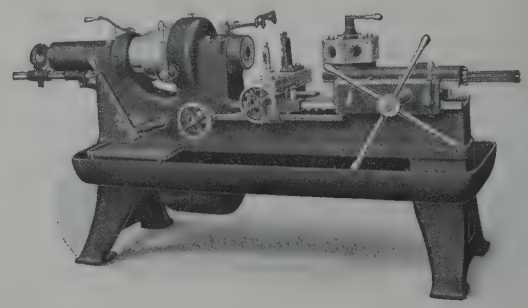
Screw Machines

The 1 1/4" x 8" Cincinnati Acme Screw Machine with Plain Head has a Turret which is hexagonal in form and is provided with six tool holes fitted with binder bushings; also bolt holes for securing tools to the faces. Power Feed is of the geared type, giving four changes. A geared Pump delivers an amply supply of oil.

The 2 1/4" x 11" Cincinnati Acme Screw Machine with Friction Geared Head is provided with Automatic Indepedent Stops for each turret face. The abutment for stops can be shifted to allow the turret a slight movement beyond stops when desired. The Cut-Off Rest is operated by handwheel and screw, and has adjustable stops.



1¼" x 8" Cincinnati Acme Screw Machine, Plain Head



2¼" x 11" Cincinnati Acme Screw Machine, Friction Back Gears

Summary

Manufacturing as we do, a complete line of Turret Lathes and Screw Machines, places us in a position to offer you the correct size and type of machine for your requirements.

We also can furnish a complete line of standard tool accessories, such as Turning Tools, Boring and Pointing Tools, Recessing Tools, Drill Chucks, Die Heads, etc.

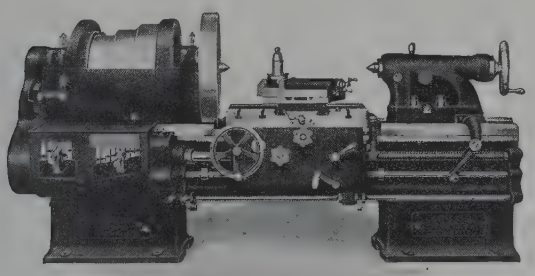
Special tooling equipments and lay-outs can be furnished on special request, and are made in accordance with blue prints and samples of work submitted.

We maintain an expert service department to help solve your production problems.

Engine Lathes

Sizes and Drives

The Quick Change Type of Engine Lathe manufactured by the Greaves-Klusman Company is built in a variety of sizes as listed below and arranged either with 3 step cone double back gear head, 4 step cone single back gear or geared



Double Back Geared Head Lathe

head as indicated in the table. These lathes may be furnished with motor drive either through belt with motor mounted on an oscillating plate within the cabinet leg, or through gears with motor mounted on top and power transmitted through a fabroid pinion. In either case the motor will be constant speed, direct or alternating current motor operating at 1200 RPM or less. Where a wide range of speeds are required and direct current is available, a 3:1 variable speed motor can be mounted on the headstock frame geared direct to a large sleeve gear on the spindle.

Features of Construction

Greaves-Klusman Engine Lathes represent the culmination of twenty years of lathe building. The superiority of these lathes are the result of the simplicity and practicability of their design, the care and accuracy exhibited in their construction, the high grade and modern equipment used in their manufacture, the rigid inspection to which each is subjected, and the intensive and specialized constant effort toward improving their design and method of manufacture.

Among the many distinctive features which have been developed in the Greaves-Klusman Lathes are:

Reinforced Bed—The twisting and bending strains have been reduced to a minimum by heavy ribbing which extends the full depth of the bed.

Reinforced Carriage—The carriage has a deep bridge and large wings with full length bearings on the bed.

Spindle Center—Back of center line of bed Patent Tailstock—Extension type which provides the necessary clearance for the carriage bridge in turning short work, and also permits the swiveling of the compound rest 90 degrees.

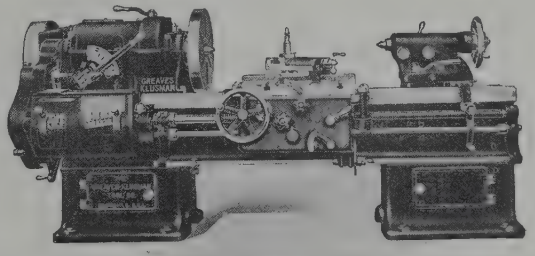
Apron—Box type, providing outboard support for all studs.

Gear Arrangement—One lever performs the functions of engaging the friction clutch and selecting the speed.

Tumbler Self-Locking Device for Reversing Lead Screw—The reverse tumbler on the headstock used for reversing the lead screw is provided with an eccentric lock, which makes it impossible for the tumbler to throw out when thread cutting.

Spindle—The spindle is turned from solid, high carbon spindle steel.

Alignment—The alignment of our lathes is given special attention in our erecting department and tested out under actual working conditions in the final inspection department. The cross feed alignment is taken from the large face plate which has been finished in position. The longitudinal alignment is determined by turning a long cast iron cylinder held by an adaptor on the spindle nose, both end diameters must measure exactly the same.

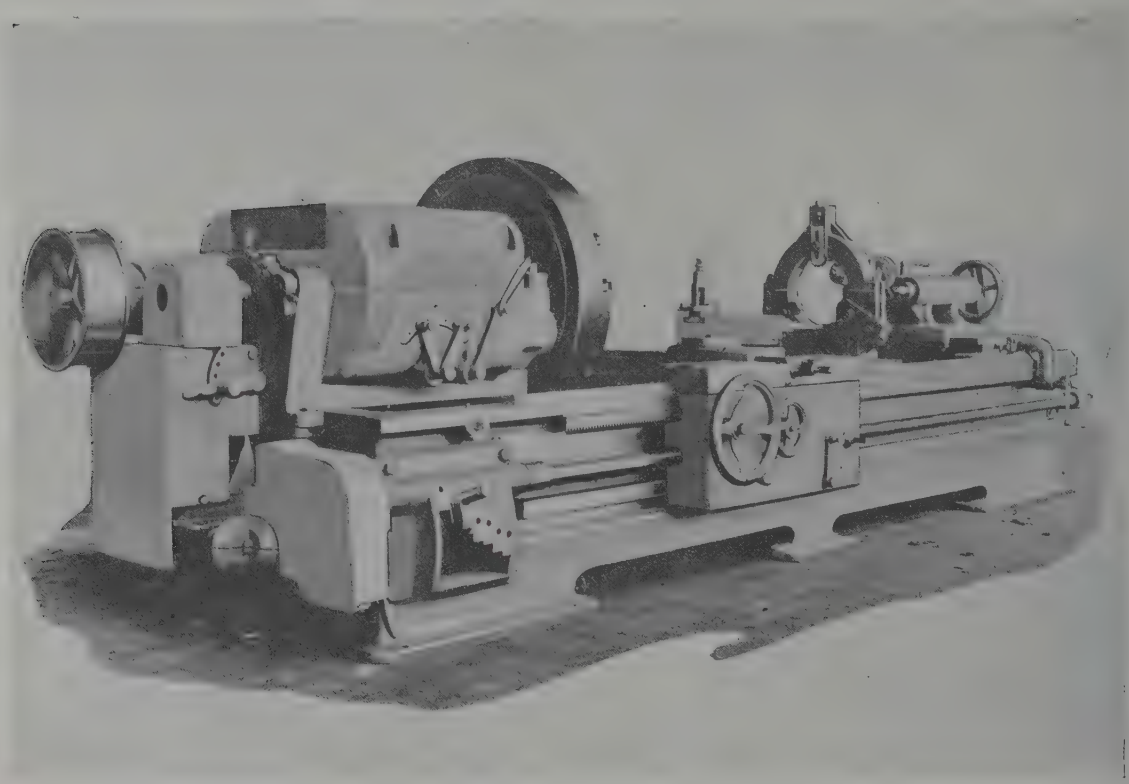


Geared Head Lathe

TABLE OF SIZES AND DIMENSIONS.

Size	14″x6′	16″x6′	18″x6′	20″x8′	24″x8′	24″x10′	30″x10′
Type	Heavy	Heavy	Heavy	Heavy	Medium	Heavy	Heavy
Types of Head furnished	4 Cone SBG 3 Cone DBG Geared	4 Cone SBG 3 Cone DBG Geared	4 Cone SBG Cone DBG Geared	3 Cone SBG Geared	3 Cone DBG Geared	3 Cone DBG Geared	3 Cone DBG Geared
Length of Bed	6′4¾″	6′7″	6′7″	8′10″	8′10″	10′8″	10′8″
Swing over Ways	16½″	18½″	20½″	22½″	25½″	27½″	33 1/2″
Swing over Carriage	10⅝″	13½″	15¾″	14¼″	17¼″	17¾″	23 1/2″
Takes between Centers	37¾″	36″	31″	3′10″	3′10″	4′10″	4′10″
Front Sp. Bg. D-L- Cone Head	2⅝″x3½″	2 13/16″x4 1/16″	3 5/16″x5 5/16″	4¼″x6 5/16″	4¼″x6 5/16″	4 5/16″x8″	4 13/16″x8″
Gear Head	2⅝″x4½″	3½″x4⅞″	3 5/16″x5 5/16″	4¼″x6 5/16″	4¼″x6 5/16″	4 5/16″x8″	4 13/16″x8″
Rear Sp. Bg. D-L Cone Head	1 15/16″x2⅛″	2 5/16″x3 3/4″	2 5/16″x4⅞″	3¼″x4 9/16″	3¼″x4 9/16″	3¾″x5 5/16″	3 3/4″x5 5/16″
Gear Head	1 15/16″x3½″	2 5/16″x3¾″	2 5/16″x5 5/16″	3¼″x4 9/16″	3¼″x5 5/16″	3¾″x5 5/16″	3 3/4″x5 5/16″
Hole through Spindle	1¼″	1½″	1 17/32″	1 5/16″	1 5/16″	2⅛″	2 1/8″
Taper of Centers—Morse	No. 3	No. 4	No. 4	No. 5	No. 5	No. 5	No. 5
Spindle Nose D-L	2¼″x1⅛″	3″x1½″	3″x1½″	3″x1½″	3″x1½″	4″x2⅛″	4″x2 1/8″
Spindle Nose Thread—U. S. S.	6	5	5	5	5	4	4
Width Belt—S B G	2½″	2¾″	3¼″				
—D B G	2¾″	3″	3½″	4½″	4½″	5″	5″
Range of Threads	2-56	2-56	2-56	1-56	1-56	½-28	½-28
Range of Feeds	.0061-.187	.0061-.187	.0061-.187	.0033-.185	.0033-.185	.0042-.222	.0042-.222
Compound Rest—Travel	2½″	4″	4″	6⅜″	6⅜″	8½″	8½″
Weight—Crated—Cone Head	1800	2400	3000	5600	5850	9700	10500
Gear Head	2000	2550	3400	6100	6350	10450	11250
Weight Bed per extra Foot	9	110	130	200	200	325	325

McCabe Lathes



Front View of McCabe "All-in-One" Lathe

Purpose of the McCabe "All-in-One" Lathe

If you have believed that the maximum in Lathe-building has been achieved, one look at the New McCabe "All-in-One" Lathe will convince you that it has been outdone.

Beginning on the new idea of a Lathe-bed, there has been built a Lathe on a firm foundation of realities.

The McCabe idea of concentrating "extra" Lathe capacity in one Machine is again incorporated in the most modern of Tools—the Lathe of all capacity, feeds and speeds, for every purpose.

And let this one thought "sink in"—when you are buying this Lathe, you are not buying an "experimental" machine. You are buying a Lathe of proved quality—proved ability—built by Manufacturers of Lathes, turning out Lathes only, for over a quarter of a century.

After years of reasearch, experimenting and the most rigorous tests, we have step by step developed this "unlimited range" in McCabe's Latest Patented Machine,—a phenomenal achievement in engineering Lathe design and construction.

There is no Lathe built you know less about—there is no Lathe built you should know more about—than the McCabe "All-in-One" Machine.

Not so much because it is "different" but because it is "better," for not in any way has any Lathe ever been built to compare with it—

For the big crowded Shipbuilding Plant where space is costly and High-speed production is important—

For the small Ship Repair Yard where a limited equipment of Tools, and one Lathe must handle everything.

You cannot see its big possibilities, without seeing the Lathe.

Features of Construction

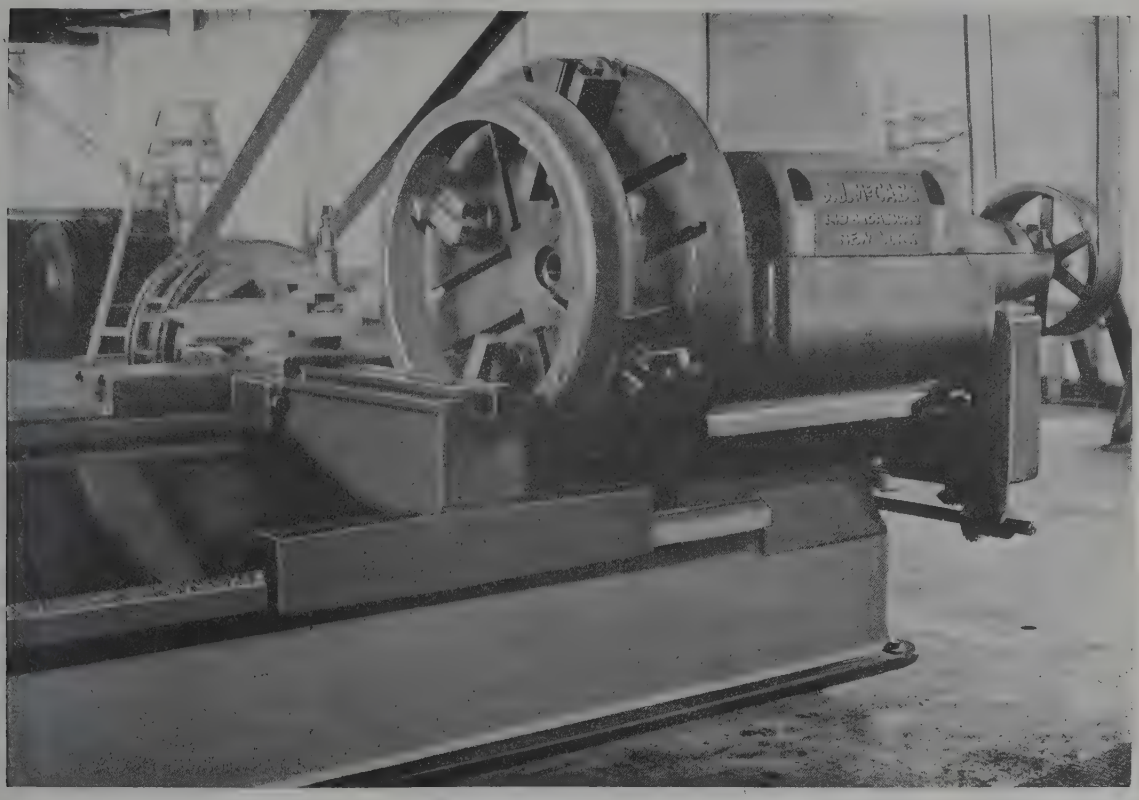
Among the many excellent and distinctive features of the McCabe "All-in-One" Lathe the following are briefly described as of particular importance and showing its principal advantages of design and construction.

A Sliding set-over Headstock is placed on a cross-slide, so as to increase the swing as desired from 24-in. to 40-in. 24-in. Double Back-geared Swing (Ratio 13 to 1) is obtained when the Head is brought forward to the front of the Lathe. 40-in. Triple-geared Swing (Ratio 156 to 1) is obtained when the Head is set over to accommodate the large Internal Geared Faceplate being put on, as the Vee on the back of the bed is dropped below the usual elevation in Lathe Construction.

A Full Swing over the Carriage can be secured the same as the full swing over the bed by quickly removing half of back end of carriage. The McCabe is the only Lathe ever built with this distinctive feature.

J. J. McCABE LATHE & MACHINERY CORP.

149 BROADWAY, NEW YORK, N. Y.



Rear View of McCabe "All-in-One" Lathe with Dropped Vee on Back of Bed Which Allows Work Up to 40 in. Swing Being Handled. Back Part of Carriage Shown Can Be Quickly Removed So as to Swing Work Full Diameter Between Centers.

A Selective Geared Head of massive design is furnished with 12 spindle speeds, arranged in progression from 184.2 to 1.6 r. p. m., changeable instantly by levers so as to cover all proper cutting speeds, when driving from line-shaft or constant-speed motor. This eliminates the necessity of any expensive variable-speed motors. Any lathe can be operated by either belt or motor if desired by simply removing the single pulley and substituting chain and gear so as to drive into the pulley on the shaft of the motor mounted directly on the Headstock of the Lathe. No special Headstocks for motor-drive are therefore required.

The Carriage is of improved simple construction, with double-plate apron entirely self-contained, and supported on the front of the bed, instead of being carried by the Vees in the usual manner. Actual tests show that all gears can be taken from the apron in 3 minutes without the necessity of removing the Lead-screw.

Bed—In designing this new style of Bed, a marked departure has been made from the established practice in Lathe-design. The Bed is extra wide, and of deep rigid construction, extending to the floor with a dropped Vee in the rear, which permits increasing the swing from 24-in. to 40-in. when the Headstock is set over. A Bed of any required length can be furnished.

The Spindle is double-nosed and usually large in diameter. The Nose is left blank, extending beyond the thread; thus the bearing surface that carries the strain of the Face-plate and work is at each side of the center threaded part, which is merely for the purpose of screwing the Face-plate on or off. This insures perfect alignment and great ridigity.

The Bevel-gear drive is furnished with Sliding Change gears for feeds, making it unnecessary to remove a single gear—a big improvement over the odinary Spur-gear drive which necessitates adding on gears to get different feeds.

The Quick-change Gear Box is compactly mounted in the bed under the Headstock with operating levers convenient to the operator. An unusually wide range of Thread-cutting and feeds is obtainable. The mechanism also permits the insertion of Special Change-gears whenever required to cut special threads.

The Tailstock is of massive design, having a long bearing on the shears with Clamps of new design, and with toggle arrangement, operated by a half turn of eccentric-shaft to give a positive lock.

The production of a lathe of this type far exceeds that of a Lathe of the ordinary style, for the limitations of a regular lathe of one size are overcome by this New McCabe unlimited capacity "All-in-one" Machine.

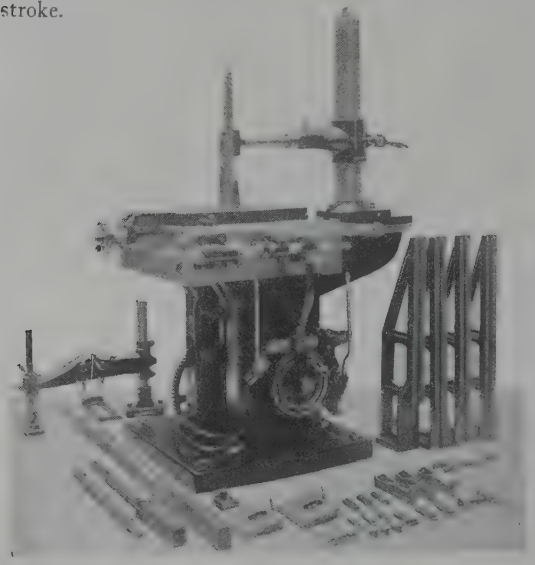
J. J. McCABE LATHE & MACHINERY CORP.

149 BROADWAY, NEW YORK, N. Y.

Morton Planers, Shapers and Keyway Cutters

Keyway Cutting Machines

Morton Keyway Cutting Machines are adaptable to such jobs as cutting keyways in wheel centers, eccentrics, eccentric arms, piston rods, crossheads, motion work arms, ports in valve chamber bushings and many other similar jobs. These machines are built for 18, 24, 30 and 48 inch stroke.



Keyway Cutting Machine

Distinctive Features

Strength, rigidity, durability, convenience and simplicity are the standards which govern the design and construction of the Morton Keyway Cutting Machine. All parts are designed with reference to the large stresses to which a machine of this class will necessarily be subjected.

All sliding bearings are eliminated, the table being bolted rigidly to the column. This arrangement eliminates the wear which is caused by the strain of heavy work and excessive cuts on a sliding bearing.

The Cutter Bar Backing is continuous the entire length of the stroke, and is provided with a feeding and relieving mechanism, and the cutter bar is supported throughout the entire length of the cut. The backing mechanism is adjustable vertically on the post to meet the varying requirements.

The Extension Bearing may be removed and the regular top gauge plate used, and the machine can be operated on small work.

A Reverse Lever for short stroking is placed on the operating side.

Operating Advantages

All work is always centered by the Bore, which is the only accurate method.

Until the cutter is operating the full length the Reverse Lever for short stroking is particularly advantageous in entering the cut.

Feeding and relieving are automatic, resulting in unexcelled ease of operation.

Moving the work for adjusting or feeding is unnecessary, because of the rigidly bolted table and elimination of sliding bearings.

Small work is quickly secured by the Rapid Binding Attachment.

Large work weighing 10 tons or more is operated as easily as small work, as the cutter is fed and adjusted to the work and the heavy weight and table do not move.

The machine may be set to cut a keyway of a given width, depth and taper before placing the work on the table, without the use of a rule or other measuring device.

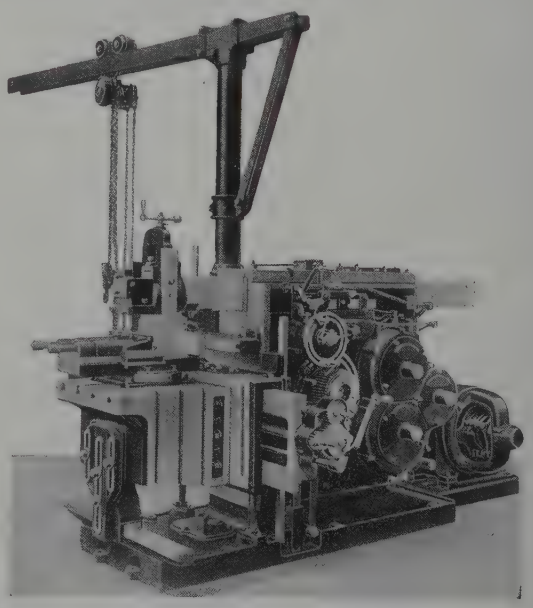
The machine is fully equipped for general work, is accurate, efficient and economical to operate, and the cutters are easily made.

Draw Cut Shaper

The Morton Draw Cut Shaper is particularly well adapted to handle such jobs as foundation chocks, bearing pads, general bearing work, rod brasses, eccentrics and straps, crosshead shoes, slide valves and valve strips, crosshead main rod keys and key blocks, frame keys, and other jobs within a range of the stroke limit of the machine. These machines are built for 30, 36 and 48 inch stroke, for electric or belt drive and are furnished with a crane serving 12 feet diameter of floor space.

Advantage of Draw Cut

The draw cut principle, which has been fully demonstrated to be the proper principle on which to construct shapers, proves its value where heavy cuts or delicate, accurate finishing cuts are desired. The thrust of the cut is transferred through the back bearing directly to the face of the column, eliminating the strains on the rail and other bearings in heavy cutting. A tensile strain is exerted in the ram, thereby eliminating vibrations, as the heavier the cut, the less tendency to vibrate.



New Type Heavy Duty Draw Cut Shaper

Morton Planers, Shapers and Keyway Cutters

Distinctive Features

The column is a box section casting having square rail bearings. All running bearings are fitted to carefully bored holes and are bolted, insuring perfect alignment and rigidity.

The ram, of high grade steel casting, has a bearing surface on all four sides throughout the entire length of the column and has provision for compensating wear on side and top.

The head, of steel throughout, is provided with special adjustable clamps to prevent the slide and base from springing open. A clamp device on the tool block permits the tool to be set at any desired angle.

The knee is of special design to enable the work to be secured and squared in both directions.

The table is particularly large and of special construction to permit securing and quick removal or positioning.

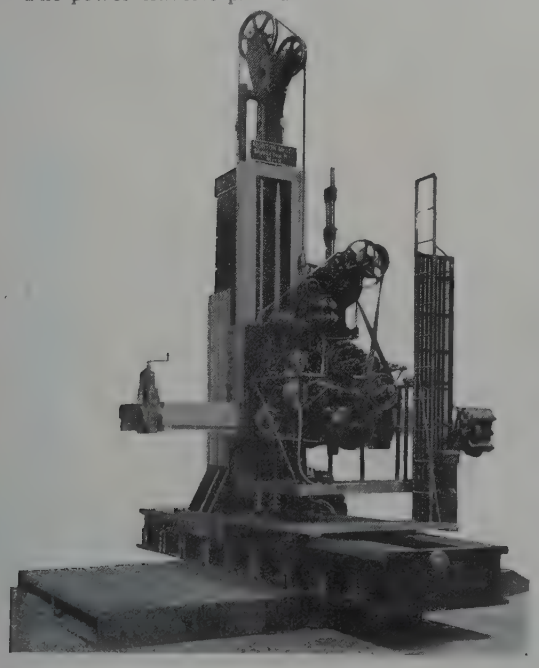
The vise is so designed as to overcome the tendency of the work to raise or buckle on the parallels and is strongly constructed of a special metal.

The adjustable back bearing transfers the thrust of the cut directly against the column of the machine and by forming a stop for the work makes it unnecessary to clamp the work so firmly as to spring it.

The clutches are of new design. The friction surfaces being made of flat revolving discs, eliminate the delays and repairs caused by the use of close fitting periphery surfaces which readily lose their size. A clutch is provided for stopping and starting the machine independent of the main drive.

The stroke is adjusted by tappets on a circular disk and adjustments can be made while the machine is in motion. It can be reversed by a lever at the will of the operator. The adjustments are so perfect that the machine will take a cut and reverse close to a line.

The power traverse provides either vertical or horizontal adjustment and is arranged for quick engaging and disengaging by a single lever. This feature effects a great saving of time as it only requires 30 seconds to move the apron the full width of the crossrail and 40 seconds to raise or lower the crossrail.



72" Traveling Head Planer

84" Traveling Head Planer Machining a Large Marine Engine Bed

The friction feed is of a special new construction with large friction surface, wide range and rapid adjustment, any desired feed may be obtained from 1/32 to 5/8 inch horizontally and 1/32 to 5/16 inch vertically. The feed screws are all of the acme thread, correctly cut and coarse pitch.

The main driving pinion and clutches are run in oil to insure proper lubrication.

A regular two speed belt drive countershaft is furnished unless electric drive is specified. Two cutting speeds are obtained by the use of an additional loose pulley, employing two belts from the line shaft.

We are prepared to furnish an electric drive using a 2 to 1 variable speed motor.

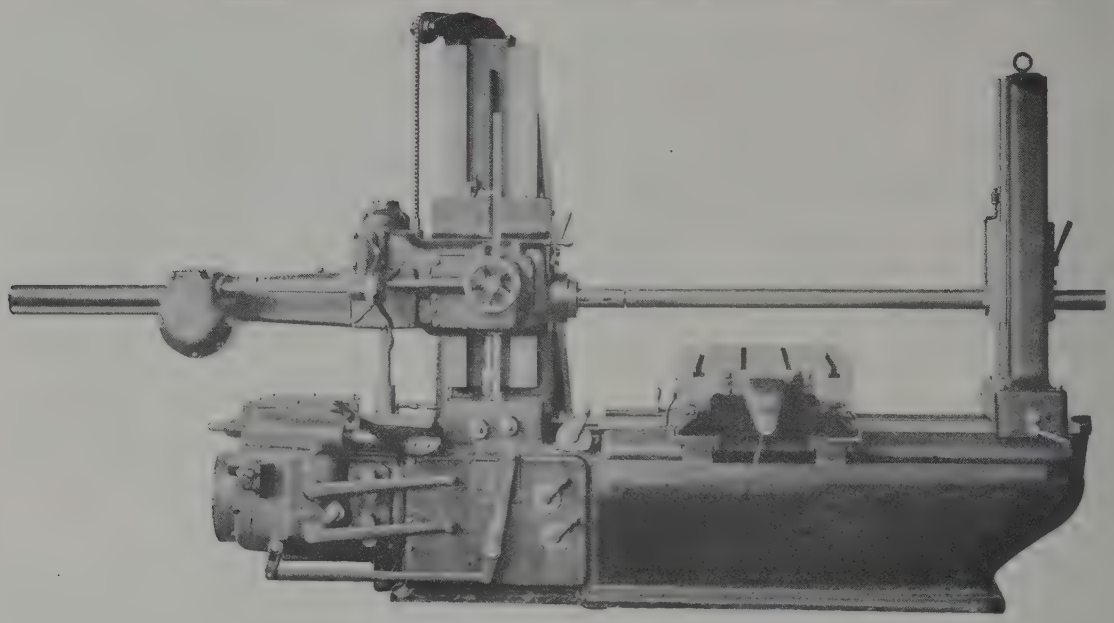
Traveling Head Planer

The Morton Draw Cut Traveling Head Planer is practically a large size shaper having the advantages of the Morton distinctive draw cut and the same general excellence of distinctive features of design and construction.

It is particularly adapted to heavy or medium work and may be used for boring, planing, milling, slotting and many other operations, saving resetting and is easily changed for any operation.

These machines are built in the following sizes: 60 inch stroke machine with 5 ft. vertical feed, 9 ft. horizontal feed; 72 inch stroke machine with 8 ft. vertical feed, 10 ft. horizontal feed; 84 inch stroke machine with 10 ft. vertical feed, 12 ft. horizontal feed, and larger machines can be finished with increased stroke, height and length of bed. 84 inch stroke Traveling head Planer, having 10 feet of vertical movement and 19 feet of horizontal movement, machining a large marine engine bed. It machines all frame pads, pillow block cap fits, and bores and faces the main journals, using a special right angle boring attachment; the work being accomplished at one setting of the casting.

Horizontal Boring Mills



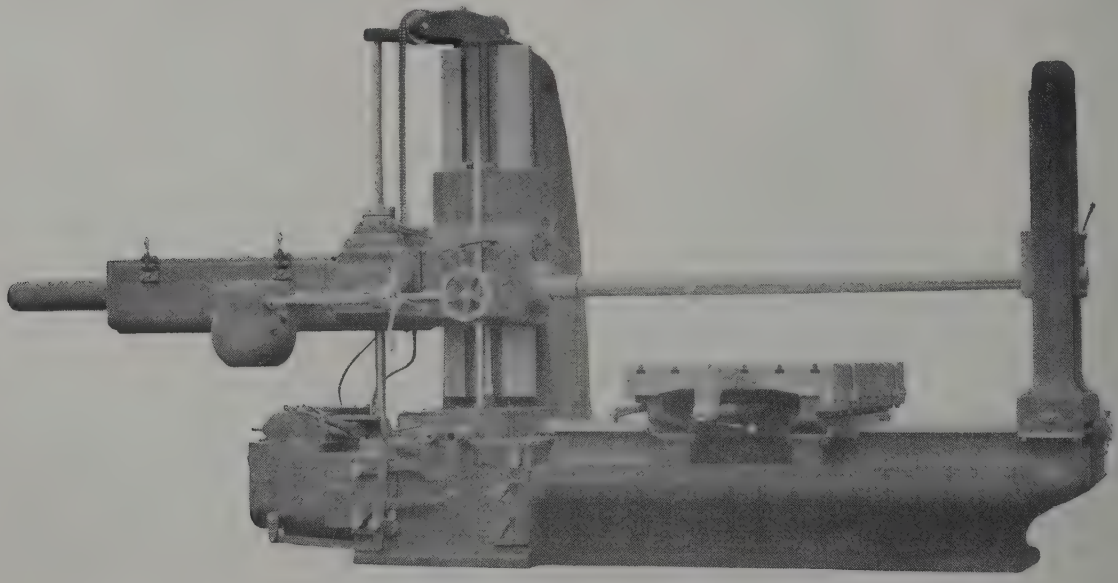
No. 5-A Horizontal Boring, Milling, Drilling and Tapping Machine

For Rapid Production and Precision

The best known methods of modern machine tool practice, combined with several distinctive improvements and an unusual simplicity and accessibility of all parts, characterize the Defiance Horizontal Boring, Milling, Drilling and Tapping Machines. These machines can be furnished in three sizes, as shown in the accompanying table of specifications, for belt or motor drive. The No. 5-A and No. 6 are illustrated herewith. The No. 5, which is not illustrated, is very similar to the No. 5-A, the chief difference being that the No. 5 is not equipped with outboard bearing. Various attachments, such as vertical milling attachments, auxiliary tables, boring bars, circular swiveling table, face milling cutters, etc., can also be supplied if desired.

TABLE OF SPECIFICATIONS

	No. 5	No. 5A	No. 6
Morse taper in spindle	3	3	4½
Diameter of spindle	3″	3″	4½″
Travel of spindle	24″	24″	60″
Vertical adjustment of spindle head	24½″	29″	36½″
Number of speed changes	10	10	10
Range of speeds, R. P. M.	15-336	15-336	7½-157
Number of speed changes for spindle, head, saddle or platen	12	12	12
Working surface of platen	24″x48″	24″x60″	36″x64″
Crossfeed to platen	40″	60″	64″
Longitudinal adjustment of saddle	36″	36″	48″
Horsepower required	7½	7½	10
Floor space occupied	108″x156″	149″x156″	160″x216″
Shipping Weight—Pounds	12,900	15,875	26,000



No. 6 Horizontal Boring, Milling, Drilling and Tapping Machine

THE DEFIANCE MACHINE WORKS, DEFIANCE, OHIO

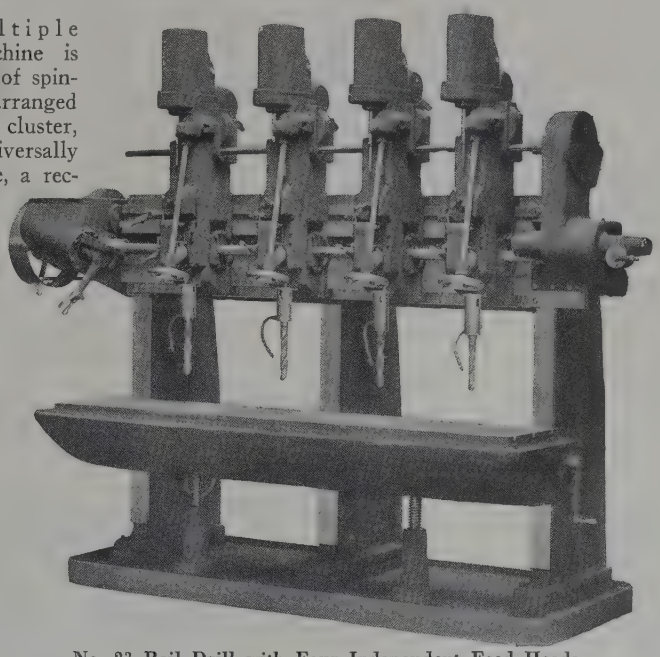
Multiple Spindle Drilling Machines

The Defiance Multiple Spindle Drilling Machine is equipped with a group of spindles with fixed centers arranged in a straight line or in a cluster, or with a group of universally adjustable spindles arranged in a straight line, a rectangular or circular cluster. This machine has many distinctive features to meet the extensive requirements of a production machine for multiple drilling operations.

Independent Feed Rail Drill

The Defiance Independent Feed Rail Drill, as shown in the accompanying illustration and covered in the first column of the specification table shown below, will serve efficiently wherever the work includes heavy gang drilling or heavy jigged drilling such as on ship's strakes, bulkhead plates, etc. When used on jigged work, the compactness of this drill enables one operator to keep a greater number of spindles—either singly or in groups—continually in operation and, as a result, the operator is kept constantly reloading the jigs while a group of drills is kept constantly producing.

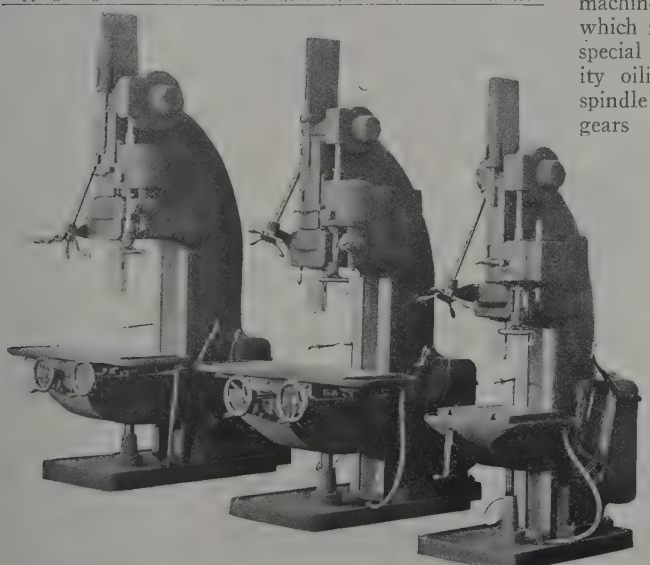
Only the most modern methods of machine tool practice are incorporated in the design and construction of this machine. The speed mechanism, feed mechanism, and each spindle head are of unit construction, and each unit is readily accessible without disturbing mechanism other than that contained in itself.



No. 23 Rail Drill with Four Independent Feed Heads

SPECIFICATION TABLE — DRILLING MACHINES WITH PLAIN TABLE

Machine	Mult. Spindle	Ind. Feed	No. 2 24″	No. 3 24″	No. 3 36″	No. 4 36″
Capacity in solid steel	8¾″ hole	2″	2″	3″	3″	4″
Length of power feed	14″	12″	16″	16″	16″	18″
Morse Taper in spindle	No. 3	No. 5	No. 4	No. 5	No. 5	No. 6
Working surface of plain table	20x36	20x98	20x20	20x22	24x26	30x30
Vertical adjustment to table	12	12	13	15	15	15
Feed changes—number	vari'ble	3	4	4	4	4
" " range	vari'ble	006-14	007-046	007-046	007-046	007-046
Spindle Speeds—number	6	6	8	8	8	8
" " range	110-334	25-186	51-408	51-408	51-408	25-204
Horsepower required	7½	10	7½	10	10	15
Floor Space	42x96	56x44	33x81	42x86	42x86	42x86
Shipping Weight—Pounds	6,500	14,880	4,550	6,150	8,155	10,000



No. 4—36″ Machine (Compound Table). No. 3—36″ Machine (Compound Table). No. 2—24″ Heavy Service Drilling Machines

Heavy Service Drilling Machines

The Defiance Heavy Service Drilling Machines are built in four sizes as listed in the specifications in opposite column and have capacities, with a large factor of safety, for driving 2″, 3″ 4″ high speed drills in solid steel.

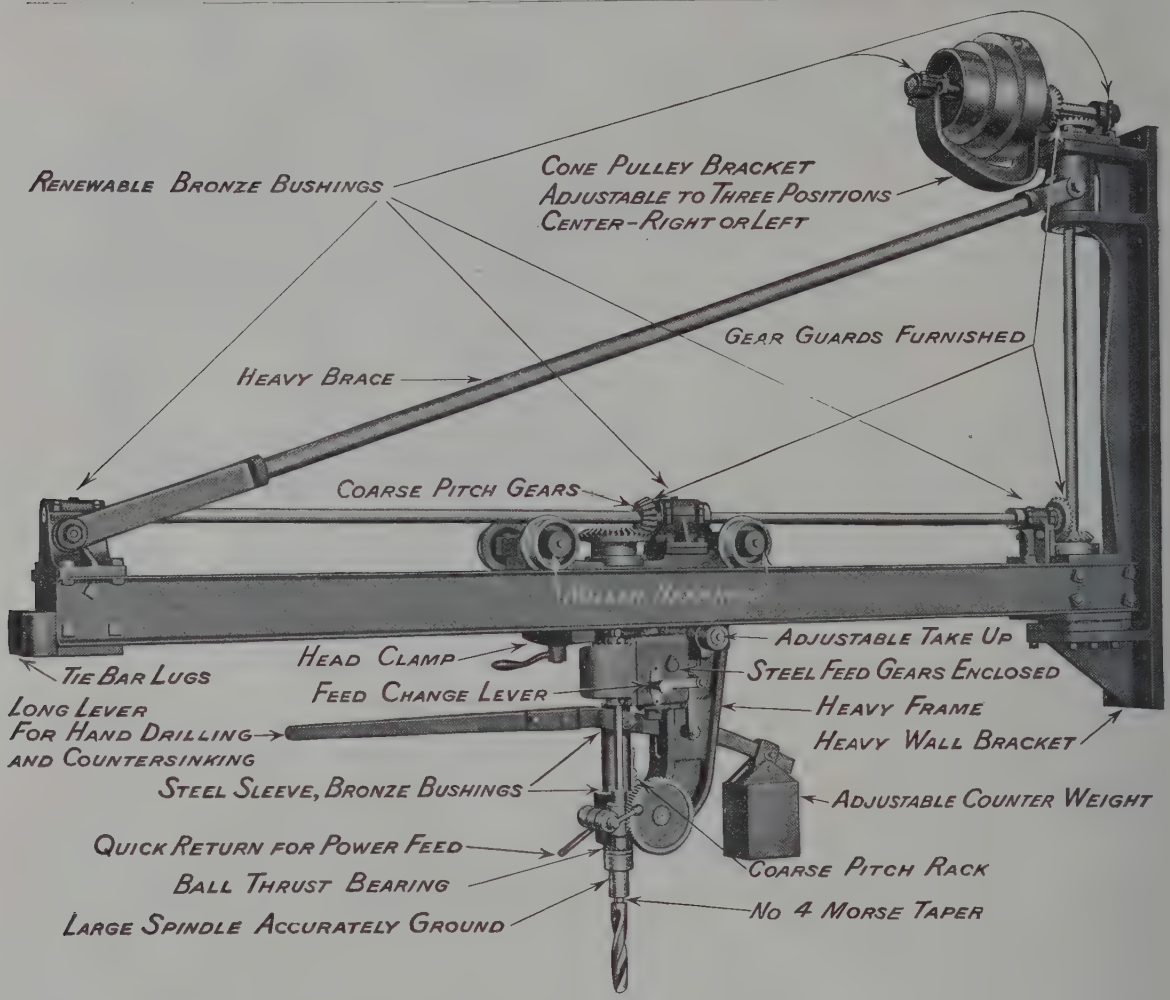
These machines have been designed to give constant service without the constant care usually given drilling machines, having embodied in them several features which make them very rigid and efficient tools. The special features of construction include continuous gravity oiling system, hardened gear cones for varying spindle speeds, large thrust bearing for helical gears used to drive the spindle, Hyatt roller bearings on all drive bearings, and S. K. F. thrust bearing taking the spindle thrust.

The Compound Table is not an attachment to the regular table furnished but may be furnished with all of these Heavy Service Drilling Machines. When the compound table is furnished it is necessary to use a higher column, in order to give the same maximum distance from nose of spindle to table as on the plain machine. The dimensions of the four sizes are given in the table below.

DIMENSIONS OF DRILLING MACHINES WITH COMPOUND TABLE

Machine	No. 3-24″	No. 3-36″	No. 4-36″
Height of Machine	9x8¾″	9x8¾″	11x1¼″
Working Surface	17¼x35	20x48	20x48
Longitudinal adjustment	18″	28″	28″
Crosswise adjustment	9″	14″	14″
Floor space	60x92	80x96	80x109
Shipping Weight—Pounds	7,660	9,220	11,500

Wall Radial Drills



The Lynd-Farquhar New Wall Radial Drill

The Lynd-Farquhar New Wall Radial Drill is built in four sizes as shown on the following page, for drills up to 2½ inches in diameter.

For belt drive a self oiling countershaft with tight and loose pulleys 18″ diameter and 4½″ face to operate at 350 R. P. M. is furnished as part of the standard equipment. The cone pulleys on the countershaft and machine are 4″ face and 11″, 13″ and 17″ diameter. A wall bracket at the top of the machine with bevel gear housing can be located at three positions for convenience in connecting belt drive from the countershaft.

For motor drive a 3 to 5 HP Variable Speed Motor may be used, mounted on a special bracket which is substituted for the bracket carrying the bevel gear housing.

This drill is a real machine tool, carefully designed, and made of the best materials and workmanship throughout, particular attention being given to locating the entire drill within easy reach of the operator.

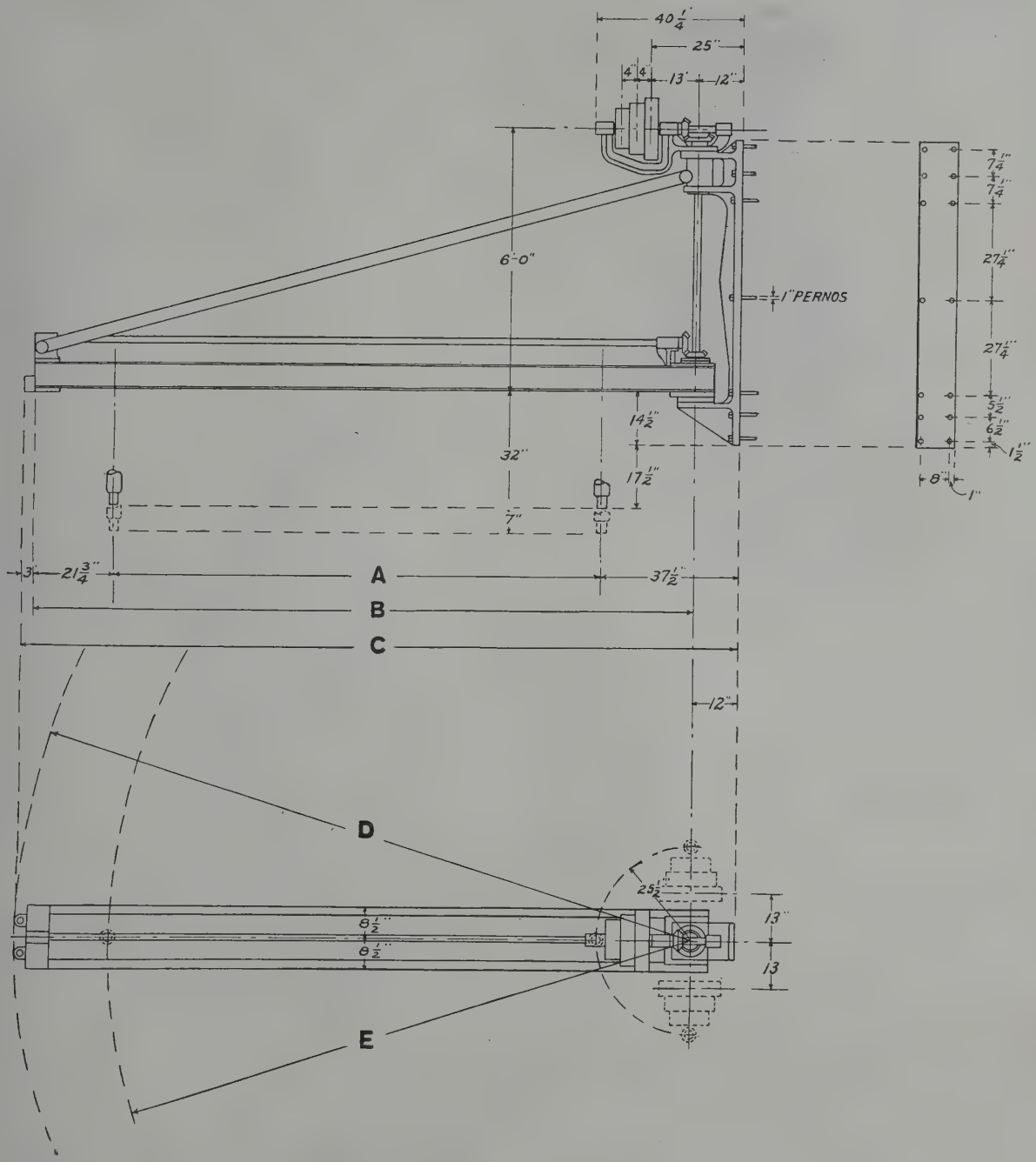
The Arm is of extra heavy channels amply supported at the outer end. Tie bar lugs are provided at this end to receive tie bar when desired for extra heavy drilling, and an eccentric wheel on the under side of the arm keeps the carriage in proper adjustment along the channels.

The Head is exceedingly rigid, and mounted on four flanged wheels fitted with roller bearings, and the clamping bar is conveniently located. The Wall Bracket is heavily ribbed and where bolted to the wall is 10″ wide, and 6 ft. 10½″ high.

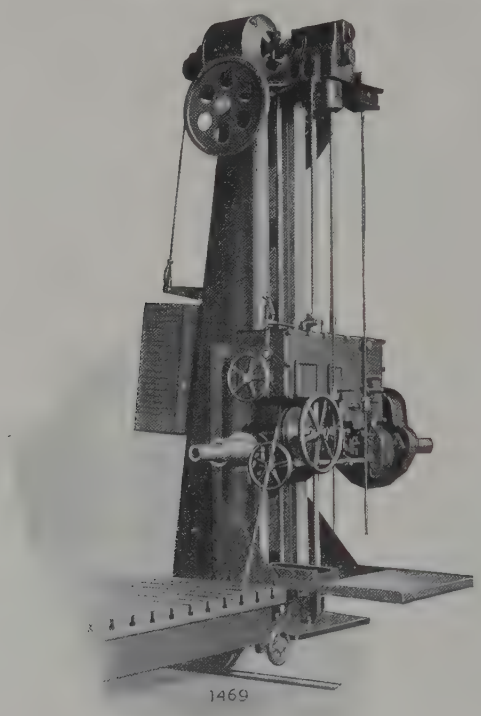
The Geared Power Feed permits two changes, .015 and .025 per spindle revolution, which can be made during operation. An automatic release at the end of the 7″ spindle traverse prevents damage to the feed gears. The Hand Lever Feed has removable handle and is nicely counterbalanced by adjustable weight for light drilling and countersinking.

The Spindle is of high carbon steel and runs in long removable bronze bushings within a steel sleeve. It has No. 4 Morse Taper hole and is fitted with high grade heavy duty ball thrust bearing.

Wall Radial Drills



SIZE	Drills to Center of	A Traverse of Head	B Center of Bracket to End of Channel	C Wall to End of Arm	D Center of Bracket to End of Arm	E Maximum Distance Center of Bracket Center of Spindle	Net Weight Lbs.	Crated Weight Lbs.	Boxed Weight Lbs.	Cubic Feet Boxed
7 ft.	14 ft Circle	5 ft - 1¾ in	9 ft - 1 in	10 ft - 4 in	9 ft - 4 in	7 ft - 3¼ in	3580	3580	4080	176
9 ft.	18 ft Circle	7 ft - 1¾ in	11 ft - 1 in	12 ft - 4 in	11 ft - 4 in	9 ft - 3¼ in	3483	3710	4310	209
11 ft.	22 ft Circle	9 ft - 1¾ in	13 ft - 1 in	14 ft - 4 in	13 ft - 4 in	11 ft - 3¼ in	3615	3870	4570	242
13 ft.	26 ft Circle	11 ft - 1¾ in	15 ft - 1 in	16 ft - 4 in	15 ft - 4 in	13 ft - 3¼ in	3750	4025	4850	275



Horizontal Drilling and Boring Machine

Horizontal Drilling and Boring Machines

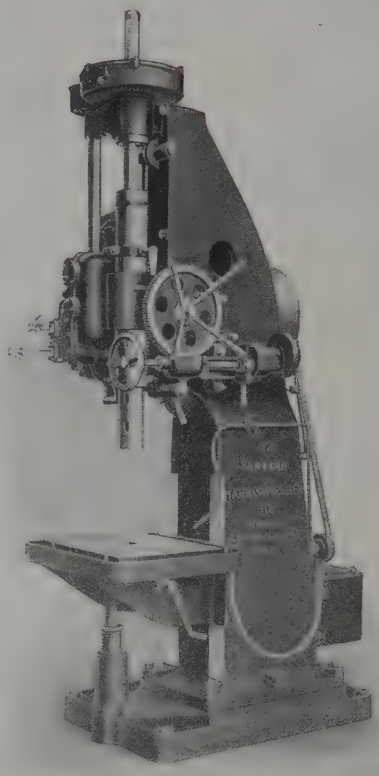
The P & H Horizontal Drilling and Boring Machines, as illustrated above, are specially well adapted to an extremely wide scope of work, and will drill, bore, ream, or tap large or small holes with equal facility. They are particularly adapted to the machining of bulky pieces, permitting ease of handling without sacrifice of accuracy.

These machines are built for motor drive in a variety of sizes and in two types,—the two column type, designed for a two point support; and the self-contained type, either stationary or portable. The motors are all direct connected and of variable speed, and are readily reversible for tapping purposes.

The compactness of design, the ease of operation, and the versatility of performance of the P & H Horizontal Drilling and Boring Machine make it indispensable equipment in the modern shipyard machine shop. The mechanism consists essentially of a vertical column, a saddle enclosing the operating parts which move vertically upon this column, and a work table upon which the piece to be worked is "spotted". Among the many distinctive features of the machine are the detached work table moving on a standard gauge track, to permit being taken to any part of the plant, operation over a wide surface of the piece to be machined by means of the horizontal movement of the work table; drilling, tapping, and facing without changing the spindle setting by simply changing fittings in the spindle; the centralization of all controlling and operating parts on the saddle for convenience of the operator; and an exceptionally wide range of activity and flexibility provided by the use of accessories such as turn table, offset drill arm, and facing head which may be furnished.

Heavy Duty Vertical Drill

The P & H Heavy Duty Vertical Drill, illustrated below, is of particularly heavy and rigid construction for severe service. It will operate a 3 1/2" high speed drill through solid steel and is arranged for nine spindle speeds and six feed changes. The construction of this machine is of the highest grade throughout and like all other P & H products is of the best materials and workmanship.



Heavy Duty Vertical Drill

Other Products

The Pawling and Harnischfeger Company can also furnish other machine tools adaptable for use in shipyard machine shops such as radial wall drills, wall cranes and jib cranes.

The Radial Wall Drill is made covering 71 square feet of surface area, to operate at variable spindle speeds from 90 to 270 RPM with No. 4 Morse Taper and a spindle feed of 15". This drill has a boom swing of 180 degrees and a 5 HP. driving motor.

A Centering Machine is made for accurate and rapid drilling, countersinking and centering of shafting. This machine is furnished for various capacities.

Safety Set Screws—Socket Head Cap Screws

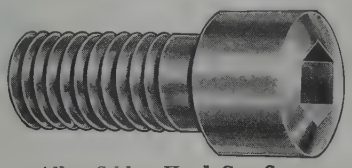
Safety Set Screws

Allen Safety Set Screws are over 30 per cent stronger than broached hollow screws—the only other kind made. The deep hexagon holes are clean and perfectly formed down to the bottom, giving greater leverage and leaving plenty of metal for the necessary strength at the point. The "Allen" has accurate die cut threads made to standard

Allen Safety Set Screws

gages and is perfect in lead. The product is heat-treated in the most scientific manner, to obtain uniform hardness. The U. S. Government, leading manufacturers and machine tool builders are using these set screws in preference to ordinary broached screws.

We make Allen Safety Set Screws in all sizes from 1/4 inch to 1 1/2 inch in diameter and up to 6 inches in length. Any style of point or thread at no extra



Allen Socket Head Cap Screw

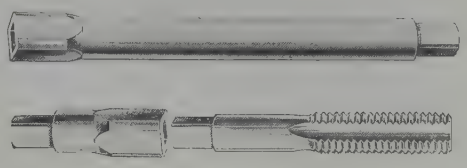
cost. A necessary number of our special wrenches will be furnished with every 100 screws.

Short lengths—We make a specialty of short length screws. The patented Allen process makes possible a hollow screw much shorter than its diameter.

Socket Head Cap Screws

The Allen Cap Screws eliminate all troubles due to slotted heads. They can be set up fully as hard as the ordinary cap screws, and are much more convenient in close corners where there is not room to apply an "S" wrench.

Our screws are all threaded accurately to standard gages and are perfect in lead. The heads are absolutely true with the body of the screw, thus saving the bother and expense of grinding off the sides to make them fit the counterbore, which is often necessary with the slotted cap screws.



Tap Extensions

Allen Socket Cap Screws can be set up as hard and as often as you want without marring the heads, thereby greatly improving the appearance of the machine.

Tap Extensions

The Allen Tap Extension sets consist of three pieces, 2 inches, 4 inches, and 6 inches long, and may be used on all standard taps from 1/4 inch to 1 inch. The shortest extension adds 1 1/2 inches to the effective length of the shank, while the three together give six different lengths ranging up to 11 inches.

Types of Allen Safety Set Screws

Round Point | Cone Point | Cup Point | Flat Point | Dog Point | Half Dog Point

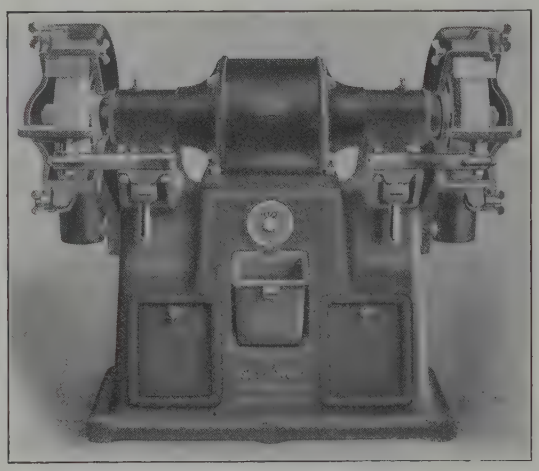
DATA TABLE—ALLEN SAFETY SET SCREWS AND SOCKET HEAD CAP SCREWS

Diameter inches	1/4	5/16	3/8	7/16	1/2	9/16	5/8	11/16	3/4	13/16	7/8	15/16	1	1 1/8	1 1/4	1 3/8	1 1/2
THREADS FOR SAFETY SET SCREWS AND CAP SCREWS																	
U.S.S. or V Threads, per inch	20	18	16	14	12–13	12	11	11	10	10	9	9	8	7	7	6	6
S. A. E. Threads, per inch	28	24	24	20	20	18	18	16	16	—	14	—	14	12	12	12	12
Whitworth threads, per inch	20	18	16	14	12	12	11	11	10	10	9	9	8	7	7	6	6
FOR SAFETY SET SCREWS																	
Size of hexagon hole, inches	1/8		5/32	3/16	1/4	1/4	5/32	5/32	3/16	1/2	1/2	3/16	3/16	1/4	5/16	3/4	3/16
Wrenches free, per 100 screws	8	8	8	8	8	8	8	8	8	8	8	4	4	4	4	4	4
DIMENSIONS OF CAP SCREWS																	
Diameter of head, inches	3/8	7/16	1/2	9/16	5/8	3/4	7/8		1		1 1/8		1 1/4				
Oval head, length of side, inches	5/16	11/32	11/32	11/32	11/32	11/32	11/32		41/64		41/64		41/64				
Length of flat head, inches	1/4	5/16	5/16	7/16	1/2	5/8	5/8		3/4		7/8		1				
Size of hexagon hole, inches	5/16	7/16	5/16	5/16	3/8	3/16	1/2		5/16		5/16		5/16				
Wrenches free, per 100 screws	4	4	4	4	4	4	4		4		4		4				

THE ALLEN MANUFACTURING CO.

HARTFORD, CONN.

Portable Electric Machine Tools

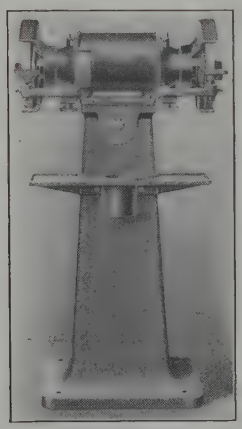


Heavy Duty Ball Bearing Grinder

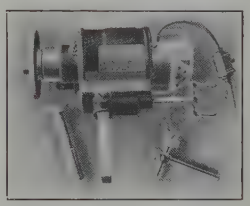
Floor Grinders

Grinders for mounting on floor, bench, portable truck, or machine tools of various types can be furnished for alternating or direct current and with various sized wheels.

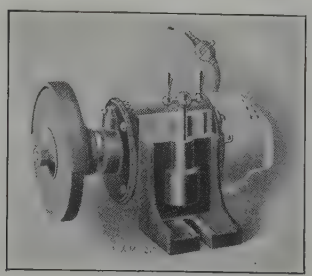
The Heavy Duty Ball Bearing Grinder shown above is made in 5 and 10 H. P. sizes and is of particularly sturdy construction for use where power and dependability are essential. The No. 4 Floor Grinder illustrated is made in four sizes, ½ to 3 H. P. The No. 2 Parallel Grinder shown is made in 4 sizes, ¼ to 3 H. P., and is adapted for all kinds of surface grinding, being designed to be attached to the tool post of a lathe, the vise of a milling machine or the head of a shaper, planer, or boring mill. A lighter Tool Post Grinder is also made, as shown, in ¼ and ½ H. P. sizes for operation in any position and particularly useful in grinding dies, rolls, holes of collars, reamers and cutters, etc. Bench Grinders are also made in a number of sizes for mounting on a bench or portable base. Full details of construction and sizes are described in catalogs which will be sent on request.



No. 4 Floor Grinder



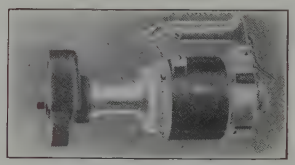
Tool Post Grinder



No. 2 Parallel Grinder

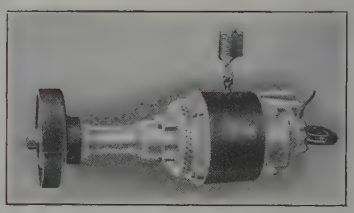
Portable Grinders

Portable Grinders are also made in 10 models and in 3 sizes, ¼ to 1 H. P. for both direct and alternating current. These grinders are of excellent construction throughout and the number of sizes and types available enables us to meet any requirement of service.



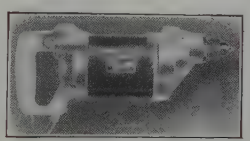
Portable Grinder with Top Handle

Portable Grinder with End Handle



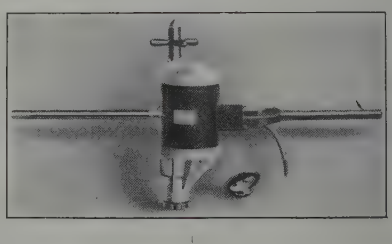
Drills and Reamers

Ball Bearing Hand and Breast Drills can be furnished in a wide variety of styles, and for direct current for capacities up to 1¼", alternating current for capacities up to 1¾", and with universal motor for operation on either direct current or single phase alternating current of the same voltage for capacities up to ⅝". Bench Drilling Stands and Universal Portable Radial Drills can also be furnished.



Ball-Bearing Hand Drill

Heavy Duty Drill and Reamer



Other Products

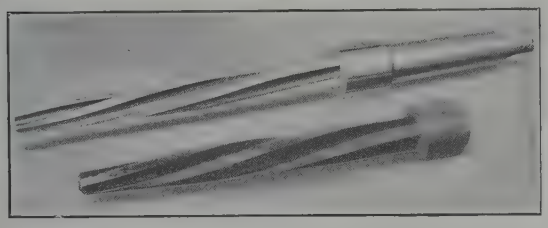
Many other types of Portable Electric Tools are made, such as Universal Screw Drivers, Buffers and Buffing Lathes, Reamers, etc.

Tool Re-Manufacturing

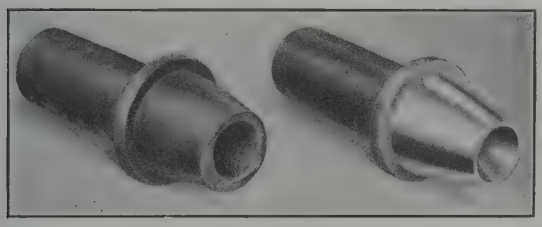
Tool Re-Manufacturing

Every urgency of present day ship production and every call for the more expeditious development of raw materials is a summons to make your tool equipment more useful and more enduring.

To be most useful, that equipment must always be kept in perfect working condition, ready for any emergency. To endure, it must have built into it rugged, wear resisting qualities that will withstand modern forcing.



Bridge Reamers Are Completely Re-Manufactured Without Annealing. Machine Reamers Are Restored to Original Sizes



Rivet Sets Are Annealed and Turned to Shapes and Sizes Required and Re-hardened at a Fraction of the Original Cost

Tools that have been "through the mill" and have proved their quality by remaining intact should not be discarded when undersize or badly worn, but should be considered as far more valuable than new tools, because they will again prove equal to the test if Re-Manufactured.

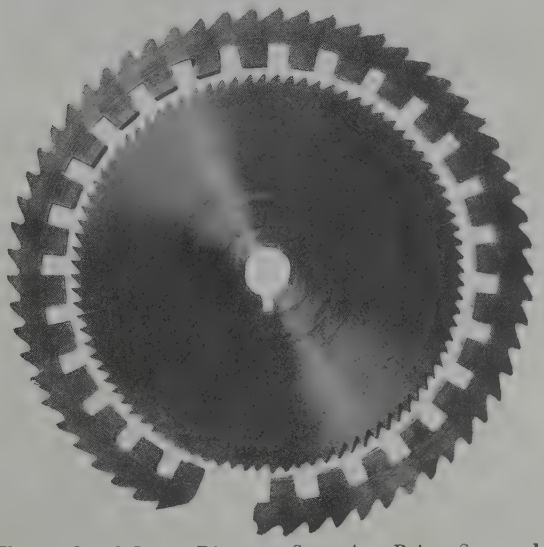
The discarding of cutting tools of proved qualities is the one costly leak that shipbuilders can effectually caulk through Re-Manufacture.

High Speed Drills, Reamers, Milling Cutters, in fact all metal cutting tools can now be made to produce greater results than ever before, to illustrate: A large Michigan Shipyard reamed 585 holes with a Re-Manufactured Reamer as compared with 200 holes, the best results obtained from a new reamer. That is increasing tool efficiency.

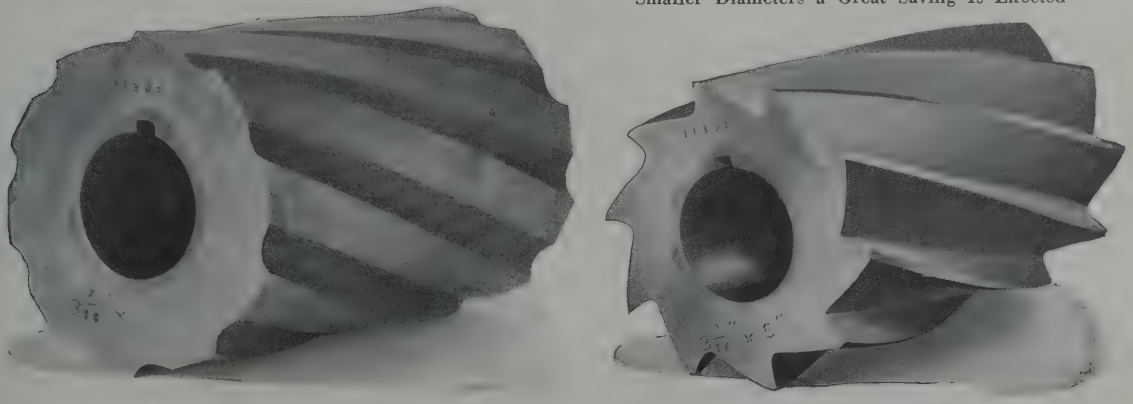
It is a fact that High Speed Tools are harder and more durable after being Re-Manufactured for the reason that all scale, resulting from hardening, is removed in grinding new contours from the heart of the steel.

Repeated tests have demonstrated that Re-Manufactured tools are all that we guarantee them to be—"The equal of new tools in accuracy, working qualities and durability at a fraction of the cost."

Trial orders are solicited at our risk.



Thousands of Large Diameter Saws Are Being Scrapped on Account of Slight Fractures. By Using the Centers of Such Saws Instead of Buying New Saws of Smaller Diameters a Great Saving Is Effected



A Sharp Properly Gummed Milling Cutter Will Produce More Than a Dozen Dull Cutters. Delay in Re-Manufacturing Necessitates Haste in Buying. Consider Well the Fact That It Takes Re-Manufactured Cutters to Trim Production Costs

THE GRINDING PROCESS TOOL CO.

818-820 WEST WARREN AVE., DETROIT, MICH.

Niles-Bement-Pond Machine Tools

Products

Machine Tools Special to
- Shipbuilding and Marine Engine Shops
- Railroad Car and Locomotive Shops.
- Small Arms and Heavy Ordnance Shops

Machine Tools
- Boring Machines
- Lathes
- Planers
- Milling Machines
- Drilling Machines
- Small Tools
- Gauges and Standards
- Electric Traveling Cranes
- Steam Hammers

Sizes and Types

Niles-Bement-Pond Company manufactures all types and sizes of machine tools for commercial use. Its products vary, both as to size and capacity, from the smallest metal working tools up to the largest. Special lathes have been built having a 168-in. swing (height of centers 2, 1m.); also 42-ft. (12, 8 m.) boring mills. In addition to tools of standard types, the Company is prepared to manufacture anything in special tools or complete equipment and would welcome inquiries regarding any metal cutting machines.

Besides these, this Company manufactures and carries in stock a complete line of small tools, gauges and standards, measuring machines and precision size blocks.

Plants

Niles-Bement-Pond Company owns and operates seven plants. It has more than 7,000 employees. These plants are well equipped for modern manufacturing and include engineering departments and drafting rooms, pattern shops and pattern lofts, foundries, machine shops, assembling and testing departments, adequate packing and shipping departments and chemical and physical laboratories.

This Company is a consolidation of Bement, Miles & Company, Philadelphia; Pond Machine Tool Company, Plainfield, N. J.; Philadelphia Engineering Works, Philadelphia, Pa.; and the Niles Tool Works Company, Hamilton, Ohio, effected in 1899. The following Companies were absorbed subsequently: Pratt & Whitney Company, Hartford, Conn.; Pratt & Whitney Company of Canada, Limited; John Bertram & Sons Co., Limited, Dundas, Ont., Canada, and Ridgway Machine Co., Ridgway, Pa.

Experience and Organization

The experience of this Company extends over a period of more than fifty years, during all of which time the output has been a product of highest quality. During these years, an extensive and efficient organization has been built up. The Company's engineers are constantly improving its products and developing new lines.

Cooperative Engineering Service

This Company's engineering department consists of a staff of skilled engineers who have specialized on this work and are fully prepared to cooperate in the solution of metal-working problems of detailed nature or in the design of complete shop equipment, plant layouts or yard layouts. The service of this department is always at the disposal of any one interested in securing either general or specific information.

Shipping Facilities

All plants of the Company are located near important seaports or on main line railroads. The Company has exceptional facilities for packing and shipping its products and special attention is given to export shipments.

BRANCH OFFICES IN THE U. S. A.

Boston	Rochester		Detroit	Los Angeles
Philadelphia	Pittsburgh	Cleveland	Chicago	San Francisco
Birmingham	Cincinnati		St. Louis	Seattle

FOREIGN BRANCHES AND REPRESENTATIVES

England: London—Niles-Bement-Pond Co., 25 Victoria St., S. W.
France: Paris—Glaenzer & Perreaud.
Belgium: Brussels—Henri Benedictus.
Italy: Milan—Ing. Ercole Vaghi.
Denmark: Copenhagen—V. Lowener.
Norway: Christiania—V. Lowener's Maskinforretning, Sverre Mohn.
Sweden: Stockholm—Aktiebolaget V. Lowener.
Japan: Tokio—Horne Co., Limited.
Australia: Melbourne—Bevan & Edwards Pty. Limited.
New Zealand: Wellington—John Chambers & Son, Limited.
Canada: Dundas—The John Bertram & Sons Co., Limited.
Cuba: Havana—Victor G. Mendoza Co.
West Coast of South America: W. R. Grace & Co.

NILES-BEMENT-POND COMPANY

111 BROADWAY, NEW YORK, N. Y.

Address nearest office. For list of offices see above

Machine Tool Drives

Practically all except the larger sized machines can be furnished with belt drive. Motor drives can be either by direct attached, variable speed direct current motors or by constant speed alternating current motor through speed change gears; or direct attached multi-speed alternating current motor.

Pratt & Whitney Small Engine Lathes

These include a wide variety of sizes and types varying from 11 in. (279 mm.) speed lathes up to 24 in. (610 mm.) standard engine lathes. They can be furnished with adequate standard attachments. The standard engine lathes can be furnished with metric screws and micrometer collars in place of English.

Heavy Engine Lathes

Heavy Engine Lathes are designed with ample strength, power and rigidity for heavy duty service. They are simple in construction and operating details. These lathes are built in sizes varying from 26 to 168-in. (660 to 4267 mm.) swing, 13 to 84-in. (330 to 2133 mm.) height of centers.

Heavy Duty or Forge Lathes

These are heavier tools, proportioned to the wear and exceptionally severe strains incident to turning rough metal forgings and similar work. All gears are steel. They are built in seven sizes, ranging from 24 to 72-in. (609 to 1828 mm.) swing, 12 to 36-in. (305 to 914 mm.) height of centers.

Pratt & Whitney Turntable Lathe

This 2½ x 26-in. (64 x 660 mm.) lathe has a cross sliding turntable or turret which has hand and variable automatic cross feed on carriage with eight positive stops. Carriage has longitudinal feeds and stops. Can be equipped with large variety of tools for casting, forging and rod work.

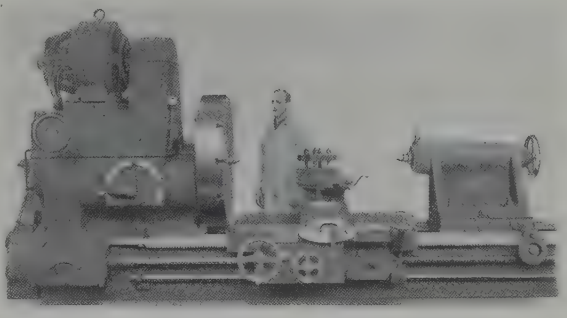


Fig. 1. 36-in. (914 mm.) Standard Engine Lathe

Boring and Drilling Machines

Boring and Drilling Machines are particularly suited for heavy work. They are made in two sizes, No. 2, having a 3⅞-in. (98 mm.) spindle diameter and No. 4, having a 5½ in. (140 mm.) spindle diameter. The work is mounted on a vertically adjustable table. The spindles have reversible automatic feeds for boring and drilling.

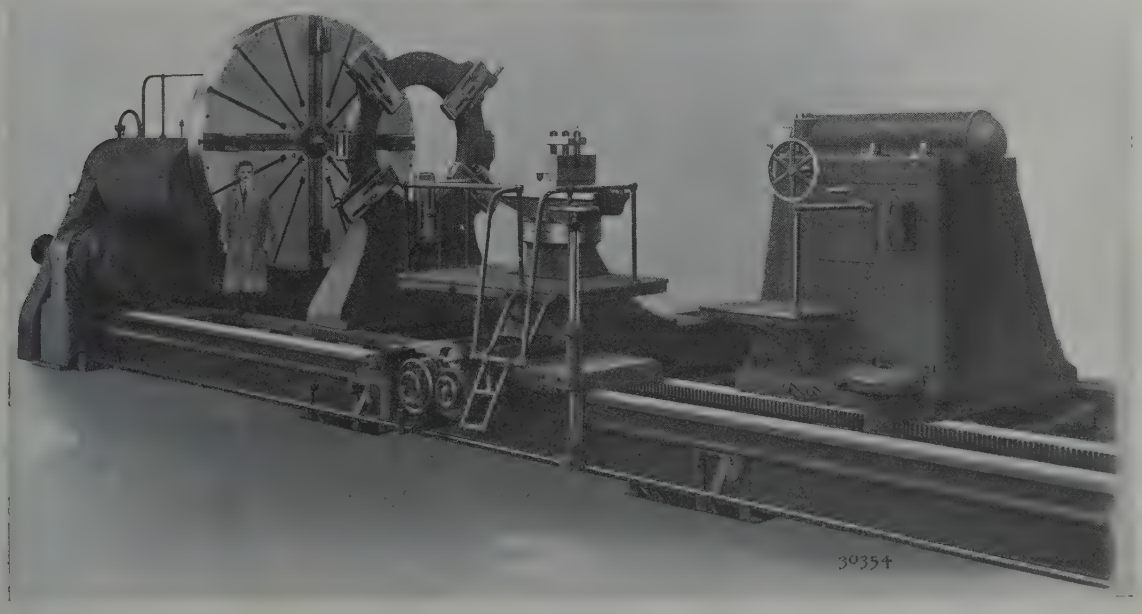


Fig. 2. 168-in. (4267 m.) Heavy Engine Lathe

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Address nearest office. For list of offices see page 730

Duplex Control Horizontal Borer

These machines, made in three sizes, No. 50, No. 60 and No. 72, with spindle diameters 3, 3½ and 4½ in. (76, 89 and 115 mm.) respectively, are designed for heavy boring combined with great accuracy. The duplication of control levers and hand wheels saves the operator's time and effort, as the machines can be operated effectively from either side. The spindle saddle is placed within the column with two V-tracks, one on either side of spindle. This insures rigidity and accuracy, absorbs the spindle thrust, and entirely eliminates distorting strains.

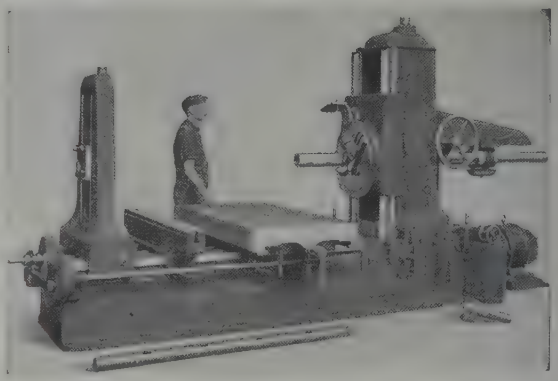


Fig. 3. 60-in. Duplex Control Horizontal Boring, Drilling and Milling Machine

Horizontal Boring Machines

The Horizontal Borer, Driller and Miller is made in five sizes with traveling column on bed. These machines can have floor plate and outboard column if specially ordered. Column has power traverse and automatic feeds along the bed for milling. Spindle has feeds for boring and drilling. Saddle has power traverse and automatic feeds on column for milling. Universal tilting and swiveling tables to order. The sizes range from HB3—5-in. (127 mm.) spindle, 3 to 4 ft. (0,9 to 1,2 m.) spindle traverse, and 15-ft. 3 in. (4,65 m.) length of bed to HM9—9½ in. (241 mm.) 6 to 8 ft. (1,8 to 2,4 m.). and 21 ft. 3 in. (6,48 m.) Three sizes with fixed column and table having longitudinal and cross feeds, and rotary movement can also be furnished.

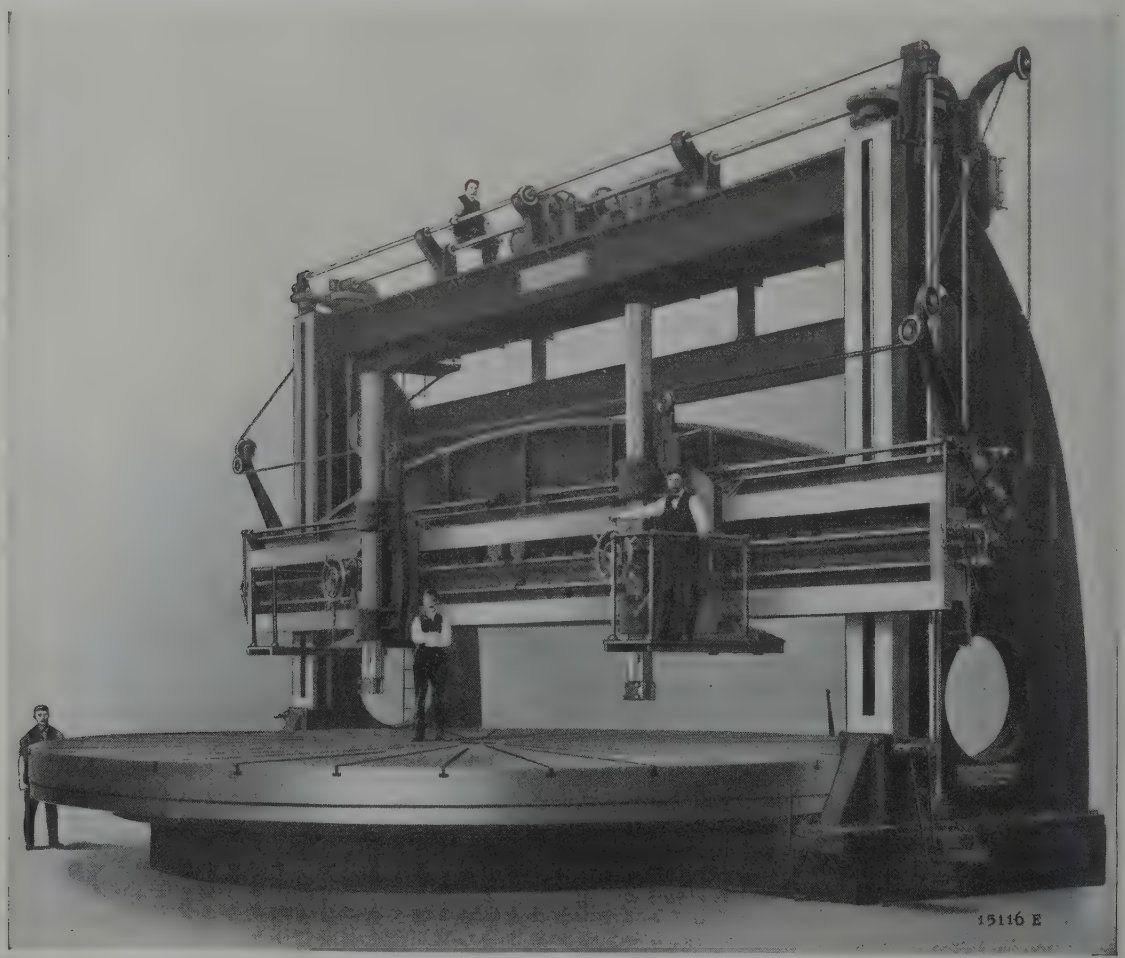


Fig. 4. 36-ft. (11 m.) Heavy Boring and Turning Mill

Vertical Boring and Turning Mills

Standard and heavy vertical mills are built along the same general lines, in a wide range of sizes of standard, heavy and extra heavy construction and with varying modifications and attachments for special work. There are 25 sizes, from the smallest side head type, having a rating size of 38 to 44 in. (965 to 1118 mm.) up to 36 ft. (11 m.) in the regular form and 42 ft. (12,8 m.) in the extension type or larger sizes.

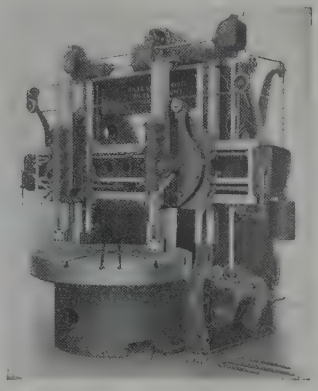


Fig. 5. 62-in. (1575 mm.) Heavy Boring and Turning Mill

Bars and saddles are equipped with power rapid traverse, variable reversible automatic feeds and hand fine adjustments. All machines have centralized control.

Right Line Vertical Drills

Right Line Vertical Drills are heavy duty, high power tools for large production with maximum convenience of operation. Standard size, 3-in. (76 mm.) diameter spindle and 18-in. (457 mm.) traverse. Unit construction permits variations as desired.

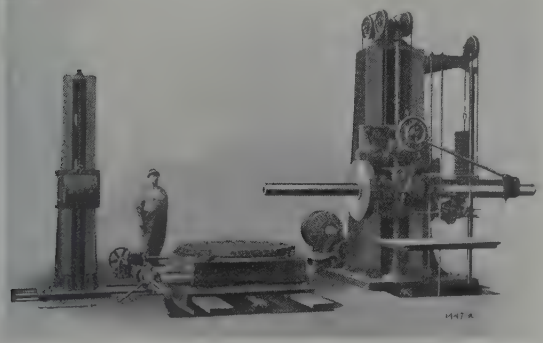


Fig. 6. Horizontal Boring, Drilling and Milling Machine with Fixed Column and Cross Feeding Table

Radial Drills

Radial Drills including right line, universal and heavy duty radials are made in sizes varying from a radius of 4 to 10 ft. (1, 2 and 3, 0 m.).

Heavy Multiple-Spindle Drilling Machines

Heavy Multiple-Spindle Drilling Machines are designed for the heaviest class of work. They are usually built with four or six spindles, but as they are built to order, special requirements in number of spindles or table construction can be met. Sizes vary from 1⅝ to 2 3/16 in. (41 to 56 mm.) spindle diameter, and 9 to 14-in. (229 to 356 mm.) traverse.

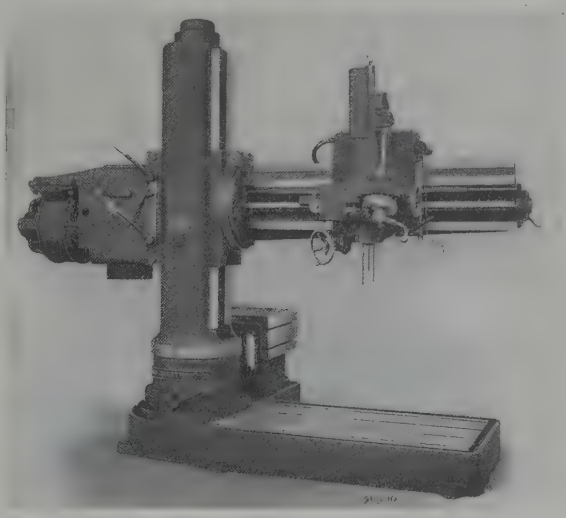


Fig. 7. Right Line Radial Drill

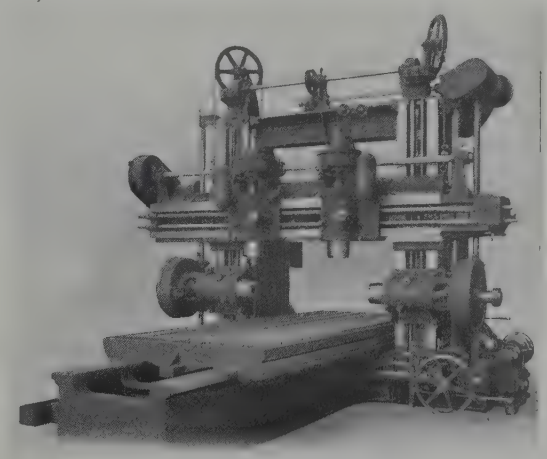


Fig. 8. 72 x 60 in. Multiple-Spindle Horizontal Milling Machine

Multiple-Spindle Horizontal Milling Machines

Multiple-Spindle Horizontal Milling Machines are built with the following arrangements of heads: Single side spindle heads; two side spindle heads; two vertical spindle heads, non-swiveling or swiveling; two side spindle heads with one or two vertical spindle heads; two vertical spindle heads with one side spindle head; and slabbing spindle, with two vertical spindle heads and with or without one or two side spindle heads.

Horizontal Slab Milling Machines

Horizontal Slab Milling Machines are well known for capacity to take heavy cuts. They are built in the following sizes: 24 x 24 in. (610 x 610 mm.), 30 x 24 in. (762 x 610 mm.), 36 x 36 in. (914 x 914 mm.), and 42 x 36 in. (1.067 x 914 mm.).

Pratt & Whitney Thread Milling Machines

These machines are designed for cutting precision screws, worms, spiral gears and splines and oil grooves in shafts. They will mill right or left hand threads of any pitch. They are built in the following sizes, maximum diameter and length of work: 4½ x 12 in. (114 x 305 mm.), 6 x 14 in. (152 x 356 mm.), 6 x 48 in. (152 x 1219 mm.), 6 x 80 in. (152 x 2032 mm.), 12 x 48 in. (305 x 1,219 mm.).

Pratt & Whitney Vertical Surface Grinders

Surface grinders are made in two sizes, 14 and 22-in. (356 and 559 mm.) diameter of wheel. They handle work formerly done on planers and milling machines, more quickly, more accurately, and more cheaply and also give a mirror finish. Table is fed past the grinding head automatically with both roughing and finishing feeds. The wheel rotates in a horizontal plane. The grinding head has hand vertical adjustment and variable automatic down feeds.

Crank and Geared Slotters

These slotters are suited specially to accurate and continuous production in marine shops. They are correctly designed and of massive construction. Power longitudinal, cross and circular feeds are provided, as well as hand traverse in all direction by means of a crank handle. They are made in eight sizes, from 6¼ to 39-in. (159 to 991 mm.) maximum stroke.

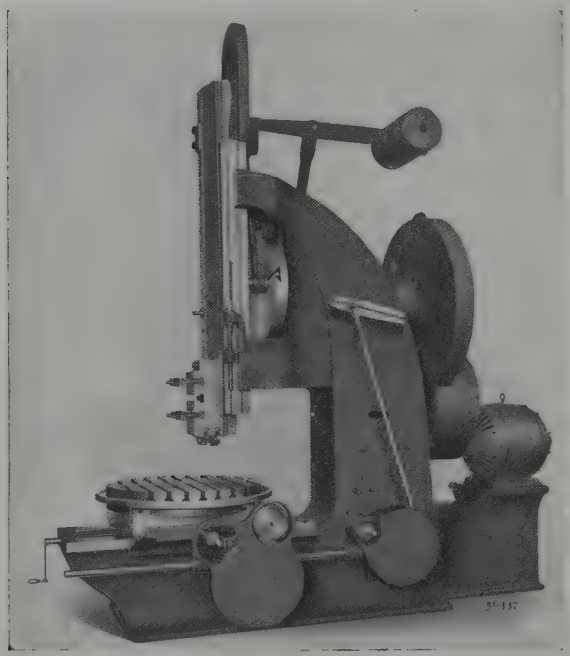


Fig. 9. 24-in. (610 mm.) Crank Slotter with Direct Current Adjustable Motor

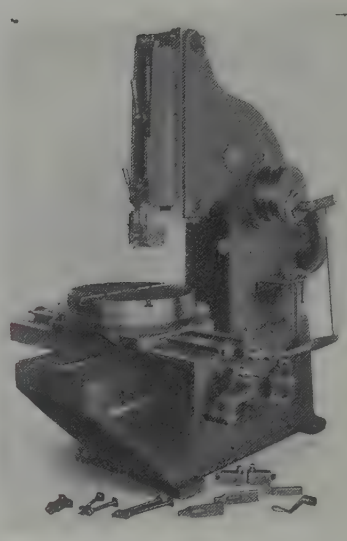


Fig. 10. 10-in. (254 mm.) Vertical Shaper with Angular Adjustment of Ram

Pratt & Whitney Vertical Shapers

Vertical Shapers are precision machines that will handle work usually done on either slotter or horizontal shaper, but are more accurate and adaptable. The ram can be swung out to machine surfaces at an angle from a vertical plane. This is especially desirable for cutting clearance on dies. By means of the rotary feed, concave and convex surfaces can be finished. Special work such as hexagonal and octagonal surfaces can also be handled.

These shapers are made in two sizes, 6 and 10-in. (152 and 254 mm.) stroke.

Traveling Head Shaper

These shapers are made with either one or two heads in any length. Heads have variable power feeds along the bed in either direction. Standard machines are made in two sizes, 22 and 26-in. (559 and 660 mm.) stroke.

Pratt & Whitney Gauges and Standards

Pratt & Whitney gauges are based on the British Imperial Yard and French standard meter. The duplicate standards, obtained and carefully preserved by Pratt & Whitney works, have been for many years world-famous for their extreme accuracy.

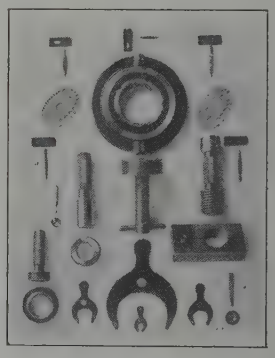


Fig. 11. Gauges and Standards

Pratt & Whitney measuring machines represent the best features which more than thirty years of practical experience and constant experimenting have proved essential. The English sizes are 12, 14, 36, 48, and 80 in.; the metric 300, 600, 1,000, 1,200 and 2,000 mm.

The Hoke method of lapping flat, parallel, opposite faces was developed at the United States Bureau of Standards, Washington. Pratt & Whitney Hoke precision gauges are kept within five millionths of an inch per in. of marked size up to one-half in. and within ten millionths of an inch per in. of length over one-half in. The sets are furnished in 81, 34, 10 and 5 blocks (English) and 103 blocks (metric). The blocks are furnished separately, if desired. Swedish type gauges, singly or in sets, toolmakers' flats, and "mikechecks" for checking micrometers, can also be furnished.

The Pratt & Whitney line of gauges includes thread gauges for all standard threads including French and International; also snap, star (for gun bores), cylindrical, plug and ring, decimal, taper and other gauges, as well as end measures and other accurate measuring and gauging instruments.

The Pratt and Whitney works make a specialty of complete equipments for manufacturing guns, sewing machines, typewriters and similar work, upon a strictly interchangeable basis. Its engineering and manufacturing facilities are most complete, covering design of building if desired, and furnishing of machinery, tools and gauges. A separate engineering force is maintained which devotes its entire time to this class of work.

Pratt & Whitney Small Tools

These include taps, dies, milling cutters, reamers, twist drills, punches, counterbores and lathe tools in regular and special sizes to meet all manufacturing requirements.

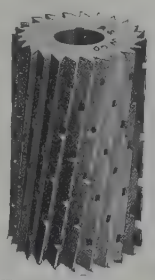


Fig. 12. Milling Cutter

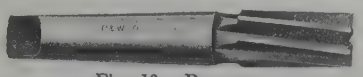


Fig. 13. Reamer

Fig. 14. Tap

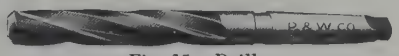


Fig. 15. Drill

Steam Hammers

Niles-Bement-Pond Company builds a very complete line of steam forge hammers, single and double frame. They are built in sizes ranging from 250 to 30,000 lb. (115 to 13,600 kg.) These are operated by steam, or by compressed air, if desired. Steam drop hammers are built in a wide variety of sizes from 600 to 12,000 lb. (270 to 5,400 kg.).

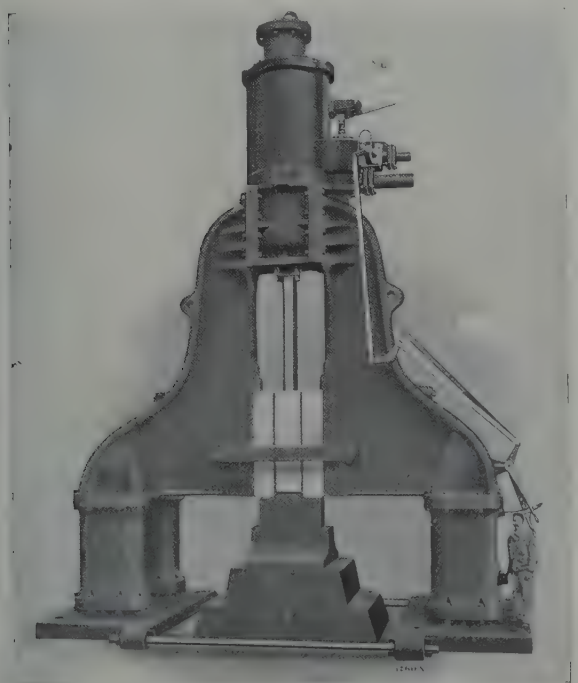


Fig. 16. 1,200 and 2,400 Pound Double Frame, Four Leg Steam Hammers

Fig. 17. 350, 600 and 800-Pound Single Frame Steam Hammer

NILES-BEMENT-POND COMPANY
111 BROADWAY, NEW YORK, N. Y.
Address nearest office. For list of offices see page 730

Bending and Straightening Rolls

N-B-P Bending Rolls and Straightening Rolls are built in sizes to handle the entire range of marine work from small tanks and boilers to the heaviest ships' plates. We build both the pinching and the pyramid types of Bending Rolls. The first is eminently fitted for bending thin plates while the latter is best suited to heavy work. Our Strongback Pyramid type as shown on this page is a machine designed for especially heavy duty. This construction allows for smaller rolls and plates may therefore be worked closer to the edges.

Our Straightening Rolls are built to cover the same range as the Bending Rolls. Comprising seven rolls in most cases, they can be supplied with six rolls for the large sizes to special order.

Our No. 7 machine combines the features of bending and straightening. It will take plates up to 1¼ in. x 10 ft. It is a very desirable unit for shops that cannot afford the installation of both types of machines.

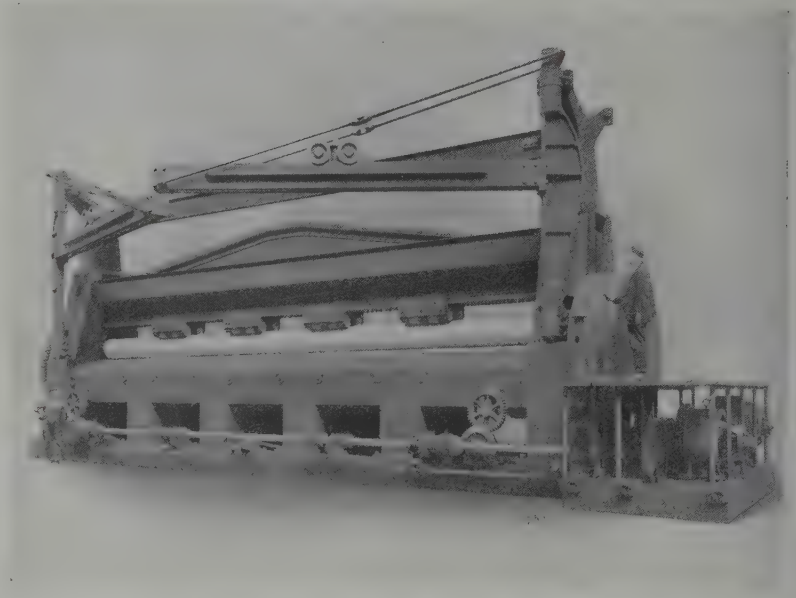


Fig. 18. Strongback Pyramid Type Bending and Straightening Roll

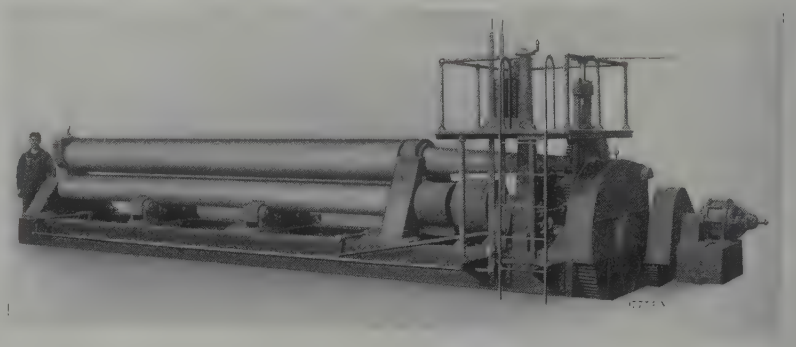


Fig. 19. Bending and Straightening Roll

Punches and Shears

Punches and shears are made in a wide range of sizes, with throat depths from 6 to 72 in. (152 to 1829 mm.) for punching holes from ⅝ in. (16 mm.) diameter, in ⅝ in. (16 mm.) thickness of plate to 3½ in. (89 mm.) diam eter and 2 in. (51 mm.) thickness of plate. Shearing capacities for flat bars range from 3 x ⅝ in. (76 x 16 mm.) to 10 x 2 in. (254 x 51 mm.).

Shearing capacities range from 3 x ½ in. (76 x 13 mm.) flats, 1 in. (25 mm.) rounds, and 1¾ x 1¾ x ¼ in. (44 x 44 x 6 mm.) angles, up to 10 x 2 in. (254 x 51 mm.) flats and 4 in. (102 mm.) rounds and 8 x 8 x 1½ in. (203 x 203 x 28 mm.) angles.

This Company also makes beam punching and coping machines, horizontal punches, shears of large capacity, double angle shears, gate shears, multiple punches, automatic spacing, punching and shearing machines, triple punching, shearing and manhole punching machines and other machines for general structural, boiler shop and similar work on plates, sheets, bars and rolled shapes.

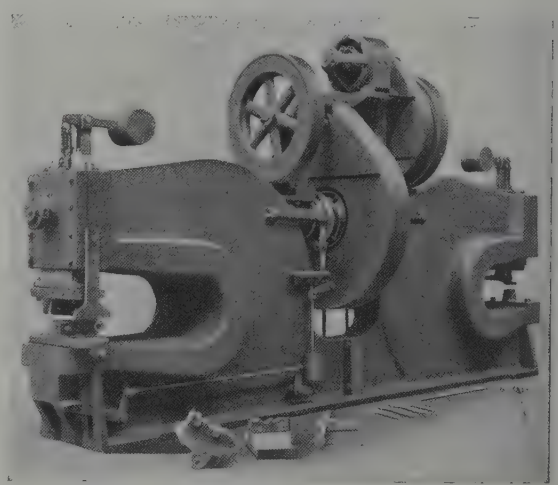


Fig. 20. Punching and Shearing Machine

Standard Planers

Standard Planers are of specially massive and rigid construction throughout. They are built in eighteen sizes which range from 26 to 192 in. (660 to 4876 mm.), and measure between housings by height under crossrail from 26½ x 26½ in. (673 x 673 mm.) to 194 x 146 in. (4928 x 3708 mm.).

Vertical and Horizontal Planers

The wall type is suitable for such large work as should be planed horizontally and vertically at one setting and consists of a vertical wall plate on which is mounted a vertical rail having horizontal traverse. The tool saddle has vertical movement on the rail.

The post or column type carries a post mounted on either plain or circular base which can swivel through 90°. The tool saddle has vertical movement on post and the post reciprocates along bed.

Armor Plate Planers

Armor Plate Planers are of two types, breast and pit. Breast planers are made in two forms, single and double. The single works at one end or side and the double at two sides. They can be built for either cross or longitudinal planing or both. The cross-rail has a swiveling adjustment for planing curves. The pit planer finishes four edges at one setting.

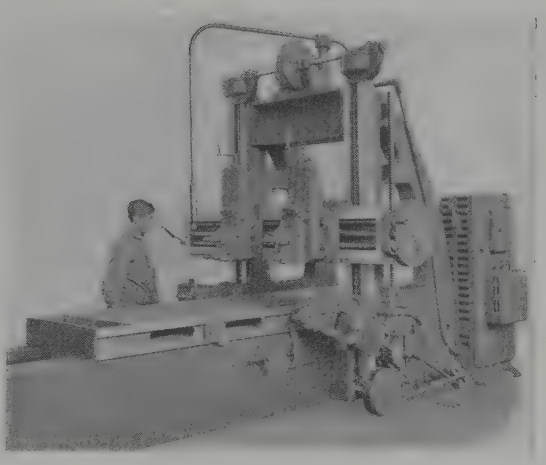


Fig. 21. Heavy 42-in. Planer with Reversing Motor Drive

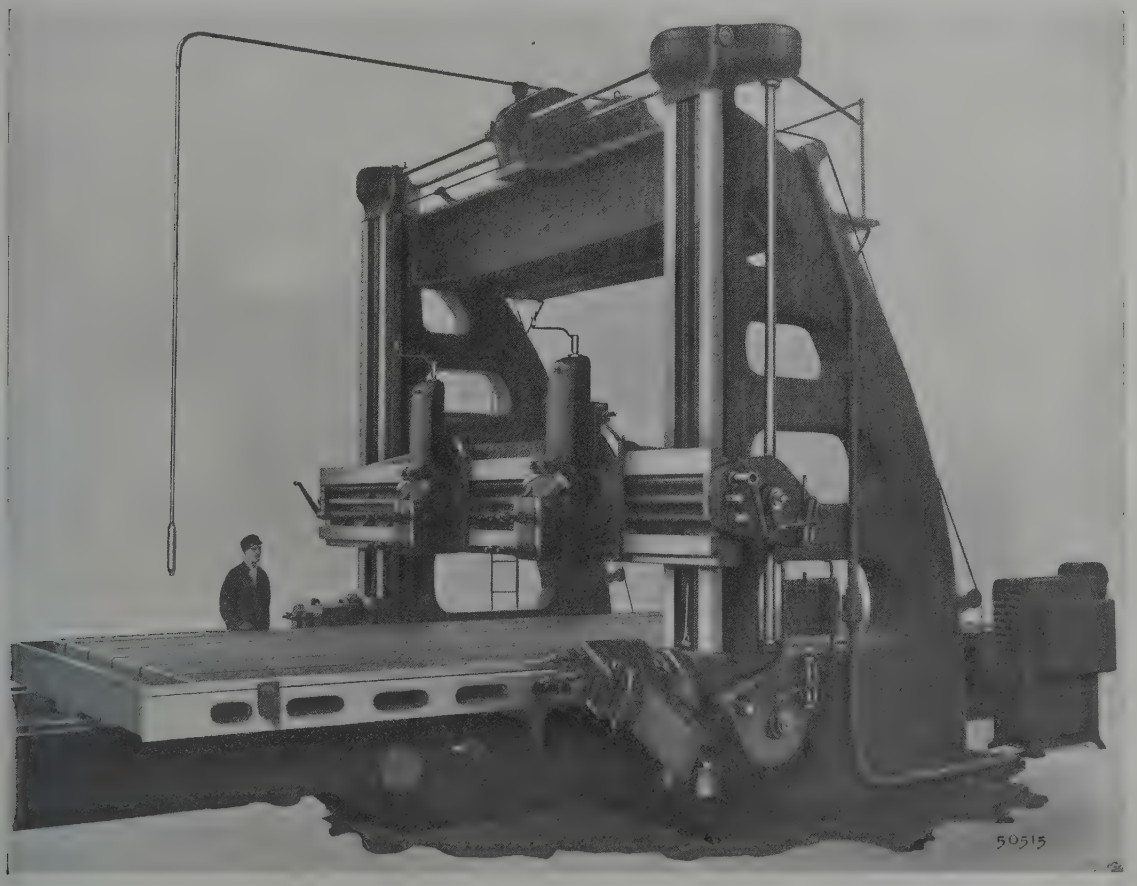


Fig. 22. 14 ft. (4.3 m.) Planer with Electric Feed and Rapid Power Traverse to Tool Heads

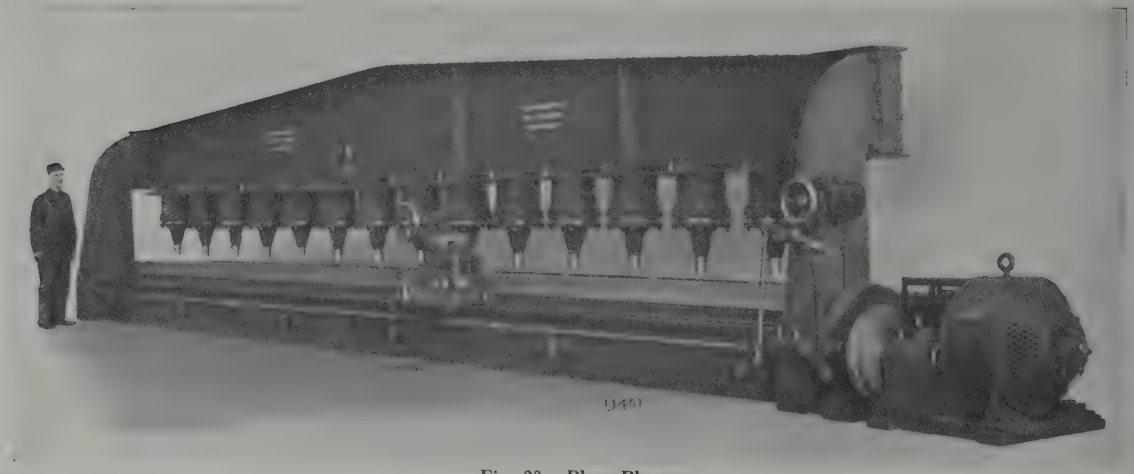


Fig. 23. Plate Planer

Plate, Rotary and Open Side Planers

Plate Planers—Designed for planing and beveling the edges of plates, and have a very wide bed with multiple screw or pneumatic clamping jacks for holding work. The clamping beam supporting these takes the place of the usual cross rail. Planing is done by reciprocating carriage with double tool rests for cutting in both directions. The six sizes range in plate capacity from 1 in. x 12 ft. (25 mm. x 3,6 m.) to 2 in. x 25 ft. (51 mm. x 7,6 m.)

Rotary Planers—A rotating head with inserted cutting tools is carried by the saddle which is fed by power along the bed. Built in either single or double form, and either fixed or portable type. Sizes from 38½ in. (978 mm.) to 120 m. (3,0 m.) diameter cutting circle or 7 ft. (2,1 m.) traverse up to 12 ft. (3,6 m.)

Open Side Planers—These machines are designed for occasional machining on work much wider than the housings. The six sizes range from 36 x 36 in. (914 x 914 mm.) to 84 x 84 (2134 x 2134 mm.)

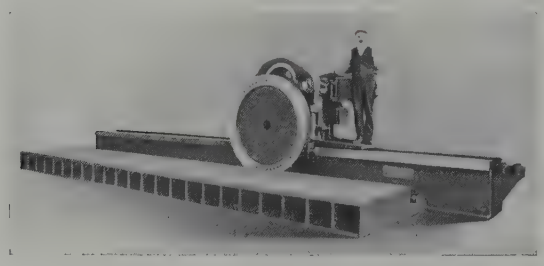


Fig. 24. 49-in. Portable Rotary Planer

Cranes

Niles-Bement-Pond Company builds cranes to meet every possible manufacturing requirement. Niles cranes are simple in construction and efficient in operation. They are built in a range of sizes suitable for every shipyard purpose, from the small chain hoist to the large electric traveling crane. This line also includes monorail trolleys, grab bucket cranes and trolleys, wall cranes and hand operated traveling cranes.

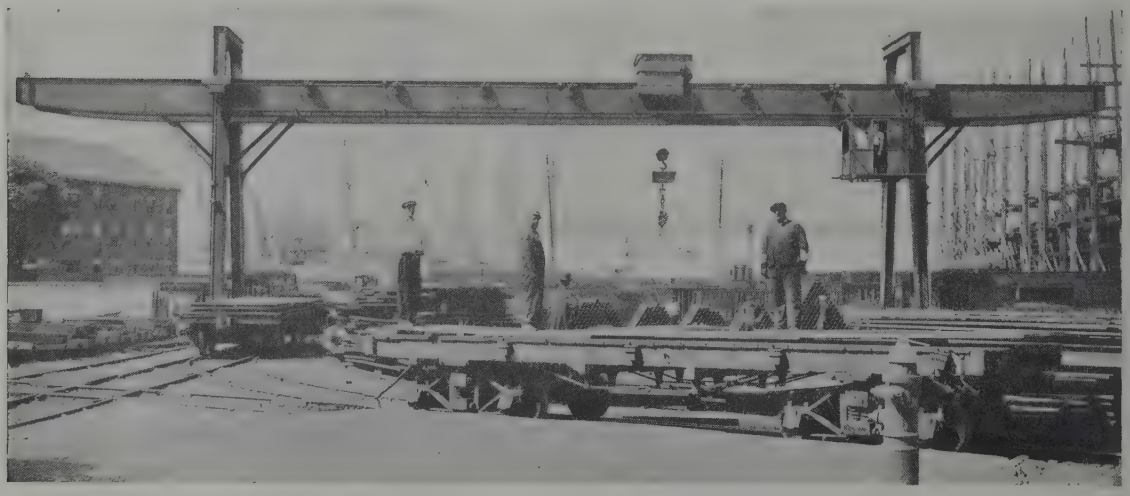


Fig. 25. Niles Standard Crane, New York Navy Yard

Plate Castors—Hyatt Roller Bearing Equipped

Plate Castors

A plate castor is any easy turning wheel mounted on top of a vertical post and capable of swinging freely in any direction. On a series of these castors plates can be easily moved in any direction with very little effort.

the plate easily and quickly into any required position, saving time and labor and releasing cranes and men for other work.

The speeding up of work due to the installation of Hyatt Roller Bearing equipped plate castors therefore results in materially increased capacity of the shipyard at considerably lower cost.

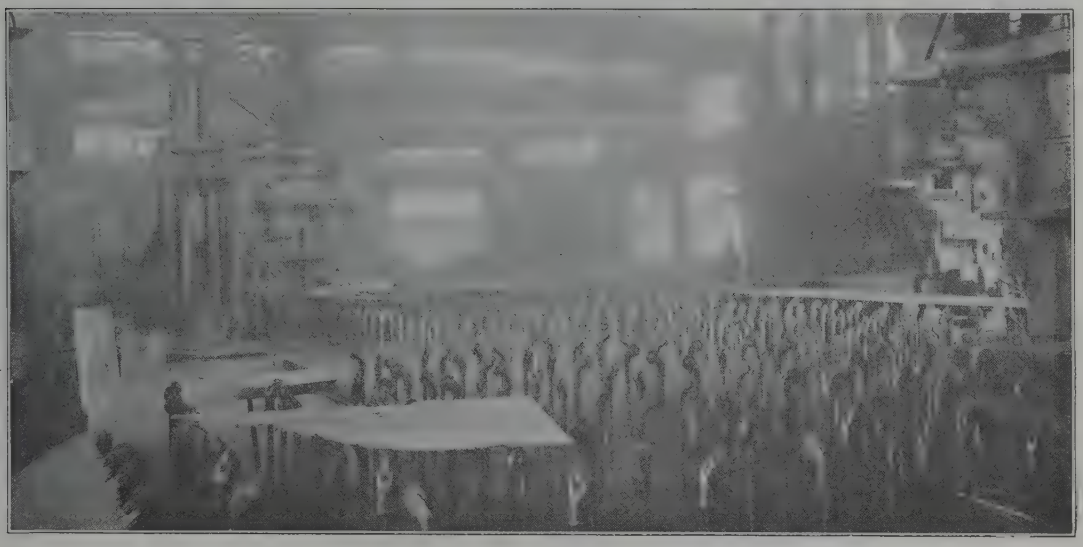


Plate shop with Hyatt Equipped Plate Castors

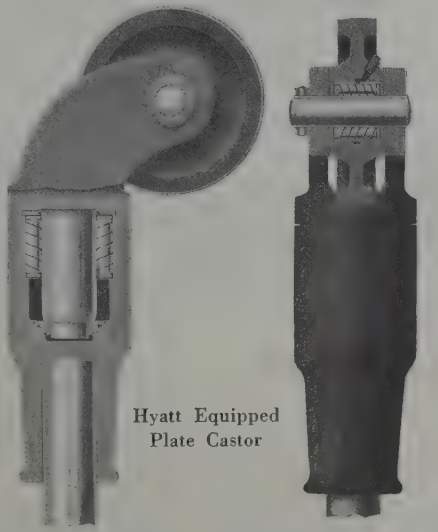
Advantages

The use of Hyatt Roller Bearing equipped plate castors in a shipyard affords several advantages in the handling of steel plates which officials responsible for quick and economical production cannot afford to overlook.

One or two men are enabled to handle the largest plates throughout the operations of laying out, shearing, punching and forming. On a bed of easy turning, easy swinging plate castors, very little effort is required to move or swing the plate sideways, lengthwise, or completely around, and the operator has complete control of the motion of the plate at all times.

Furthermore, plate handling becomes a continuous operation, free from delays. By means of a bed of these easy turning castors around each plate working machine, and a lane of castors between machines, the handling of plates is speeded up, resulting in a greatly increased output.

The troublesome use of cranes for handling plates is made unnecessary by the use of plate castors. Instead of several men jockeying a plate in all directions with a crane, one or two men can roll



Hyatt Equipped Plate Castor

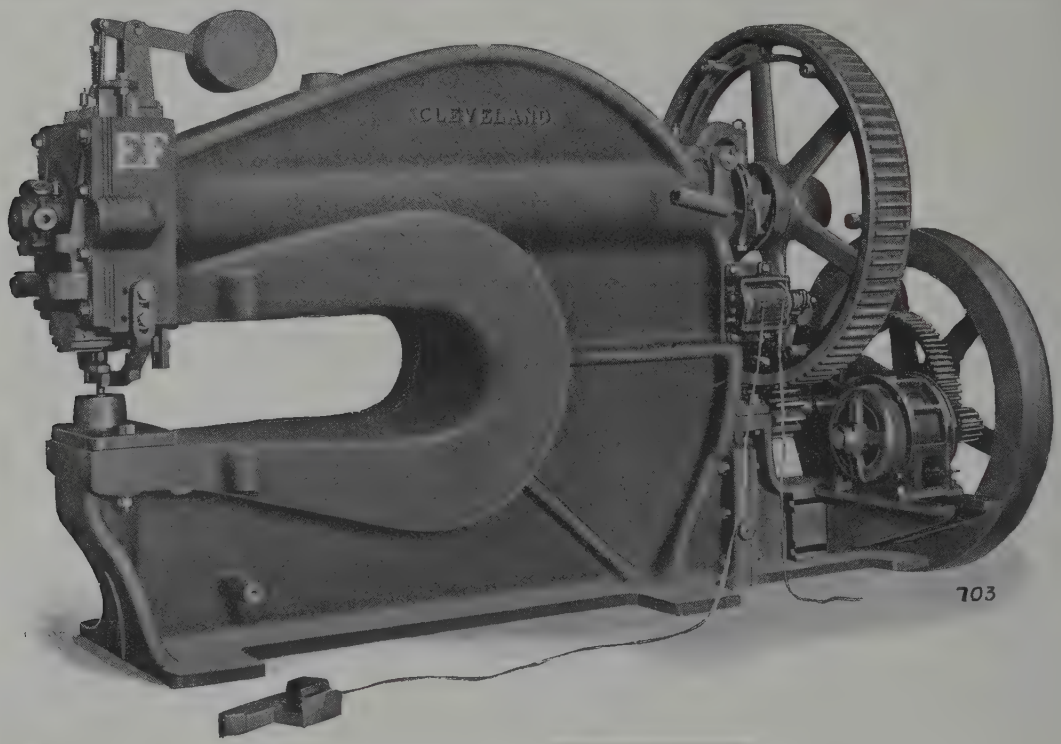
Installations

Plate Castor Installations may be divided into three main classes.

Working Beds consist of castors installed around punches, shears, layout tables and other equipment for working plates. They enable the operator to handle and move the plate into the required position quickly and easily.

Castor Lanes provide a rapid and efficient method of transferring plates from one machine to the next. The use of these lanes makes it possible to move the plates without cranes, which are thus released for other duties. In a shop laid out so that the plates can be passed through the machines in one general direction, castor lanes are both quicker and more efficient than either cranes or trucks.

Storage Beds consist of castors installed to provide storage space where plates sufficient for the immediate needs of the operator are kept. This storage space is indispensable in order to obtain the maximum output from shears and punches that are speeded up by roller tables or plate castor working beds.



Punches and Shears

Cleveland Punches and Shears are made Solid—because experience has taught us that this is the strongest, most rigid and durable construction.

Our engineers have carefully studied the proper distribution of metal and made ample provision for the stress and shocks to which machines of this type are subjected, and we unhesitatingly recommend Cleveland Solid Semi-Steel Frame Machines where serviceability is the determining factor.

The frame is cast Solid of semi-steel with heavy central horse-shoe strengthened by heavy outer flange, and radiating cross ribs, giving a rigid reinforced I beam type construction, which is the best stress resisting cross section construction for this class of machinery.

The only cores in the frame are those in which the main shaft revolves and the slug hole in the plain type of jaw.

Cleveland Vertical Open Gap Machines can be furnished with capacities ranging from ½″ hole through ½″ material to 6″ hole through 1½″ material without shear to punch, (with shear to punch the capacity rating can be increased) and with throat depths from 6″ to 72″.

Any two Cleveland Machines of the same capacity of equal or unequal throat depths, can be combined into making one double machine.

Attachment and Drives

On all Machines of like jaws, standard punching and shearing attachments are interchangeable.

Standard drives are tight and loose pulley belt, direct connected motor or marine type steam engine.

Solenoid Clutch Control and Floating Punch

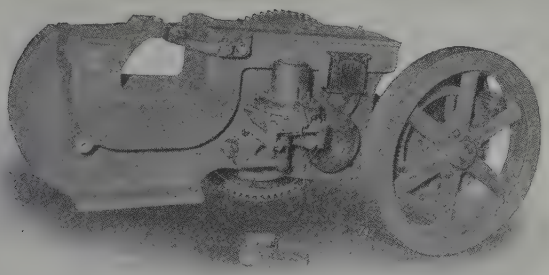
When punching plates of large area, the operator must necessarily stand some distance from the machine. Therefore, for operating the clutch from a remote point, we developed the Solenoid Operated Clutch, controlled by a push botton. These solenoids can be furnished for either alternating or direct current, and the push button may be the ring type, flat type (shown above) or a hand spike. The flat type is operated by a side movement of the foot, thus eliminating any possibility of tripping the clutch accidentally, and is particularly adapted for use with a spacing table. With the Solenoid Operated Clutch, the main shaft, sliding head and its parts are at rest and therefore do not bring constant wear on bearings and bearing surfaces.

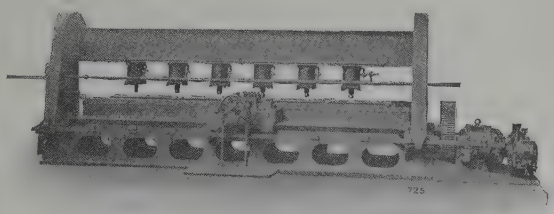
The Cleveland (Patented) Floating Punch permits the operator to center the punch accurately, without loss of time, while standing close to or at a distance from the Machine. Its operation is entirely automatic. The punch rests continually on the material, rising and falling with the buckles. The center point on the punch drops unerringly into the previously laid out prick marks. The power stroke is then given, the punch is forced through the material, strips clear and again returns to the material, ready for further centering.

These two attachments are applicable to Cleveland Machines already in use and the Floating Punch Attachment is interchangeable with all other standard attachments.

THE CLEVELAND PUNCH & SHEAR WORKS CO.

CLEVELAND, O.





Horizontal Punches

Horizontal Punches are used for punching flanged work and angles, but they can also be used for punching plate, pipe and miscellaneous sections.

Cleveland Horizontal Punches are made in five sizes with capacity ranging from 3/16″ hole through ¾″ material to 2″ hole through 1″ material.

The operation of all Cleveland Horizontal Punches is through steel casting rocker arm, bronzed bushed at all bearing surfaces.

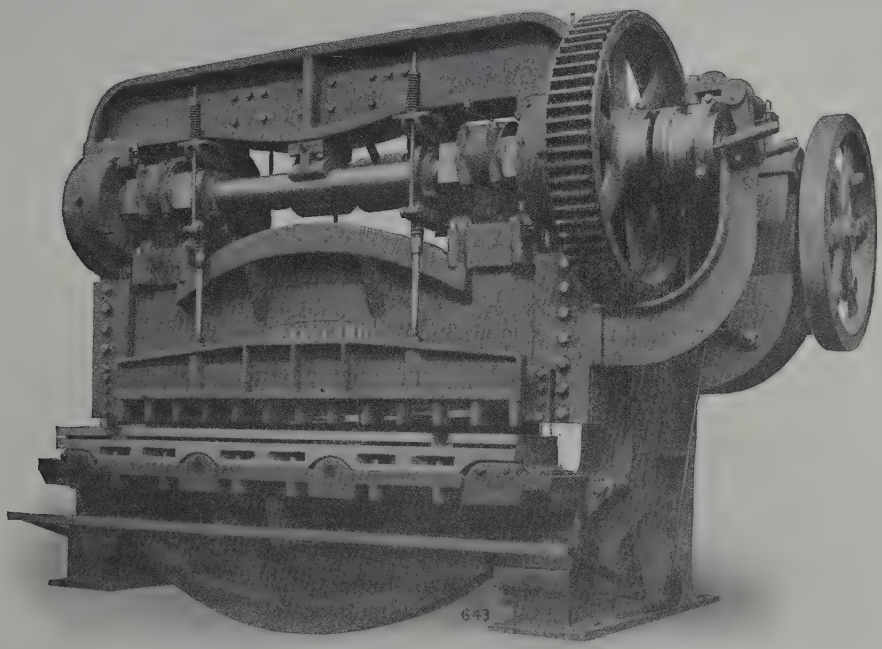
Any Cleveland Horizontal Punch can be arranged with a Solenoid Clutch Control as shown above, description of which will be found on the preceding page.

Plate Planers

Cleveland Plate Planers are built in three types, the maximum distance between housings being governed by the capacity of the machine. All housings are overhanging to permit the planing of plates wider than the distance between housings by re-setting.

The Standard carriage is equipped with a swiveling tool holder carrying two tools for cutting in either direction. The design of the tool carriage is such that the inoperative tool is clear of the work and does not drag.

Drive may be through open and cross belts from countershaft or from motor mounted overhead on structural stand or direct connected reversing motor.



Gate Shears

Cleveland Gate Shears are built to meet the most exacting plate shearing requirements. The sliding head, lower girder and shear block are heavily reinforced to obtain the required "stiffness" for accurate shearing.

All bearing surfaces are amply proportioned and attention is directed to the extremely long sliding head bearing which can be taken up when wear occurs, thus insuring correct alignment and eliminating all unnecessary play.

Special attention has been given to clear working space behind the machine for the removal of material by crane, if desired.

Standard equipment includes complete shearing attachments and automatic hold-down.

Drive may be either direct connected motor or belt drive with tight and loose pulleys.

Multiple Punches, Spacing Tables, Etc.

For Punching Steel Ship Plates

Thomas Automatic Multiple Punches, and Electrically Operated Spacing Tables are built in capacities from 100,000 lbs. to 3,000,000 lbs. ram pressure, for handling any width and length of ship plate. The punching tool set-up on the punch provides for complete punching of rectangular plates at both ends and both sides with one setting, and one pass of the plate through the punch, the spacing of the holes lengthwise of the plate being controlled by a simple strip templet with spacing pins. Thus duplicate layouts can be punched with the required accuracy and with great speed.

Automatic Multiple Punch and Spacing Table

For Punching Irregular Layouts

Thomas "Universal" Type Multiple Punch and Hand Operated Spacing Table is built in four sizes, up to 600,000 lbs. ram pressure. Width of punch and width and length of spacing table can be made to suit requirements. The construction of the punch is such that the tool holders are movable on the ram and bed bolsters, so that the operator can "spot" the holes to be punched, one or more at a time, at any point on the plate. The movement of the tools in and out from the center line of the plate may be spaced by means of a templet. Likewise the movement of the plate through the punch is controlled by the operator, working to a strip templet. Thus a plate of regular or irregular layout can be completely punched with great facility with one setting on the spacing table and one pass through the punch.

One-Man Roll Table

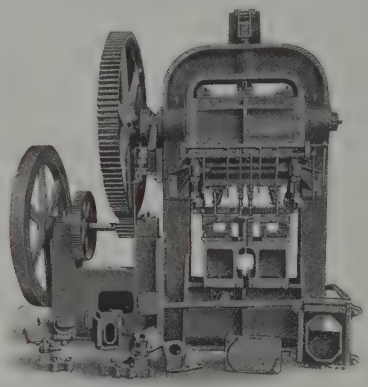
Thomas One-Man Roll Table is used with standard vertical open throat punch for punching regular or irregular plate layouts. A less expensive type of equipment than the "Universal" Punch and Table, and less rapid in operation.

For Punching Small Detail Plates

The Thomas Pantograph Table and Open Throat Single Punch allows of rapid punching of detail plates, gusset plates, etc., by following a templet which is clamped on one-half of the table, the plate being clamped on the other half of the table under the punch. The templet remains in place while a given layout of plates is being run through. Quick changing of plates is facilitated by means of the quick-acting clamps with which the table is provided. The clutch of the punch is controlled automatically.

For Punching Structural Shapes

Thomas No. 14 Multiple Punch and Spacing Table handles narrow plates, angles in pairs, channels in pairs for flange punching, beams and channels for web or flange punching. Punch can be equipped also with tool set-ups for coping, shearing, splitting, blanking out, etc.

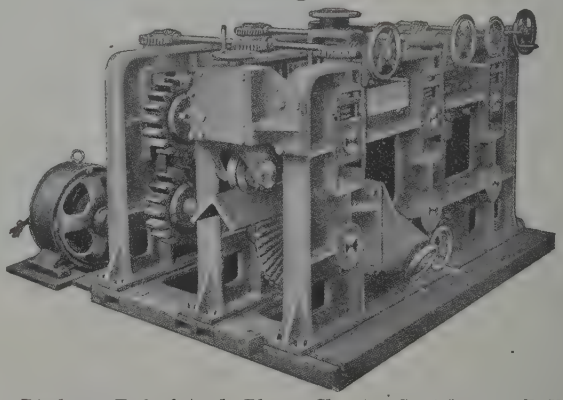


No. 14 Multiple Punch

For Planing and Beveling Angles

Thomas Angle Planer planes both lips and heel of angles up to 8" x 8" x 1" ordinarily with one pass through the machine.

Thomas Angle Beveler handles the beveling of Angles, Channels, Z-Bars and Bulb Angles, receiving the material direct from the heating furnace.



Discharge End of Angle Planer, Showing Straightening Roll

Standard Line of Punches and Shears

Gate Shears, Angle Shears, Copers, Punches, etc., and standard and special tool set ups—built to suit requirements.

THOMAS SPACING MACHINE CO.

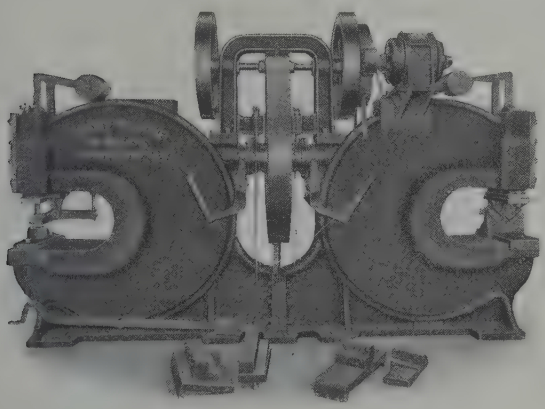
PITTSBURGH, PA., U. S. A.

Power Punches and Shears

Power Punches and Shears

The Punching and Shearing machinery manufactured by the Beatty Machine and Manufacturing Co. is of particularly sturdy construction, admirably adapted to shipyard use. These machines are built in sizes as listed below, all sizes being made in any depth of throat permitting material to be punched up to 72 inches from edge.

The standard equipment included with these machines comprises Plain Table, Belt drive, one set Single Punching Tools and one set Bar Shears. To meet special requirements, special equipment can be furnished such as Double or Triple Gag Punching Tools, Bar Angle or Splitting Shears, Motor drive, Architectural Table, Overhead Crane, etc.



No. 7 Double Punch and Shear

Features of Construction

The Main Frame is of the box housing type, heavily re-inforced and made of semi-steel.

The Ram or Sliding Head is of cast steel, fitted with brass taper gib for lateral adjustment.

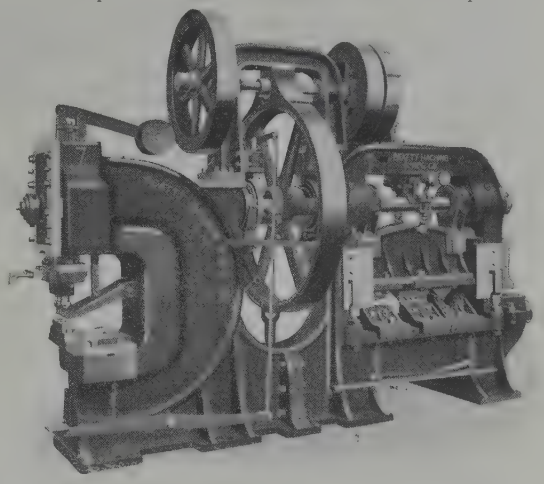
The Main Shafts are of high grade open hearth steel. The main shaft and flywheel shaft bearings are phosphor bronze bushed and fitted with ring oilers, originated by the Beatty Machine and Manufacuring Co. on this type of machine.

The Gears are made of semi-steel with cut teeth, the hub being bronze bushed. The pinions are of forged steel, the teeth also being cut.

TABLE OF CAPACITY FOR POWER PUNCHES, SHEARS AND COPUNSHEARS

No.	Punching		Shearing			Splitting Plate Thickness
	Pres. Tons	Max. Hole	Flat Bars	Round Bars	Angles	
1	7.5	¾x ¼	2¾x ¼	¾	1¼x1¼x ⅜	¼
2	20	½x ½	3 x ½	1	1¾x1¾x ¼	⅜
3	30	⅝x ⅝	3 x ⅝	1⅛	2½x2½x ¼	½
4	43	¾x ¾	5 x ⅝	1½	2¾x2¾x ⅜	⅝
5	50	⅞x ¾	5 x ¾	1½	4 x4 x ¼	¾
6	78	1 x1	6 x ⅞	1¾	4 x4 x ⅜	⅞
7	100	1¼x1	7 x1	2	6 x6 x ⅜	1
8	137	1¾x1	8 x1⅛	2¼	6 x6 x ½	1⅛
9	200	2¼x1⅛	9 x1¼	2½	6 x6 x ¾	1¼
10	242	2¼x1¾	10 x1¼	2¾	6 x6 x ⅞	1⅜
11	300	2½x1½	11 x1½	3¼	8 x8 x ¾	1½
12	475	3 x2	10 x2½	4¼	8 x8 x1¼	2½

The Clutches are fitted with an automatic release which stops the machine at the end of the upstroke.

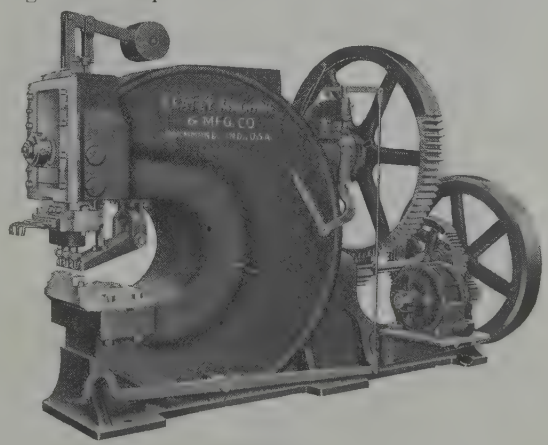


CoPunShear

The Copunshear

The CoPunShear is the ultimate development of punching and shearing machines in efficient combination. The Punching end is equipped with triple selective gag punching tools, permitting the use of three different diameter punches at one setting. The Shearing end, of the guillotine type, is equipped with tools for shearing angles, rounds, or flats, without change.

This machine is fitted with a single leg, inverted type coping tool suitable for a wide range of work and is equally efficient on I beams, channels, angle or notch plates.

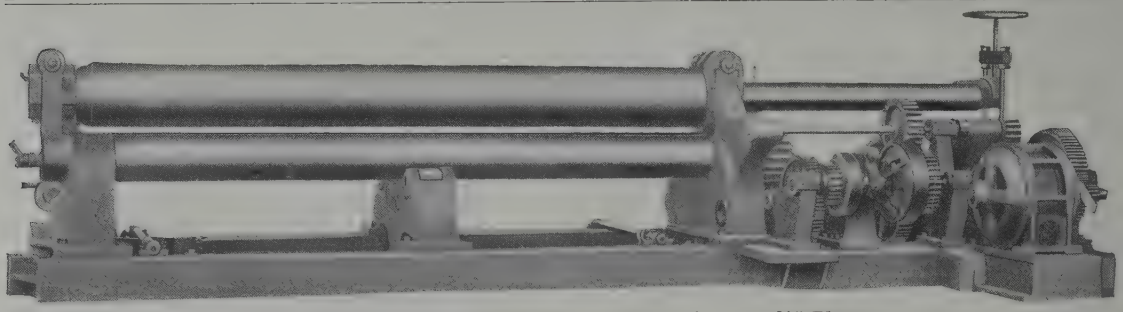


No. 7—25″ Single End Punch with triple gag socket punch tools

Facilities

A large and completely equipped factory in the Chicago manufacturing district and a location on a Belt Railroad serving seventeen trunk lines provide the Beatty Machine and Manufacturing Co. with unequalled facilities for promptly meeting all requirements for Punching and Shearing machinery.

Kling Bending Rolls, Punches and Shears

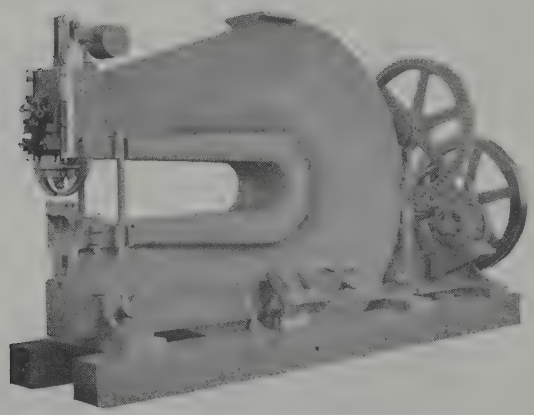


Kling 12'-2" Horizontal Plate Bending Rolls—Capacity ¾" Plate

Horizontal Plate Bending Rolls

The Kling Pyramid Type Horizontal Plate Bending Rolls, as illustrated above, can be furnished with any distance between housings for various thicknesses of plate. The rolls are steel forgings, top roll being provided with balance bar and drop housings so that full rolled circles may be removed. The top roll is adjusted by power, operated through worm gearing and with clutches so that either end may be raised and lowered independent of the other end. All gearing cast steel with cut teeth. The housings are mounted on heavy cast iron sub-base.

These machines may be furnished either arranged for belt drive with pair of friction clutch pulleys, both for main drive and for top roll adjustment, or arranged for direct geared motor drive. On motor driven rolls it is necessary to furnish reversing motor with drum type controller.



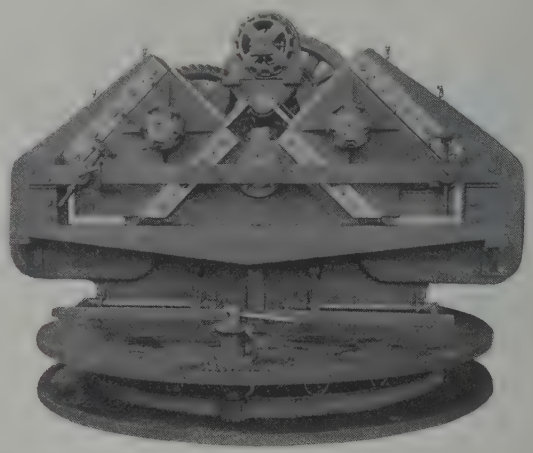
Kling 72" Throat Cored Frame Geared Punch

Single End Cored Frame Geared Punches

The Kling Single End Cored Frame Geared Punches, as illustrated above, are equipped with clutch having adjustable automatic stop, and eccentric shaft forged in one piece of open hearth steel. The slide is operated by means of cast steel pintle, which is bushed with bronze and bears against tool-steel block set in the slide.

These machines can be furnished with cast steel architectural jaw, as shown, or with plain flat jaw, and arranged either for belt drive with tight and loose pulley or, at an extra charge, for direct geared motor drive.

Gear guards are only furnished when ordered and at an extra price. Various shearing attachments can be furnished at an extra charge, these being interchangeable with the punching attachments.



Kling Double Angle Shears

Double Angle Shears

The Kling Double Angle Machines shear angles either square or on bevels up to 45 degrees. We recommend shears mounted on turntable where any bevel cuts are to be made, as this will prevent the necessity of swinging the material in the shop for bevel cuts.

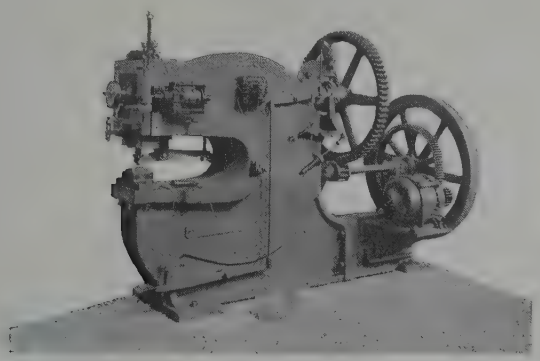
The slides are steel castings, provided with bronze gib for taking up wear; each slide has independent drive shaft and is operated by means of cast steel pitman bushed with bronze. The eccentric shafts are forged in one piece of open hearth steel; front eccentric shaft bearings being bronze bushed. Each side of the machine has independent clutch with automatic stop and independent foot treadle. A tee-slotted table is provided as well as adjustable hold-down for the material. When the shears are furnished without turntable they can be provided for either belt drive or geared motor drive, but when mounted on turntable they can be furnished for motor drive only.

These machines are furnished in two sizes, one with a capacity for angles 6" x 6" x ¾" and the other 8" x 8" x 1".

Punching and Shearing Machines

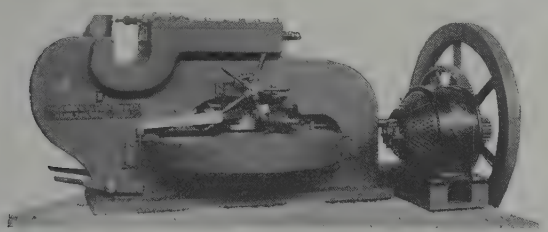
Power Punching and Shearing Machines

Long and Allstatter Power Punching and Shearing Machines are made for general purpose use, belt or motor drive, single or double end, with throat depths ranging from 4″ to 84″. All standard or regular machines are furnished with one set of tools (for ordinary punching or shearing) but can be modified or supplied with special punches or shears, if desired. To adapt the machines to a greater variety of work, the form of the lower jaw can be modified and furnished with a removable block for punching structural shapes. Machines can also be equipped with floating punches, or with patented electric gag control for remote operation by means of push button.



Single Motor Driven Power Punching and Shearing Machine with Electric Gag Control Through Push Button

Horizontal machines are made single or double end, for punching or bending flanged work, beams, channels, angles, etc. and can also be used for punching plate work.



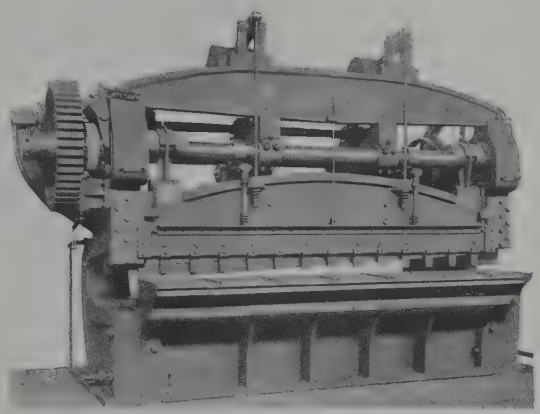
Motor Driven Horizontal Punch

Multiple Punches

Multiple Punches are designed to punch any number of holes at a time, in groups or in rows, distance between centers fixed or adjustable; punching tools made with and without gag. These machines are made in various sizes and different widths up to 16 feet between housings with throat of various depths, to drive by belt or motor. Automatic stop for bringing the slide to rest at the completion of the stroke is included in the regular equipment. Machines may also be equipped with slide adjustment to compensate for the wear of the punches when specially ordered, and furnished with hand or automatic feed spacing tables, if desired.

Gate Shears

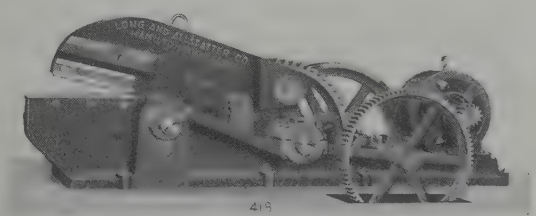
Gate shears are similar to the multiple punches in general design, but made to trim and split long sheets or plates. These machines are made in various sizes and widths between housings in different throat depths, and are furnished with table in front for supporting the work, automatic hold down for clamping and holding the work while being cut off, and automatic stop for bringing the slide to rest at the completion of the stroke with the blades open ready for the next cut.



Gate Shear

Alligator Shears

Alligator shears are made in a number of sizes, either right or left hand, for belt, motor or engine drive. These machines range in capacity from 1 to 5 inches square iron or mild steel bars, cold. The regular equipment includes one pair of solid crucible tool steel shear knives, varying in length according to the size of the machine.



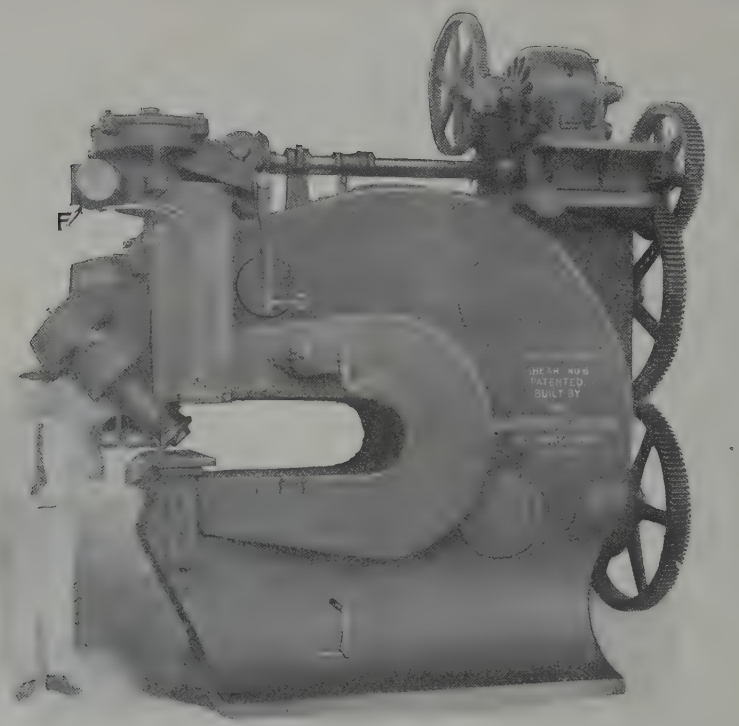
Motor Driven Alligator Shear

Other Products

The Long and Allstatter Line of tools also includes Angle Iron, Plate Splitting and Bar Iron Shears, as well as Bulldozers or Horizontal Bending and Forming Machines, Board Drop Hammers, Helve Hammers, and Open Back Inclinable Presses.

THE LONG & ALLSTATTER CO., HAMILTON, OHIO

Quickwork Rotary Shears



Purpose

The "Quickwork" Rotary Shear, as demonstrated by eight years of successful use, meets the need of a universal plate and sheet metal cutting machine. "Quickwork" Shears are made in seven sizes, and will cut all gauges of metal from the lightest up to one inch thick mild steel. They eliminate oxy-acetylene cutting and plate planing, and will be found to be the most economical cutting equipment obtainable for use in the building of boilers, ships, tanks, stacks, piping, blowers, forms, and general plate and sheet metal work of every description.

Advantages

The "Quickwork" Rotary Shear performs in one operation, with one handling of the material, work that has heretofore required several machines, some hand work, and all the consequent handlings of material. It requires less metal, less men, less machines, less floor space, less power, less tool expense, etc., and makes it easy and profitable to do work that it is not practical to cut by any other means excepting blanking dies in a press.

Metal is saved because the lines are cut and the parts finished at one passage of the metal, and the cut edges are straight, true and clean, requiring no further finishing for lapped, riveted or caulked seams.

It will shear straight lines in a plate of steel faster than any other method excepting long bladed shears that cut the entire length of plate at one stroke.

Besides cutting straight lines, "Quickwork" Shears will cut serpentine and zig-zag shapes and openings of almost any shape without cutting in from the side of the sheet.

Features of Construction

Workmanship and material throughout "Quickwork" Rotary Shears, are first class, and all parts are proportioned and machines are rated with ample safety factors. The main castings are of semi-steel; the gears are all of material best suited to the service required, and have teeth cut from the solid. All bearings are bronze bushed in bored and reamed holes, and ample provision is made for lubrication, and adjustment of wear throughout the machine.

An indicating-signalling mechanism shown in the cut above is furnished on shears Nos. 40, 50 and 60, and is of material assistance in cutting straight lines quickly and correctly.

Three speeds are provided, permitting operation of the machine at the speed best suited for the kind of cutting to be done, and both cutters are driven, automatically drawing the sheet rapidly and continuously through the machine.

Main and Branch Offices

The Main Office and Works of The Quickwork Company—sole builders of "Quickwork" Rotary Shears—are located at St. Marys, Ohio. Cable address "Quickwork." W. U. Code—General Code.

Eastern Branch Office—Grand Central Palace, New York City.

Write nearest office, stating the character of your work and the gauge of metal you use and we will send you our catalog with recommendations covering the proper machines to fulfill your requirements.

THE QUICKWORK CO., ST. MARYS, OHIO

The Bradley Hammers

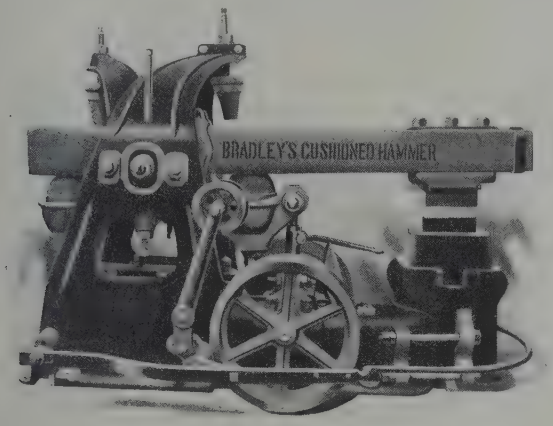
Purpose

In the development of Bradley Hammers, it has been the aim of this Company to build a tool that would—

First: Eliminate the slow and costly methods of forging and welding by hand.

Second: Deliver light blows or heavy, with extreme rapidity or slowly as the job demanded; and that would produce a finished part, ready to use, thereby eliminating costly machine operations.

Third: Forge the smaller sizes of material quicker and more uniformly than could several men by hand; and that would handle equally well the larger sizes



that would otherwise require the service of the larger and slower steam hammer.

Types

There are four types of Bradley Hammers. The Bradley Compact Hammer—the Bradley Upright Helve Hammer—the Upright Strap Hammer and the Bradley Rubber Cushioned Helve Hammer. The Compact Hammer, as its name indicates, is distinctive for its general compactness of design and the high speed at which it may be run. This type is adaptable where limited floor space restricts size. Compact Hammers are made in sizes ranging from 15 lb. that delivers 525 blows per minute to 200 lb. size with 325 blows per minute.

The Bradley Upright Helve Hammer has a helve of wood and with this exception differs but slightly from the Upright Strap Hammer shown in accompanying shop scene. Both types are made in many sizes varying from 15 lbs. to 500 lbs.—both have equal speed—averaging from 175 to 400 blows per minute according to size of hammer. Both handle with equal facility, all sizes of material from ¼″ up to 5″.

The Bradley Rubber Cushioned Helve Hammer shown above is the Company's oldest and best known type and like the others, can be furnished in many sizes. While all Bradley Hammers are used to advantage in shipyards, this type is used more extensively than any other in this class of work. This hammer delivers from 240 to 435 blows per minute, according to size, successfully forging material up to and including 4 1/2″.

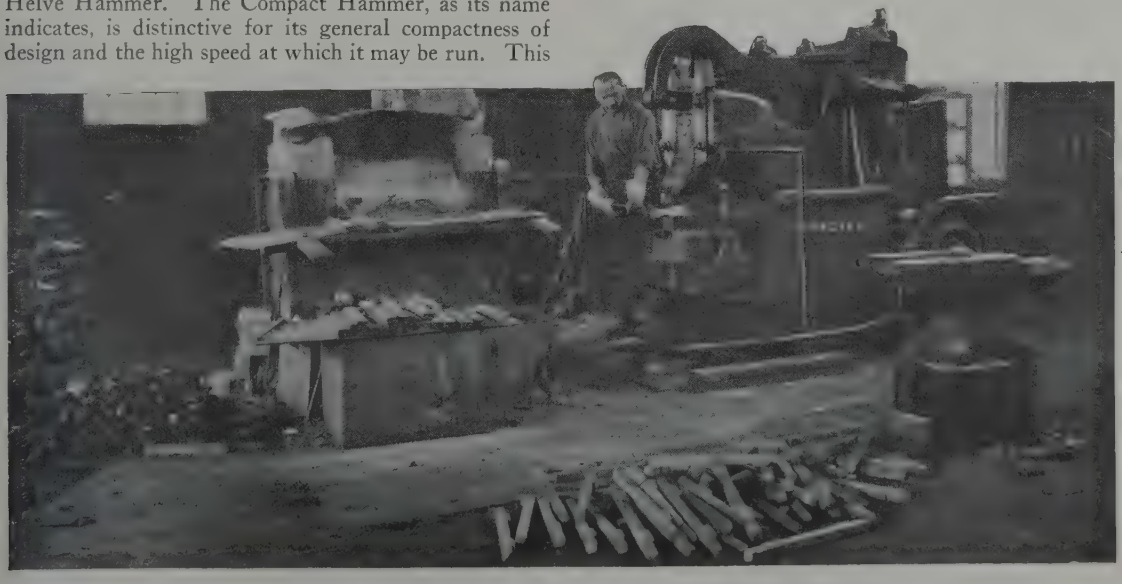
Advantages

Rugged construction and simplicity of design are distinctive features in all Bradley Hammers. Naturally—less complication means less repair cost.

Pressure upon the foot treadle, which extends around front and both sides of the hammer base, gives operator complete control both in speed and force of blow.

By means of Bradley Hammers, labor costs are heavily reduced while high production is not only maintained but may even be increased. One skilled Hammer Operator can do more work than several Blacksmiths and their Helpers. When the job is finished, machining is unnecessary.

Old parts ordinarily scrapped can be reforged by Bradley Hammers without addition of new material. Scrap steel is quickly drawn down to suitable size and made into tools of every description. The saving in material must be plainly apparent to every mechanic.



C. C. BRADLEY & SON, INC., SYRACUSE, N. Y.

Hydraulic Jacks

These hydraulic jacks are the most advanced development of this well known principle, and where heavy lifting is to be done, they are indispensable.

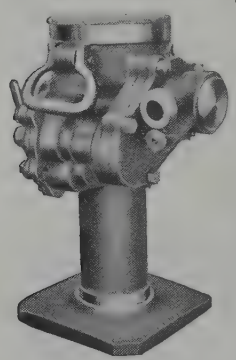
This jack is designed to fill the requirements of a universal purpose jack, for work where the old style jacks have proved inadequate. It is provided with a large round steel bottom which gives it a firm foundation and makes it easy to handle. It has a horizontal head which enables the jack to work at any angle from vertical to horizontal, and when laid flat upon the side, the ram will push out its entire lifting length. To the bottom of the head is attached a cylinder, which passes over the outside for the purpose of preventing sand and dirt from lodging between the ram and cylinder.

Hydraulic Jack

An independent claw can be used when a low lift is required, and removed when the jack is used for other purposes, thus relieving the tool of the additional weight. This jack will be found durable, plain in construction, and reliable in service.

Ball Bearing Self Lowering Jacks

The Ball Bearing Self Lowering Jack is a new development of the screw jack. It is especially adapted for work where a high speed jack is required and it has many features not to be found in other jacks of this type. It is ball bearing, doing away with much friction and allowing a greater lifting capacity with less effort.



Screw Jack

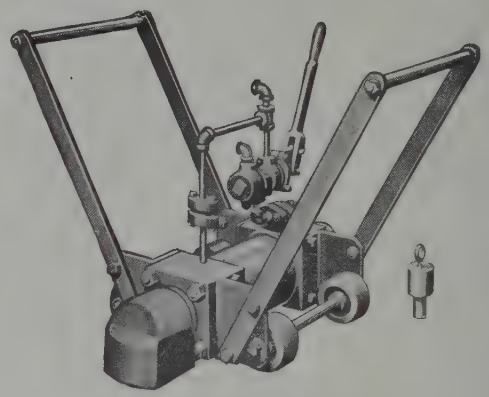
The self lowering device enables the jack to be lowered under load by simply throwing a hand lever without the necessity of pumping, making it a safe easy jack for loads up to 60 tons.

These jacks are built in sizes from 10 to 60 tons.

Portable Ship Frame Bender

This is a particularly handy machine for bending heavy steel shapes for ship frames, deck beams, etc., and is indispensable where much bending is to be done since it will reduce the number of men usually required.

It is mounted on broad rollers so that it may be moved quickly over the bending slabs, thus making it possible to bend long members to template without re-heating and with a minimum of labor. A loose pin is provided, which fits the holes in the bending slabs and serves as an abutment for the machine.



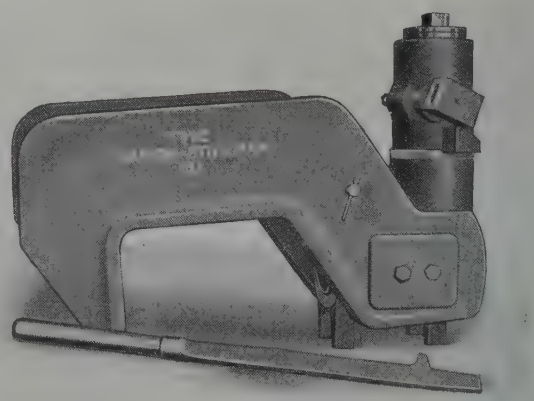
Portable Ship Frame Bender

The ram movement, both forward and return, is rapid and under perfect control at all times, and provision is made to prevent over-stroke. Power may be supplied from a suitable pump, or, preferably, an accumulator service.

The machine is built in two types, in capacities of 18 to 20 tons, one with a rolling movement at right angles to the axis of the ram, as illustrated; the other in a direction parallel to the ram axis.

Coupling Bolt Forcer

These machines are made for forcing bolts in or out of heavy shaft couplings. They are made to operate in restricted spaces and at the same time provide the heavy pressures that are often needed to move a coupling bolt. The side plates hook over the coupling and the ram forces the bolt through from the opposite side. The side plates are removable, so that plates of different length can be used on the same machine.



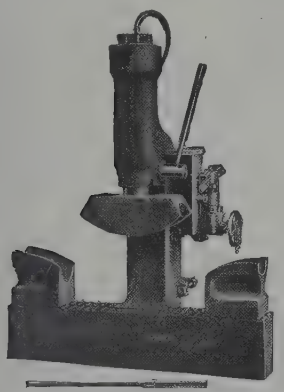
Hydraulic Bolt Forcer

Hydraulic Machinery and Tools

Hydraulic Pipe Bender

This machine is in almost universal use wherever pipe is to be bent. It will make bends without buckling or crushing.

The base is ribbed so that the lower bending blocks may be placed wherever desired to bend a required curvature. The upper block is held on the ram by a dove tail joint. A set of blocks is required for each size of pipe to be bent. It is a self-contained tool and is light enough to be taken from job to job.



Hydraulic Pipe Bender

The ram motion is 9 inches and the rack and pinion facilitates bringing the ram to or away from the work.

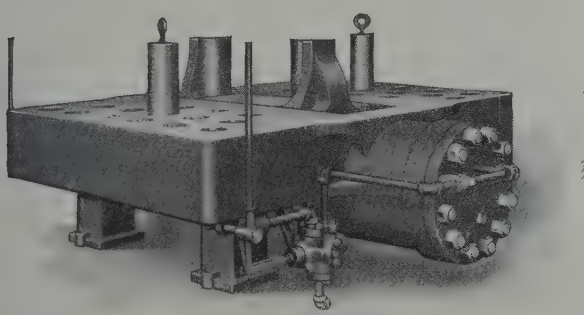
The hand pump shown is used on all benders of this type.

Built in 30 and 40 ton capacities weighing 550 and 760 pounds.

Beam and Structural Shape Bender

These machines are adaptable to bending I beams Z bars, and structural shapes and also for making bends in pipe.

We make holes in the table round or square and in sizes and arrangement desired by the user. The bending blocks are dovetailed into a double-headed saddle, which is firmly attached to the ram. Covers, to prevent the scale from blowing on the surface of the ram and block slides, and finding its way into the cylinder itself and cutting it, are provided. The heads of both cylinders are removable, and provided with air passages for allowing the air to be driven out, or to drain the water or fluid from them in cold weather if desired. The valves are placed in one body, and can be operated from either side of the press, and govern the motion completely. The motion is automatically stopped by removing the hand from the lever.

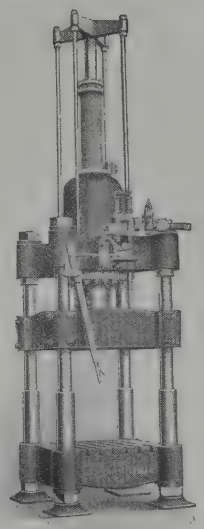


Beam and Structural Shape Bender

Hydraulic Presses

These presses are built in a wide range of sizes and capacities for die forging, forcing, bending, straightening, flanging, and many miscellaneous shop requirements. The press shown here is operated by a single lever balanced spindle valve, which has the ram under instant control at any part of its stroke. The hydraulic pull back cylinder is opened to the main pressure line so that no valves are required for its operation. The cylinders are packed from the outside. All castings are made of Open Hearth Steel.

The working table or platen of this press ranges from 34 x 35 inches to 46½ x 46½ inches and can handle work within these limits under pressures varying from 100 to 350 tons. The floor space required by this machine varies from 38 x 44 inches to 56 x 56 inches for weights ranging from 11,000 to 26,500 pounds.

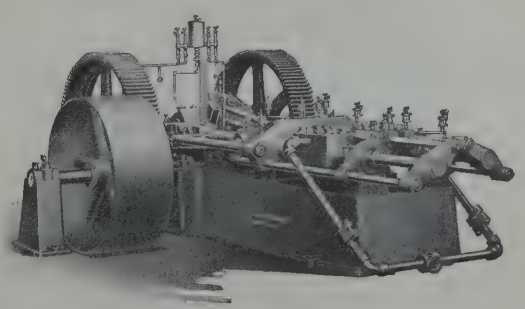


Hydraulic Forcing Press

Hydraulic Pressure Pumps

These pumps are heavily and substantially built for high pressure and heavy duty. Nothing but the highest grade of materials is used for any part in their construction. The unit pressures and stresses are very conservative, and all parts are exposed and easily accessible for inspection and repairs. A central sight-feed oiling system and individual oil cups insure excellent lubrication for all bearings, which are renewable and adjustable. The gears are cast iron, the pinions forged steel with straight or herringbone cut teeth. For moderate and high pressures the pump cylinders are machined from solid steel forgings, and for low pressures from open-hearth steel castings. They are made in two units with plungers in both ends of each and the valve chambers in the center. The valves, valve seats, bonnets and packing glands are bronze and the plungers hardened tool steel.

These pumps are made in five different styles to suit this number of operating conditions.



Hydraulic Pressure Pump

Steam Hammers

Designs and Adaptability

Chambersburg Hammers are adaptable to every phase of forging in shipbuilding work. The respective types of hammers are Single Frame and Double Frame Steam Hammers, Guided Ram and Guided Rod designs, for general forging and welding, and Steam Drop Hammers and Board Drop Hammers for the smaller forgings and marine hardware.

Sizes

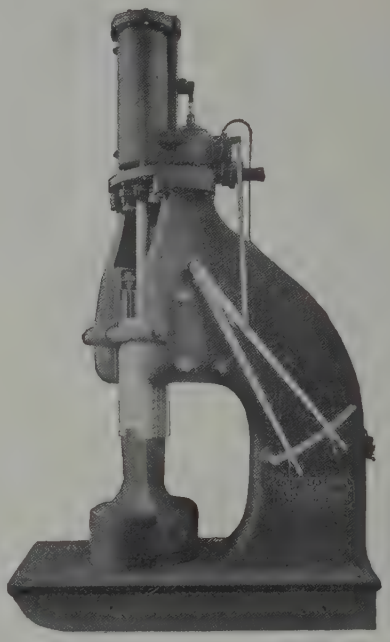
The Single Frame Hammers are built in sizes ranging from 50 to 5000 lbs. The Double Frame Hammers from 600 lbs. to 25 tons. Steam Drops from 300 lbs. to 12 tons. Board Drops from 50 lbs. to 4000 lbs. Respective sizes are designated by the actual weight of the falling parts—Ram, rod, die, etc.

Operation and Valve Design

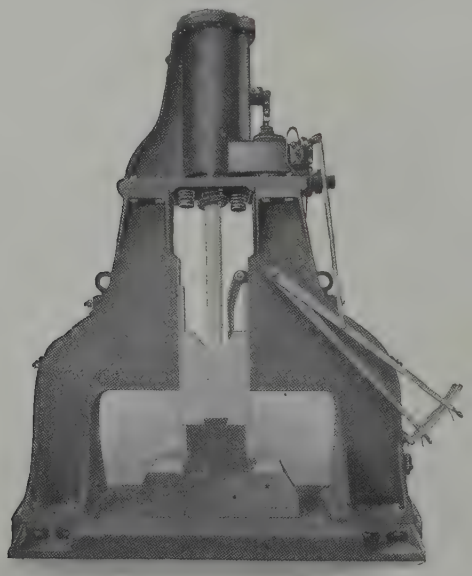
All Steam Hammers and Steam Drop Hammers are double acting, taking steam above and below piston, and any variation of blow may be obtained. They may be operated either automatically or by hand. All hammers operate as well by compressed air as by steam. Valve gear is of the simplest and most durable construction, is not liable to get out of order, and affords the operator accurate control of the hammer at all times.

Single and Double Frame Hammers

The cylinders on all hammers are made of Cast Iron of special mixture and are cast on end to secure clean sound casting. The Frames are Cast Iron, Semi-Steel or Cast Steel as desired, box section, well proportioned and of extra thickness to give great strength and rigidity. The Guides are adjustable for taking up wear of ram. They are hung in pockets planed in the frames, the weight of guide being carried by a lug solid on the guide which fits in a corresponding recess in the guide pocket. The adjustment is made by a steel taper shoe which bears full width and length of guide and adjusts the guide equally top and bottom. These Guides are of the most approved design and have successfully overcome the difficulties and objections of other forms. The Piston Rods and Rams are made of a high grade of selected Open Hearth Steel carefully treated to insure long service. The anvils are made of air furnace iron, semi-steel or cast steel as desired. One pair of Dies is furnished with all Steam Hammers but no Dies are included with Drop Hammers.



3,300 lb. Single Frame Steam Hammer



8 Ton Double Frame Steam Hammer

Steam Drop Hammers

The general characteristics of the Cylinders are the same as on Single and Double Frame Hammers. The Frames are Cast Steel. The Guides are Forged Steel with an improved method of adjustment. The Anvils are Cast Steel. The Piston Rods are Chrome Vanadium special treated steel and the Rams may be Forged Steel or Cast Steel. The Anvil Caps are Forged Steel. A tieplate of heavy Cast Steel section is placed between the Cylinder and the Frames to protect the Cylinder from shock.

Erection and Test

All hammers are carefully erected at our extensive plant and are subjected to a most severe test in actual operation before shipment. Design, workmanship and material are guaranteed to be superior in all respects.

The extensive experience of our forging engineers is at the service of clients at all times.

CHAMBERSBURG ENGINEERING CO.
CHAMBERSBURG, PA., U. S. A.

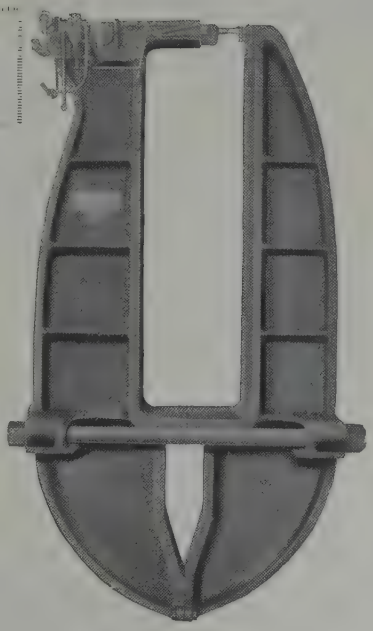
Hydraulic Riveters—Forging and Flanging Presses

Hydraulic Riveters

Chambersburg Hydraulic Riveters are built in a large range of sizes and tonnages and of various designs specially adapted to shipbuilding work.

These designs include portable riveters built in sizes from 6″ to 60″ gap, hinged riveters, floor mounted, in sizes from 15″ to 60″ gap. Bull riveters, single or two piece frame, in sizes from 38″ to 252″ gap.

Pressures on dies are 35, 50, 75, 100, 125, 150, 175 and 200 tons. Usual line pressures are 1500 lbs. per square inch, but we can design to accommodate any line pressure in use.



204″ Gap Hydraulic Riveter

Forging and Bending Machines

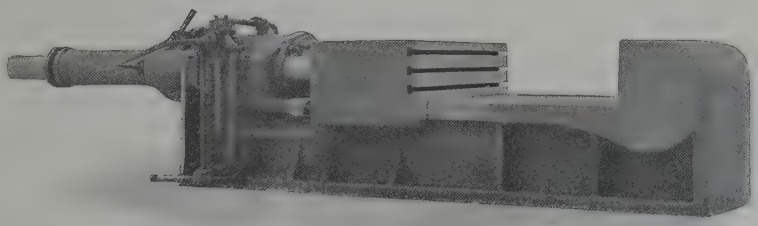
The wide range of tools which has been adopted for this class of work has resulted in some very unique and successful tools having been added to our line and we illustrate one type with cut No. 631 which shows a 300 ton Horizontal Forging and Bending Press.

This machine consists of a cast iron frame to which is attached our improved multiple pressure cylinder system and high speed valves. It is rapid in action, covers a large range of work and has proven very popular in shipyards.

Universal Flanging Press

Our line of Universal Hydraulic Flanging Machines meets every requirement in shipyard work for shaping and bending plates, angles and beams, etc., economically and quickly. The frame is of cast iron construction, cylinders cast steel, rams are provided with outside packed glands, valves are of simple but improved design and are rapid in action and efficient and accurate in operation.

These presses are built in sizes having 54″, 60″, and 66″ depth at gap, 200 tons pressure on each vertical ram, 50 tons on horizontal ram and 75 tons on the stripping ram.



No. 631. 300 Ton Horizontal Hydraulic Forging and Bending Press

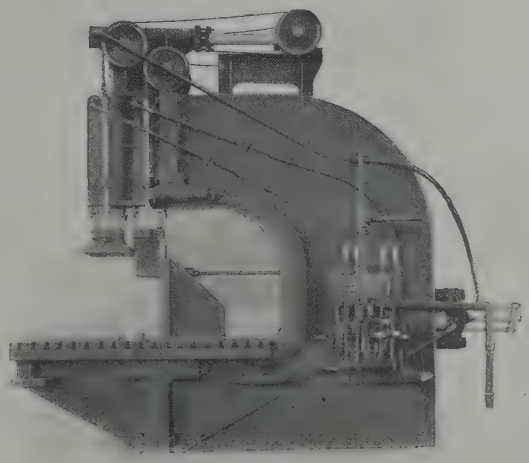
Cylinder Design

Chambersburg multiple pressure riveters are provided with a very superior and compact system of cylinders which is unexcelled for economy in water consumption, and general maintenance. All rams are provided with outside packing glands, which are accessible at all times, thereby, providing quick and easy change of packings. Hemp or flax is used, doing away with the troublesome and expensive leather packings.

Construction

All riveters are built of a select grade of cast steel throughout. The valves are simple in construction and very rapid in operation and perfect operation is guaranteed.

All machines are given a thorough test under hydraulic pressure before shipment so as to insure that each tool complies with specifications in every respect.



No. 460. Universal Hydraulic Flanging Press
200 Tons Pressure—66″ Horizontal Gap

Uses in Shipyards

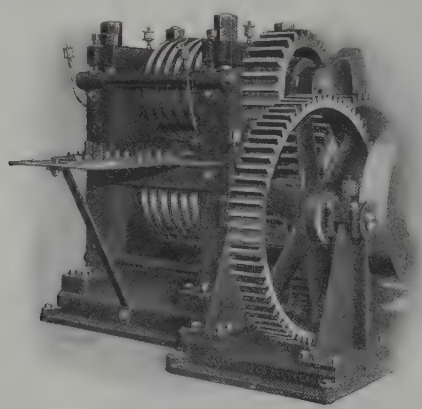
For the past thirty years Ajax Forging Machines have been extensively used in shipyards throughout the world for the production of forgings in quantities. There are many types, each adapted for a particular group of uses, such as Rivet and Bolt Heading Machines, Taper Forging Rolls, Hot Pressed Nut Machines, large sizes of Upsetting Forging Machines and Universal Forging Machines. By these machines all kinds of forgings from rivets up to ship stanchions, large anchor shackles, etc., are made far better and more uniform in a fraction of the time required to make them by hand or under hammer.

Ajax Liner Forging Rolls and Ajax Continuous Motion Headers have proved to be of special value to the modern shipyard, and for this reason these two typical machines are described at length.

Ajax Ship Liner Forging Rolls

Ajax Ship Liner Forging Rolls are used for producing ship liners, at a lower cost than they can be made under the hammer, at the same time insuring a better finish and a complete absence of marks. Taper forging rolls can be supplied for belt drive or with the motor direct connected to the machine.

The dies are semi-cylindrical and are secured to the



Ajax Ship Liner Forging Rolls. Capacity Any Normal Size Ship Liner. Output 40 to 100 Liners Per Hour

roll shafts which are carried in a pair of large bearings mounted in a substantial housing. The dies operate between these housings, thus making an exceedingly rigid construction. The roll dies are made from a special steel mixture approximately .90 carbon and .90 manganese which gives a very hard rolling surface and long life. The roll die surfaces are finished plain with a slight eccentric taper. The dies are provided with two adjustments, one vertical and the other eccentric. The former is utilized when old rolls have been refinished by setting them up to normal centers. The eccentric adjustment provides for rolling varying degrees of taper to ship liners.

The roll shafts revolve continuously at 30 revolutions per minute, and the stock is inserted between the open gap of the roll shafts, and as the rolls revolve they grip the stock and force it back towards the operator, at the same time forming the taper.

By loosening the set screws on one side of the dies and tightening up those on the other, the degree of eccentricity and consequently the taper of the finished forging, can be varied.

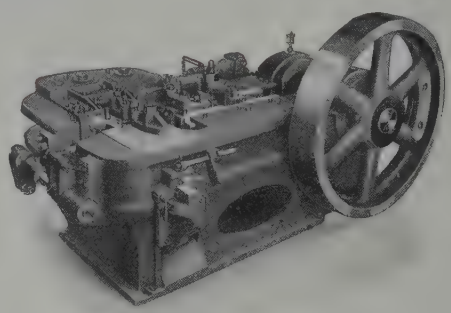
Cut gears and pinions are furnished throughout, except the long tooth pinions on the end of the roll shafts which are cast with special long teeth to take care of the vertical adjustment. Lubrication is exceptionally well provided for and bronze bushings are used throughout.

The best production is obtained with an operating crew consisting of a heater and an operator. Liners are rolled at one heat, and the tapered end of such liners as do not exceed 5½" width can be trimmed on the side shear which is a part of the machine equipment.

One of the most important items of economy besides greater production in using an Ajax Ship Liner Taper Forging Roll, as compared with a hammer, is the very low cost of machine and die maintenance, as the extreme thinness of which ship liners must be drawn causes undue failure to hammer parts and dies.

Ajax Continuous Motion Hand Feed Rivet Header

Ajax Continuous Motion Bolt and Rivet Headers are made in two types—Hand Feed and Automatic—both for hot heading only. In the hand feed type the stock is fed into the machine by hand, the operator having heated the bar



Ajax Continuous Motion Hand Feed Rivet and Bolt Header

for a length of from four to five feet. A rivet is made at every revolution of the machine. The average production is from 1400 to 1800 rivets per hour.

Ajax Automatic Feed Continuous Header

The output of the Ajax Automatic Feed Continuous Heading Machine is more than double that of the hand feed type. Productions vary, according to the length and size of the rivets being made from 2800 to 4200 rivets per hour. Even greater output has been made on motor driven machines where a variable speed motor has been used by which the short length rivets are produced at a higher rate of speed than normal.

Both the hand feed and automatic feed continuous motion headers are made in the following sizes, ½", ¾", 1", 1¼", 1½", 2"—these figures indicating the

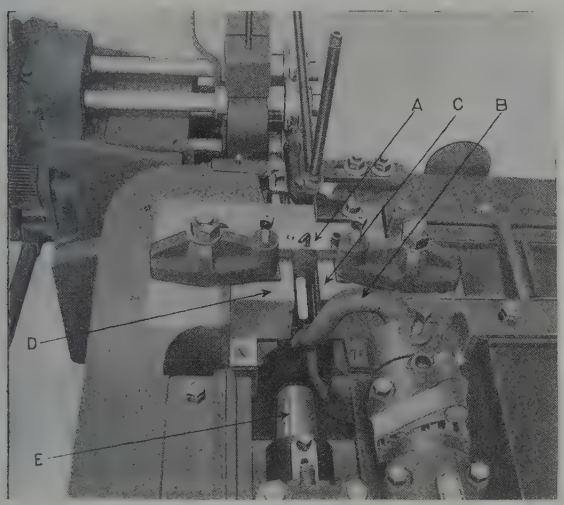
largest diameter of rivet or bolt which the machine will make.

The bed plate is of solid steel, carefully annealed. Crankshaft is forged from special analysis steel, heat treated. The bearings to crankshaft, pitman and knuckle pins are bronze bushed. Bronze liners are fitted to the bottom of the header and die slides, which wear on steel liners fitted to bed plate.

All bearings are extremely large and are provided withpockets or oil reservoirs.

Sequence of Operation

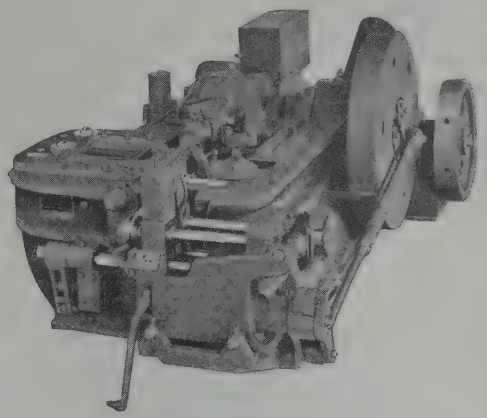
The heated bar is ported through the backing plate, "A" until it strikes the stock gauge "B", which is so set that just enough of the bar projects through the backing plate to make the finished rivet or bolt. The moving die "C" then travels across the face of the backing plate, shears off the blank and grips it against the stationary die "D" in the lower groove. The header tool "E" moves forward and heads the stock which projects from the



dies against the die faces. As the header tool backs off the dies open and the rivet is ejected by a kick out device. Thus a rivet is made at each revolution of the machine. The dies are water cooled.

Safety Mechanism

An automatic self adjusting safety relief is incorporated in the moving or gripping die mechanism which protects the machine against stickers lodged between the gripping faces of the dies. This safety mechanism assumes normal working position immediately on removal of obstruction or sticker.



Ajax Automatic Feed Continuous Rivet and Bolt Header

In the direct motor driven type a further safety device, in the form of a slip clutch, saves the motor and machine from the risk of damage.

Ajax Die Blocks are machined with four grooves, two in each of the vertical faces, thus the vertical centers of the grooves are not altered when the dies are re-dressed which also means less time required to set dies.

Service Department

Our engineering department, backed by thirty years of forge shop experience is freely at your service and is prepared to give definite figures and guarantees as to the saving which you can make by the use of Ajax Machines.

TABLE OF DIMENSIONS

Mach. Size	Motor H. P.	Floor Space	Normal Speed Strokes per Minute	Capacity
		Hand Feed		
½ in.	5	7′ 3″ x 4′ 9″	90	½ in.
¾ in.	7½	7′ 5″ x 4′ 10″	85	¾ in.
1 in.	10	8′ 3″ x 5′ 4″	80	1 in.
1¼ in.	15	8′ 9″ x 6′ 0″	70	1¼ in.
1½ in.	20	11′ 2″ x 6′ 11″	65	1½ in.
2 in.	20	13′ 7″ x 10′ 0″	50	2 in.
		Automatic Feed		
½ in.	7½	8′ 8″ x 5′ 0″	110	½ in.
¾ in.	10	8′ 11″ x 5′ 0″	105	¾ in.
1 in.	15	10′ 2″ x 5′ 11″	100	1 in.
1¼ in.	20	10′ 9½″ x 6′ 8½″	90	1¼ in.
1½ in.	25	13′ 11″ x 7′ 5″	85	1½ in.
2 in.	30	16′ 5″ x 10′ 0″	60	2 in.

Bolts and Rivets Made on Ajax Machines

Hex Head Bolt Before and After Trimming

Rivet as It Comes from Machine

Carbo-Hydrogen Cutting and Welding

Carbo-Hydrogen Complete Cutting Process

The Carbo-Hydrogen Co. of America offers a complete Process for cutting metals, this Process consisting of Carbo-Hydrogen Gas, Carbo Cutting Apparatus and Service. These features are not separated, and ordinarily gas or apparatus for cutting is not furnished separately by the company.

Portable Cutting Outfit

Carbo Cutting and Welding Apparatus

Carbo Cutting Apparatus is of the best material and workmanship and as part of Carbo Service is sold at practically cost. The upkeep cost is also exceedingly low as it is of particularly simple construction and lasts much longer than other types. The cylinders are furnished on a loan basis without charge, and the total cost of fuel gas, oxygen and labor is considerably less than by any other process.

Carbo Welding Apparatus, for use with acetylene gas, is sold separate from the Carbo Process. It is, in many respects, the best welding apparatus obtainable, and is designed to assure a correct mixture of the gases.

Advantages of Carbo Hydrogen Gas

Carbo-Hydrogen Gas assures safety as it is a true inflammable and in no sense an explosive. It burns practically wholly to water vapor, which is a great benefit to the health of operators. Practically all other gases on the market for cutting purposes burn to large proportions of carbon monoxide and carbon dioxide, with resultant bad effects on the stomach, eyes and general health of the operators.

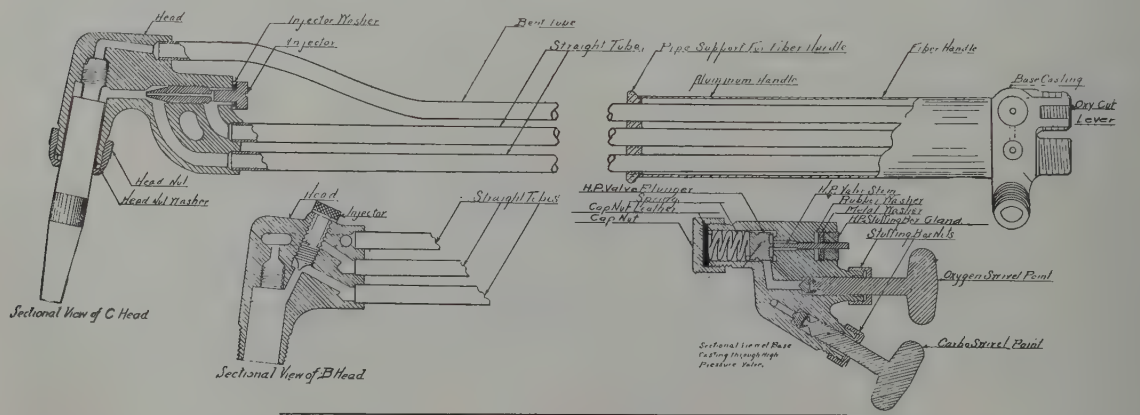
Cutting Data Table

The approximate cutting data table given below is useful for estimating purposes. It is to be noted that many conditions of the steel, as well as different grades of steel, will have an effect in altering these figures one way or another, and that the pressures can be varied to advantage at times on various grades of steel. The figures are meant to represent good efficient work, and in favorable conditions even better results can be obtained.

Thickness of Steel in Inches	Size of Cutting Tip	Lineal Feet Cut per Hour by Hand	Pressure of Cutting Oxygen in Pounds	Cu. Ft. of Oxygen Used per Lineal Ft. of Cut	Cu. Ft. of Carbo-Hydrogen Used per Lineal Ft. of Cut
¼"	1-A	110	15	1	1
½"	2	90	25	1⅜	1
¾"	2	75	32	2⅛	1½
1"	2	60	35	3	1½
1½"	3	45	45	4⅜	2½
2"	3	38	50	7	3½
3"	3	28	60	14	6
4"	3-A	18	75	26	9
5"	4	13	85	32	12
6"	4	11	100	40	13
7"	5	8	120	50	13
8"	5-A	7	140	64	14
9"	5-A	6	160	78	16

Carbo Service

Carbo Cutting Service is furnished without extra cost and includes a corps of traveling experts in the operation and repairs of the apparatus. The close and personal attention given each plant assures maximum possible efficiency of operation, and the advice of this department is always available in working out special advantages or new problems.



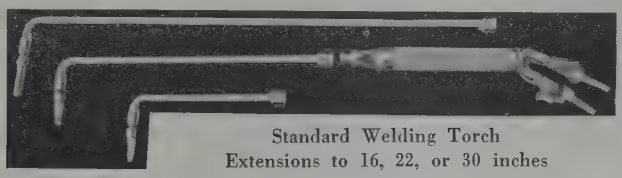
CARBO-HYDROGEN CO. OF AMERICA, PITTSBURGH, PA.

Welding and Cutting Equipment

Welding and Cutting Equipment

The Welding and Cutting Equipment manufactured by the General Welding and Equipment Company is highly efficient. It is designed so that any part which may be damaged in service or by accident, is accessible, and can be replaced quickly by the operator. Therefore losses incurred by the inability of the equipment to operate steadily are negligible.

Each part of the Regulators, Welding and Cutting Torches, etc., has distinctive features which are not found in other equipment of this type.

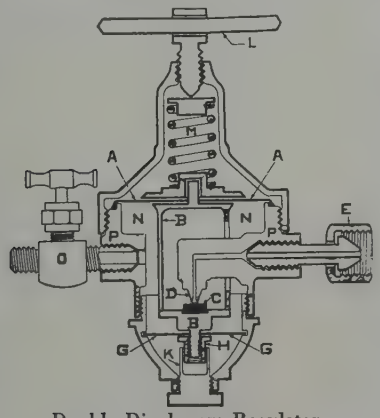


Standard Welding Torch
Extensions to 16, 22, or 30 inches

Regulators

One of the principal features of the Regulators is the fact that nozzle D (see sketch) invariably comes back to the same spot on seat C. The Regulators are also provided with an extremely sensitive spring system. The moving system that is cage B, carrying seat C, is not only securely fastened to the main diaphragm A, but also to the perforated rear diaphragm H by means of a fitting. Thus a lateral deviation of seat C in relation to nozzle D is impossible and restricted to an absolutely straight up and down movement. A sleeve guide K is an added feature which insures perfect alignment.

The Regulators do not rely entirely upon spring action of main diaphragm A, but also upon the two way action of rear diaphragm G. If diaphragm A should act too slowly, diaphragm G supplements the action.



Double Diaphragm Regulator

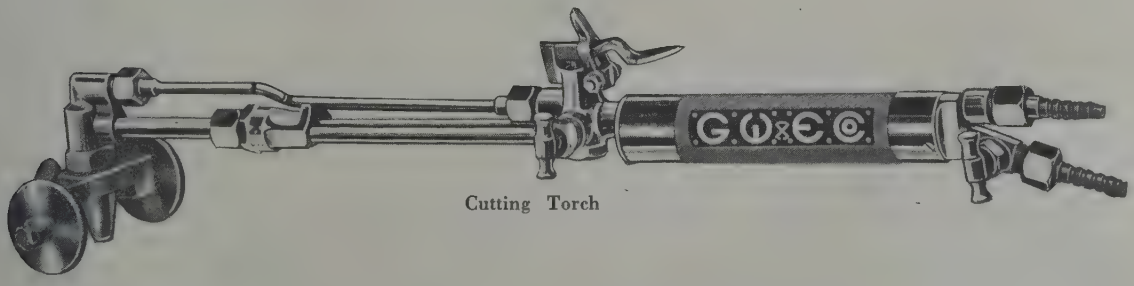
Welding Torches

The majority of our Welding Torches are furnished as Combination Torches; that is, a torch base with two extensions, a short and a longer one. The operator can then use it either as a 16 inch or a 22 inch torch. A third extension can be supplied, if desired, to make the torch 30 inches overall.

Cutting Torches

Our Cutting Torches, which are subjected to unusually severe work, are of superior material and design in order to withstand the strain of constant service.

These Torches are usually operated by unskilled workmen, and for this reason they must be simple in construction and operation. Torches manufactured by the General Welding & Equipment Co. fulfill these conditions. They are efficient and economical in every respect.

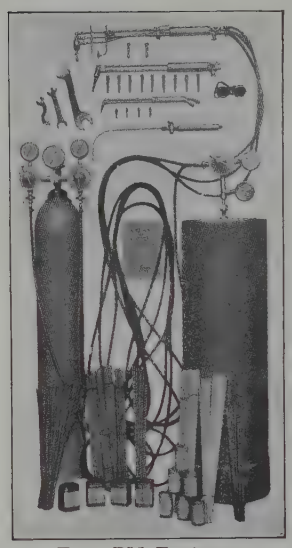


Cutting Torch

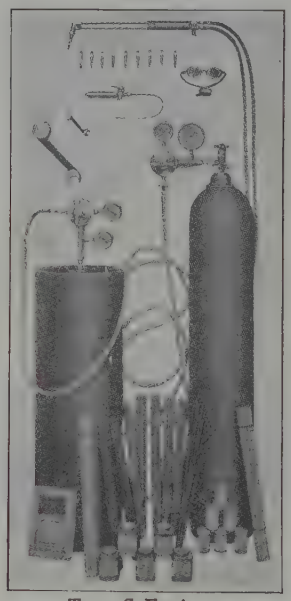
GENERAL WELDING & EQUIPMENT CO.

107 MASSACHUSETTS AVE., BOSTON, MASS.

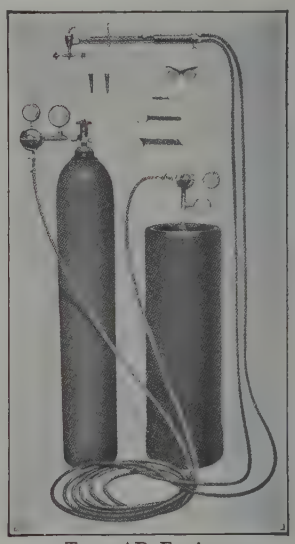
Welding, Cutting and Burning Equipments



Type BM Equipment



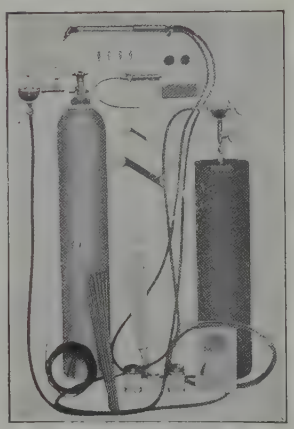
Type S Equipment



Type AP Equipment

Waterhouse Welding & Cutting Equipments

Waterhouse oxy-acetylene welding and cutting equipments fill the requirements that arise wherever metal parts are being manufactured or repaired. Fittings on the regulators connect directly to standard oxygen and acetylene tanks. The equipments shown are complete in every detail with the exception of tanks, and these can be secured in any city. The various style Waterhouse welding outfits fill all possible requirements that might arise demanding the use of a portable oxy-acetylene welding and cutting equipment. Perhaps the most predominating features of this equipment are the flexibility of its use, the service that is given by its manufacturers, its ease of operation, and its dependability for service.



Type J Equipment

Welding

Equipment "S" is built to meet the requirements of the most severe user. It will handle anything within the range of the oxy-acetylene welding process, and is used largely on manufacturing and repair work of a heavy nature where constant service is demanded.

Equipment "J" is designed to meet the requirements of the ordinary user. The equipment is light and easy to handle, and is the proper equipment where the work is of not too heavy a nature.

Equipment "B" (not shown) is designed particularly for light welding and lead burning, and for reaching work of a secluded nature which is inaccessible with a heavier or larger torch.

Cutting

Perhaps no tool has played a greater part in revolutionizing the shipbuilding industry than the oxy-acetylene cutting torch. It is indispensable in any shipyard, regardless of its size. Waterhouse cutting equipment is characterized by its simplicity, ease of operation, wide adaptability, and accomplishment of results which would be impossible by any other process.

Equipment "AP" is designed particularly to meet the requirements of a shipyard; and, by means of interchangeable tips, any thickness of iron or steel up to 20" can be cut. A welding torch can be substituted for a cutting torch on this equipment without making it necessary to duplicate regulators, provided a welding and cutting equipment are not required to be in operation at the same time.

Equipment "BM" is a combination equipment which will handle anything within the range of the oxy-acetylene welding and cutting process without any duplication of unnecessary parts. It will handle cutting as well as both light and heavy welding.

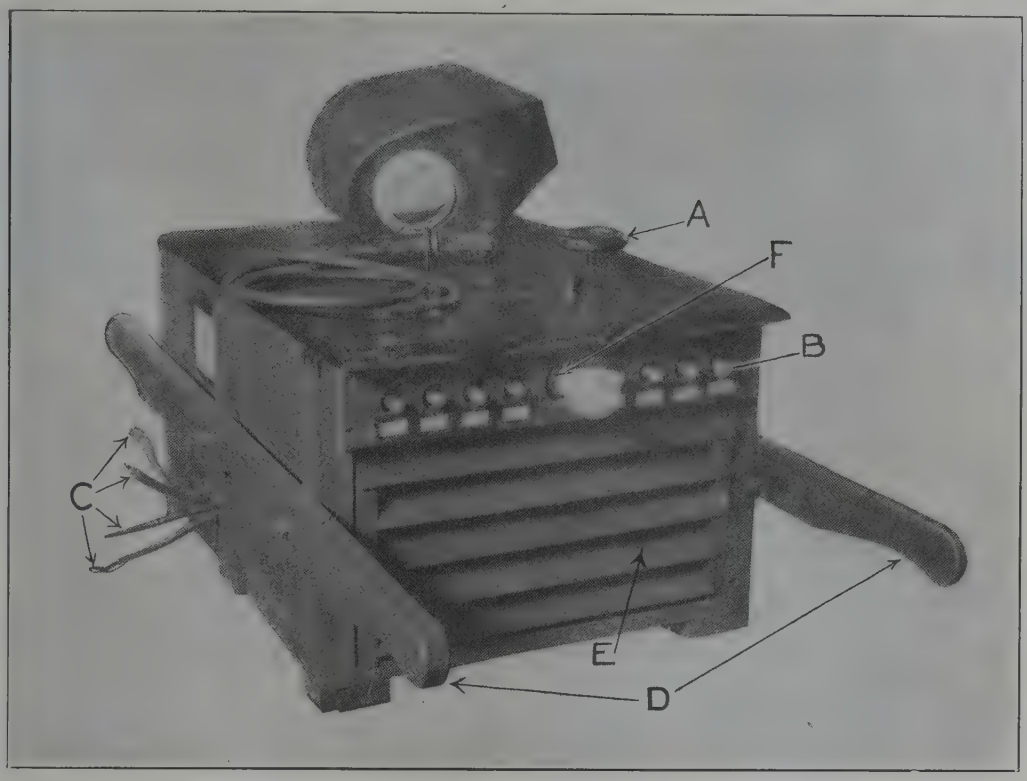
Supplies and Accesories

We carry a complete line of accessories and supplies incidental to the use or maintenance of oxy-acetylene welding and cutting equipments. We maintain a welding department for the service of our customers, chiefly that our own engineers may become more thoroughly conversant with the most recent and modern practises in the oxy-acetylene industry and pass this information on to our users.

WATERHOUSE WELDING COMPANY

15 PELHAM ST., BOSTON, MASS.

A. C. Electric Welder and Cutter



Standard Welder showing our type 17 mask and type A welding handle

A—Flux diverter which gives the small increments of current to give exact condition of heat.
B—Secondary taps, either side may be grounded. These give the larger increments to current for heat conditions. Brass plates under each tap designates the kind of work to be done. Light work; Slag coated electrode, Flux coated electrode, Bare wire, Light work, Medium work, Heavy work, Cutting.
C—Primary connections two 5% taps for below normal voltage.
D—Handles for carrying Welder. E—Ventilator. F—Lamp Socket for light grinder. G—Oak case.

Adaptability

The Alternating Current Arc Welder and Cutter is a special portable transformer delivering the arc voltage of the necessary characteristics for the work to be done at the terminals of the apparatus, and is made to meet any A. C. Primary power supply, voltage or frequency.

This A. C. Welder will use any make of bare or covered, iron or steel, electrode and the process used also enables cast iron, aluminum, brass or copper to be welded with special electrodes.

Advantages

The A. C. Electric Arc Welder and Cutter embodies several features of superiority over any other machine serving the same purpose.

Good, smooth welds are assured by the machine which maintains a close and constant-heat arc which all experts agree is necessary for proper fusing of the metal. The high penetrative quality necessary to bite through the slag, dirt, oil, or hard metal skin in starting the weld is provided by the high initial voltage generated by the machine.

The first cost of the A. C. Electric Arc Welder is least because of its simplicity and the light high tension wire used for distribution. The cost ot operation is lower than any other, the machine being guaranteed to deposit a pound of metal for less than 2 K W hours, and the use of alternating current also permitting a speed of welding 20 to 30% faster than any D. C. system. The cost of maintenance is nil as there are no moving parts to require attention or get out of order.

Unusual convenience in operation is an outstanding characteristic of the A. C. Electric Arc Welder and Cutter by reason of its portability, the total weight being but 260 lbs., its ability to use any make or type of electrode, its construction permitting its use in any kind of weather, and its speed of welding or cutting.

Special Accessories and Service

Flux Coated welding electrodes and special electrodes which deposit mild steel or alloy steels can be supplied by the manufacturer in 50 lb. bundles for immediate shipment.

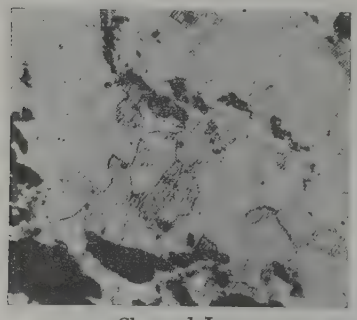
Special light weight and re-inforced masks for operators and shields for observers and patented welding handles and cutting handles can also be furnished.

We have established a welding school where men can study iron and steel and apply it to welding. A free consultation and instruction service is maintained for the use of customers. Our Booklet 96 gives full information.

ELECTRIC ARC CUTTING AND WELDING CO.

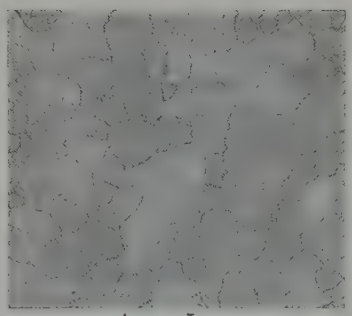
222 HALSEY ST., NEWARK, N. J.

Armco Iron Welding Rods



Charcoal Iron

The black spots indicate slag and impurities detrimental to the welding operation and the strength of the weld.



Armco Iron

The black and muddy spots indicate gases and blow holes. The lack of individual grains is due to impurities.

Open Hearth Steel

Clearness and evenness of the grains indicate uniform density, purity, and freedom from occluded gases.

Welding Advantages

Armco Iron Welding Rods are made for both electric arc welding and oxy-acetylene welding. Those who make this guaranteed welding iron their standard will find that for mild steel and iron welding it will do all the work that formerly was thought to require a wide range of welding materials of various analyses. The advantages are obvious. A comparatively small stock of welding rods will meet all usual requirements and the investment in welding material and the space required to store it are greatly reduced. The use of a single standard composition is very convenient for both workman and employer and there is an assurance that the best material obtainable goes into every weld.

The standard lengths for Armco Iron Welding Wire are:

Electric, 14 inches.

Oxy-Acetylene, 36 inches.

Welding Quality

Armco Iron Welding Rods are the purest commercial iron made. As all authorities since the first commercial application of oxy-acetylene welding have agreed that the best welds are secured by the use of pure iron, the following guaranteed analysis of Armco Iron Welding Rods is convincing proof of its purity and advantages in a weld.

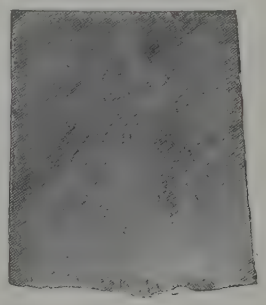
Sulphur, Phosphorus, Carbon, Manganese, Silicon, Copper, Oxygen, Nitrogen, Hydrogen	16/100 of 1%
Iron	99.84%
	100%

The usual electric welding wire specifications for mild steel welding permit a maximum total of impurities — carbon, manganese, phosphorus, sulphur, and silicon (five elements)—of 91/100 of 1 per cent. As will be noted from the foregoing analysis, Armco Iron is analyzed for nine elements, including oxygen, hydrogen, nitrogen, and copper, and even then the total impurities do not exceed 16/100 of 1 per cent.

By specifying that welding metal must be iron and as pure as possible, a metal possessing the proper welding qualities will be obtained.

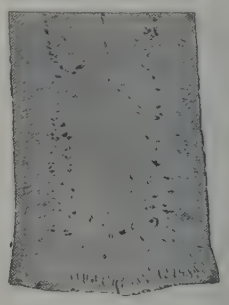
Manufacture of Armco Iron Welding Rods

In the manufacture of Armco Iron the process is one of elimination of impurities from start to finish, and the raw materials entering into its manufacture are very carefully selected. Test samples are taken from the furnaces at various times and in no instances is a heat poured until the chemist has determined that it is of the proper analysis. Further tests are taken of the ingots for gas determinations.



Armco Iron

Part of ingot sawed in half to show uniformity and practical freedom from blow holes.



Steel

Part of split ingot showing typical blow holes and uncertain density.

The physical properties of welding rods are equally as important as the chemical purity. Great care is exercised in the rolling and wire drawing processes and the finished product combines the highest achievements of the open hearth furnace and wire mill.

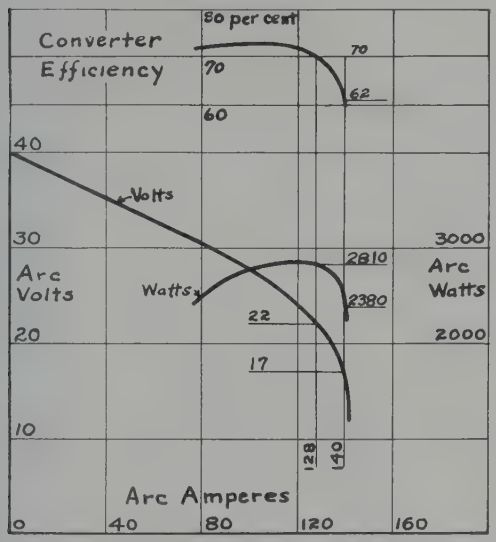
PAGE STEEL AND WIRE CO.

SALES OFFICE, 30 CHURCH ST., NEW YORK

Electric Arc Welder

Applications of USL Electric Arc Welder

The USL Electric Arc Welder has proved especially valuable in shipyard work because of the comparative ease with which it efficiently maintains a steady arc. Shipyard welding experts have been taught by experience to prefer the USL Arc Welder for difficult jobs because of the certanty of obtaining dependable, high quality welds.



Characteristic Curves of USL Arc Welder Converter

Among the innumerable uses for the USL Electric Arc Welder in a shipyard or on shipboard may be mentioned the securing of brackets to watertight bulkheads, tank sides and tops, anchoring shims and various equipment in place on foundations, closing up holes, making repairs, securing ship's frame members to each other, and so forth, in every case producing a strong, durable, quick, clean, and remarkably economical job.

Types of USL Arc Welder

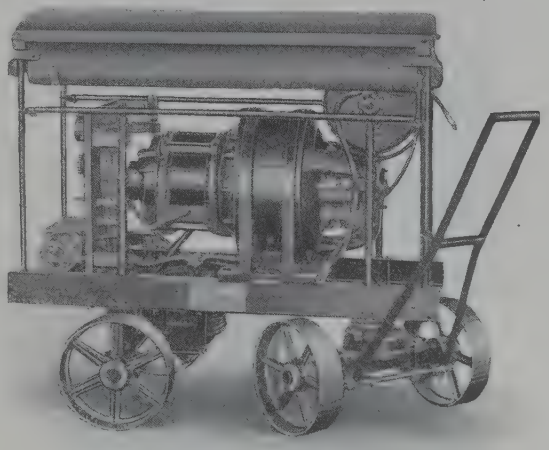
The USL Arc Welder is a variable voltage type of portable or stationary machine of exclusive design for providing the necessary direct current range,—50 to 200 amps,—and voltage range,—20 to 65 volts,—required for arc welding. With a supply circuit of direct current up to 125 volts, the converter type is used; and with a supply circuit of alternating current of any voltage and direct current of more than 125 volts, the Motor Generator type is used. This Arc Welder is intended for single operator use and comprises the motor-generator or converter, a switch and metal panel, an arc stabilizing reactor, an electrode holder, a face shield, and for portable use a truck and cable reel with two fifty foot lengths of flexible cable.

To enable the operator to vary the current to meet his requirements USL Arc Welders are equipped with both a voltage adjusting rheostat and a current adjusting switch.

Features of Construction

The USL Electric Arc Welder is specially designed in every detail to meet the exacting requirements of electric arc welding. Heavy, well built commutators of ample capacity, together with liberally proportioned windings and structural parts contribute to their reliability and long life. The windings and connections are in plain view and are readily accessible. The armature rotates on high grade annular ball bearings reducing friction to a minimum.

These welders are remarkably compact so that the space taken by them is negligible whether mounted for stationary or portable use. The all metal truck on which the portable machines are placed is 28 inches wide, 55 inches high, and 54 inches long, and no portion of the equipment extends beyond the guard rails which serve as rugged bumpers to protect the welder from damage by collision. Readily adjustable curtains are provided to keep out rain and dirt. The motor-generator set mounted on a truck weighs 1530 pounds complete, and the converter set similarly mounted weighs 1410 pounds.



Portable Motor Generator Type of USL Arc Welder

Advantages

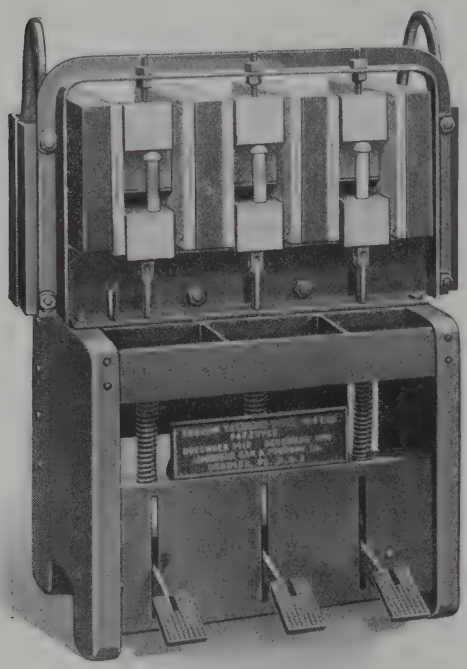
The USL Electric Arc Welder operates at maximum efficiency, is self excited, automatically regulated and simple to operate. Instantaneous response of the arc when the electrode strikes the work; perfect safety from excessive current on short circuit, yet enough current available above normal to preheat the work locally on striking the arc; volt-ampere characteristics that maintain practically constant heat in the arc; no regulators to get out of order; positive, steady current, giving a uniform flow of metal into the weld; these are some of the features of the USL Arc Welder which enables an ordinary operator to make welds that are solid, homogeneous and reliable, and to make them for the lowest possible cost.

Actual tests of the machine show an operating efficiency of 65 to 70% within the welding range, and a welding efficiency of 94 to more than 100% of the original strength of the metal in tension.

Berwick Electric Rivet Heaters

Object

The primary object of the Berwick Electric Rivet Heater is to improve the working conditions in the erecting shop, and hulls of vessels; to eliminate smoke and gas which are injurious to the workmen; to eliminate heat prostrations, dirt, pipe connections for oil and gas, and air blast connections for oil, coal and coke heaters; to eliminate the thirty-minute delay in firing up before charging and the continual burning throughout the day; further to eliminate burned and scaled rivets, and to effect a large saving both in the heating cost and by reducing the rivet loss from over 10% to less than 1/2 of 1%; to provide flexibility by placing the Heaters in close proximity to the work in hand, thereby eliminating both loss of time and waste of rivets, and avoiding discomfort to the workmen by the excessive heat which is thrown out by other types of Heaters; to reduce to a minimum the fire hazard.



No. 3—Three-electrode Berwick Electric Rivet Heater, for 5/8 to 1" Diameter Rivets; Capacity 300 Rivets or More per Hour. Built Also with Two or Five Electrodes.

The only requirement is an electric connection to Alternating Current of standard frequencies and voltages, single phase; can be joined up in groups or singly, to a three-phase line, without any serious disturbance to same.

Benefits

Absolute portability, with close proximity to work.

Thirty seconds' notice for hot rivets.

The use of power only when hot rivets are required.

The individual heating of rivets, one by one, eliminating burned and scaled rivets.

Absolute control.

Eliminating fire risks.

Eliminating heater boy's judgment as to amount of fuel consumption, and quantity of rivets in furnace at closing time, which is the source of greatest loss by other heating methods.

Twenty (20) kilowatt hours will heat one hundred pounds of rivets, regardless of size.

Savings

Seventeen (17) to twenty (20) kilowatt hours will heat one hundred pounds of any size rivet. The maintenance charge is practically nil as compared with the heavy charge for relining and upkeep of all other types of furnaces. It is a simple matter to compute what your electric power cost will be as compared with your present fuel cost, plus maintenance charges. In the Berwick Electric Rivet Heater no current is used until a rivet is placed between the electrodes; hence, only current sufficient to heat each rivet is consumed. There is no wear except where rivet makes contact with electrodes, and no burning out of wiring unless constantly being used for heating rivets larger than the Heater is designed to heat.

The heater boy has two, three, four or five vertically placed rivets to watch, in plain view, with no intense heat or flame to contend with, so the loss of spoiled rivets is nil; there are no heated or matted rivets pulled out of the Heater at closing time; the rivet loss is thereby reduced from about 10% to less than 1/2 of 1%.

History

Since 1911, the Berwick plant of the American Car and Foundry Company has been constantly improving the Berwick Electric Rivet Heater; all the so-called experimental features have been eliminated, and a Heater has been perfected which gives a constant and steady supply of rivets properly heated, with no scaled or burned rivets, no smoke, gas or dirt; the heating cost is reduced 25% to 75%, and the rivet loss to less than 1/2 of 1%. This saving, when the Heaters are working at full ca-

Berwick Electric Rivet Heaters

pacity, daily, is sufficient to cover the entire cost of the Heater in a short time, besides improving vastly the working conditions in the erecting shops and vessel hulls.

Fifty-seven are now in daily use in the Berwick plant, with fifty-five more in course of construction, making a total of one hundred twelve.

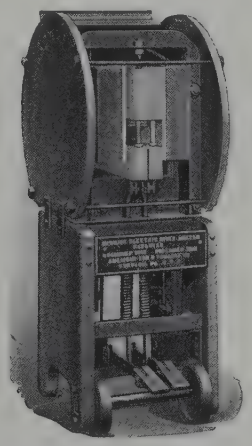
Design

The Berwick Electric Rivet Heaters are compact, simple to operate, and with ordinary care, in not overloading them, by trying to heat rivets larger than they are designed to heat, the maintenance cost is practically eliminated.

The standard sizes have two, three, four or five electrodes, or heating-units, controlled by individual foot-treadles, one movement of which separates the electrodes sufficiently to insert a rivet vertically; and when the switch is thrown on, the rivet instantly begins to heat, and within twenty seconds for the smaller size, and thirty seconds for the larger size, the rivets are ready for use. Each heat-unit works independently.

Six, seven or nine electrode Heaters are furnished when a larger volume of rivets are required.

Variable heat-control is provided so that the time of heating rivets can be varied, as conditions necessitate.



No. 3—Two-electrode Berwick Electric Rivet Heater with Telescope Hood for Outdoor Work.

No. 2—Two-electrode Berwick Electric Rivet Heater, for ½ to ⅝″ Diameter Rivets; Capacity 300 Rivets or More per Hour.

STANDARD SIZES

60-Cycle, 220 or 440-volt, single-phase, but any other standard frequencies and voltages furnished.

Type	No. of Electrodes	Hourly Capacity	Diameter of Rivet	*Maximum Length of Rivet	Kilowatt Consumption	
No. 1	2	400	1/4″ to 3/8″	2″	2 1/2	7 1/2
No. 1	4	600	1/4″ to 3/8″	2″	4	10
No. 2	2	350	3/8″ to 5/8″	3 1/2″	3 1/2	8 1/2
No. 2	4	500	3/8″ to 5/8″	3 1/2″	7 1/2	15
No. 3	1	80	5/8″ to 1″	4 1/2″	7 1/2	15
No. 3	2	160	5/8″ to 1″	4 1/2″	10	20
No. 3	3	260	5/8″ to 1″	4 1/2″	18	45
No. 3	5	350	5/8″ to 1″	4 1/2″	25	65
No. 4	1	30	1″ to 1 1/2″	10″	10	20
No. 4	3	90	1″ to 1 1/2″	10″	20	42
No. 4	5	150	1″ to 1 1/2″	10″	30	75

*When so ordered, can be built to take in longer rivets.

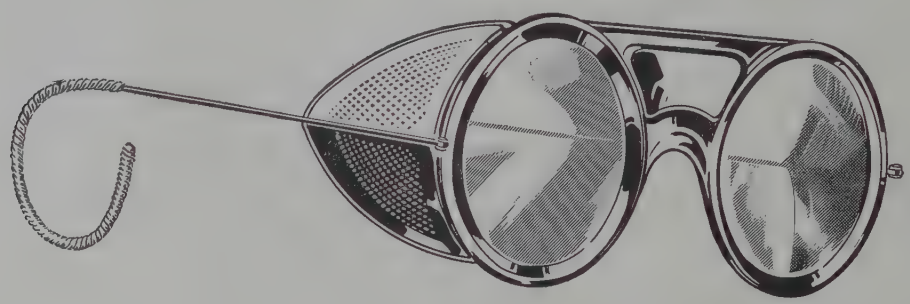
Safety Goggles

Protection

The protection afforded by the "Stoco" safety goggle is complete. It is impossible for any missile — no matter how large or small it may be or from what angle it may be traveling —to reach the eyes of a wearer of this protection glass. All safety goggles are designed to protect the eyes from direct frontal attack, most safety goggles provide more or less protection at the sides. The "Stoco" safety goggles by means of their exclusive design and construction, not only afford all the protection afforded by other goggles but also protect between the eyes. Chippers and riveters in particular will appreciate this feature.

Durability

The frame of the "Stoco" safety goggle is stamped from a single sheet of metal, consequently it has no soldered joints to come apart and no screws to work loose and be lost. The broad strip of metal above the bridge makes it impossible for the goggle to warp or bend out of shape and incidentally provides very valuable protection between the eyes. The side shields, being of perforated metal, allow the same amount of side vision and ventilation, but are much stronger than the common wire mesh shields. The "Stoco" safety goggle is made from heavily nickeled metal that will not rust or corrode from the action of perspiration and may be sterilized daily without damage. When pitted or otherwise damaged, lenses may be instantly changed by anyone without the aid of special tools. A stock clerk, if he has fiddled with tiny screw devices, microscopic screws and a frame slightly out of alignment, will appreciate the convenience of the "Stoco" rim-locked lenses.

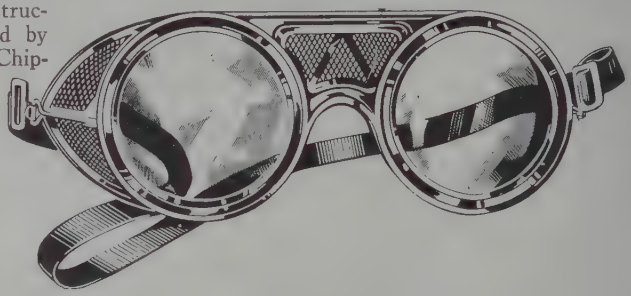


Comfort

In spite of its substantial construction, the "Stoco" safety goggle is light in weight and extremely comfortable. All surfaces that bear on the face are broad and smooth so that the weight is widely distributed and all danger of cutting the face eliminated. The earbows are broad and flexible and hold the goggle snugly in place with no suggestion of cutting or chafing back of the ears. If desired, the "Stoco" safety goggle may be had with elastic head band in place of the metal earbows. It may be worn in perfect comfort over regular glasses if desired.

Lenses

The "Stoco" safety goggle may be had with either one of two types of lenses as desired, "Celoglas" lenses or ordinary optical glass lenses. "Stoco" safety goggles with "Celoglas"



shatter-proof lenses are the best possible protection for every occupation that involves eye hazards. "Celoglas" lenses are the height of achievement in lenses for protection purposes. They are composed of a thin sheet of celluloid cemented between two pieces of glass by an exclusive process. Even though the glass may be fractured by a severe blow, the lens will not leave the frame nor will particles fly into the eyes of the wearer. The "Celoglas" lens has a high degree of visibility, insuring perfect sight, and on casual inspection has the appearance of a lens of ordinary optical glass.

Optical glass lenses, specially treated for strength and free from defects, are also supplied in "Stoco" safety goggles. These are satisfactory for ordinary requirements but the "Celoglas" lens is earnestly recommended for all extra hazardous occupations, such as chipping, etc. Optical glass lenses are supplied in light or heavy weight.

Sample

We will send a sample of the "Stoco" Safety Goggle without charge to any Safety Engineer, Superintendent or Purchasing Agent on receipt of request on letter head. State whether you desire sample supplied with easy cable earbows or black elastic headbands.

STANDARD OPTICAL CO., GENEVA, N. Y.

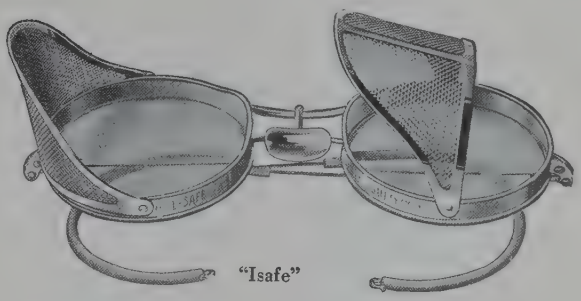
Goggles and Masks

"Saniglas"

"Saniglas" Rigid Bridge

Recommended for chipping, caulking or other extreme hazards.

The lenses are Saniglas "Armnplate" heat treated, and surface ground. They are tough, strong and free from waves and imperfections. Frames of non-rusting white metal with folding screens. Prescription lenses may be fitted, obviating the necessity for wearing two pairs.

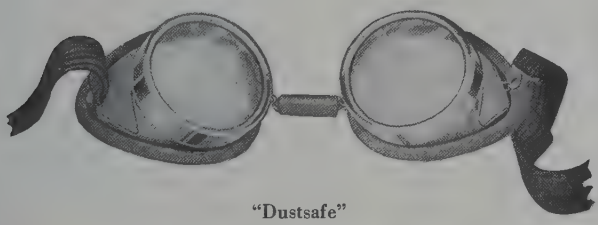


"Isafe"

"Isafe" Adjustable

"Saniglas" quality throughout, but fitted with adjustable broad bearing bridge so the goggle may be raised, lowered or angled as may be necessary to afford full protection.

Padded Bridge and screens may be had for operations where metal would be uncomfortable next to the skin. Either model may be had with elastic headbands instead of regular temples.



"Dustsafe"

"Dustsafe"

Heat insulated cups, shaped to fit the eye sockets.

Several models for grinders, chippers and welders. The screen side model shown is excellent for grinders and permits side vision. Model "C" has aluminum cups with adjustable ventilation. Model "N" holds lenses by screw joint rim and Model "W" has extended eyecups.

Face Shield

For protection against injurious light rays in arc welding; fitted with scientifically cured lenses. The shield is made of light tough fibre, a non-conductor of electricity, and is the most efficient shield yet offered. Lenses are firmly held but may easily be replaced, or new cover glass inserted.

Face Mask

Designed for tapping at Blast Furnace, or for Lapwelders, Ladlemen or Firemen. Made of light fireproof fibre pivoted at the sides permitting it to be turned back.

Lenses may be white or colored for the particular work required.

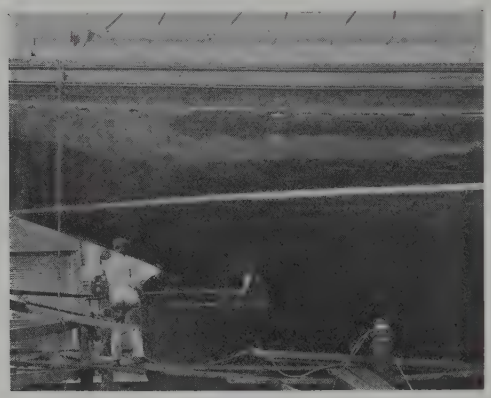
Model 700 is intended for light arc welding and protects the entire face and ears.

Pneumatic Painting Equipments

The Spraco System—Advantages

The modern method of applying various kinds of paints and other protective coatings is by the use of compressed air. This is rapidly superseding the old handbrushing method, not only by reason of the great saving in time and labor, but also due to the fact that better results are obtained.

One "handy" workman can do the work of three to twelve or more skilled painters using hand brushes, depending upon the nature of the work.



Painting Exterior of Ship, Using Form P-3 Equipment and Extension Pole

Uniformly finished coatings free from streaks and brush marks are produced.

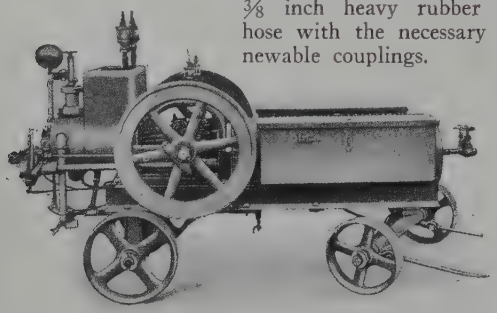
Rough, irregular surfaces and those inaccessible or difficult to reach with a brush are readily coated.

By means of interchangeable nose pieces, standard guns are capable of handling all classes of liquid coatings.

The gun may be quickly mounted on an Extension Pole Attachment for painting surfaces beyond the reach of the operator.

Portable Equipment

The complete Form "P-3" Portable Equipment illustrated is recommended for all general purposes. This consists of the Model 7 Paint Gun with adjustable spreader attachment, one pressure control head, one 3 or 5 gallon material container, one 12-foot length of 5/16 inch flexible, metal-lined material hose, and one 12-foot length of 3/8 inch heavy rubber air hose with the necessary renewable couplings.



Portable Engine Driven Air Compressor Unit

Air Compressors

For installations where a supply of compressed air suitable for operating the painting equipment is not available, we are prepared to furnish either gasoline engine or motor-driven air compressor units. Each unit is complete with automatic unloader and all necessary accessories, ready for operation.

These outfits are low in construction, and are rigidly secured to a steel truck. All power is transferred directly to the air cylinder, thus eliminating any losses, due to belts, chains, or gears. The entire outfit is automatic in operation, both air pressure and speed remaining constant at whatever point they may be set. The engines are 4-cycle, horizontal, water-cooled; the compressors, single-acting, water-cooled.

Form P-3 Equipment

Paint Gun

The Model 7 Gun may be used to produce either a broad fishtail spray in any plane, or a plain conical spray by rotating the spreader attachment

All necessary reducing valves, gauges, etc., for maintaining the proper pressures on both the air and material supplied to the gun are embodied in the control head.

Paint Gun Model 7

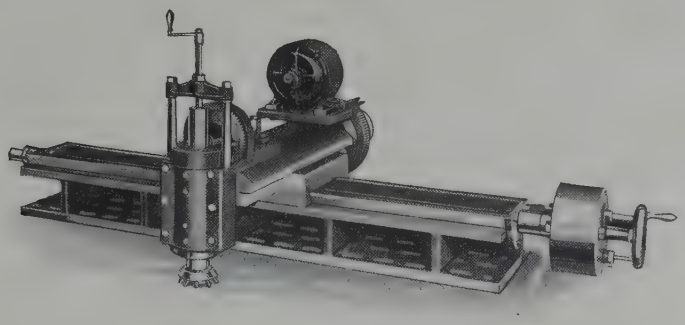
Extension Pole

By use of the Extension Pole Attachment, the amount of staging, scaffolding, or ladders otherwise required can be greatly reduced. The operator's reach is increased at least 8 feet or more, a decided advantage.

SPRAY ENGINEERING CO.

93 FEDERAL STREET, BOSTON, MASS.

Portable Milling Machines and Pipe Benders



Pedrick Portable Milling Machine

Need of Portable Milling Machine

Shipyards engaged in installing turbines and reduction gearing have experienced the trouble of surfacing the foundation plates for these parts within the close limits required for the work.

Purpose of Design

It was to overcome this trouble, to lessen the time and to perform a much more accurate job that the Pedrick No. 4 size Portable Milling Machine was developed.

Saving in Time

A saving is made in another direction, too, as the installation crew, instead of taking 7 to 10 days to level and connect the turbine to the gear case, is doing the work in about 2½ days. Altogether the machine is credited with returning its cost on every ship.

Pedrick Portable Milling Machine

The No. 4 machine has a 3½″ spindle, 12 ft. travel, 27″ cross traverse, 9″ vertical adjustment. Smaller machines for surfacing hatch combings or other parts are also built.

Pedrick Pipe Bender

Another machine which may be taken to the ship for doing useful work is the Pipe Bender here illustrated. It has capacity for bending up to 2″ pipe and accomplishes excellent results. It is a time saver in fitting pipe and is especially constructed for working between decks. Powerfully geared and substantially built.

Type A Pedrick Pipe Bender

Type A Pipe Bender

The Type A machine is furnished with quadrants for bending

1″ pipe to a radius of 6″
1¼″ pipe to a radius of 9″
1½″ pipe to a radius of 12″
2″ pipe to a radius of 14″

A Type B, having somewhat different fixtures than this one, is arranged for bending pipe to smaller radii.

PEDRICK TOOL & MACHINE CO.

3636 N. LAWRENCE ST., PHILA., PA.

Portable Boring Bars

Purposes

Rooksby Portable Boring Bars for shipyard service are heavy duty tools of standardized types and sizes expressly adapted to boring and facing stern tube bearings, boring, grooving and facing turbine engine casings, boring rudder post gudgeons and boring or reboring vertical cylinders.

Special Features

Many years of specializing in the manufacture and operation of boring bars have enabled E. J. Rooksby & Co. to produce the most advanced tools of their class, incorporating a complete combination of exclusive features and improvements of great importance to safe and efficient operation.

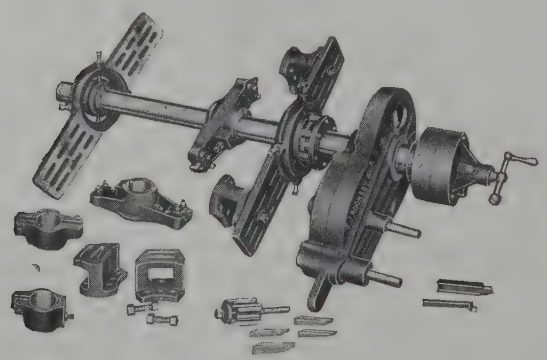
Chief among these features are two-speed quick-change gear drive, safety gear guards enclosing all gears, double-arm cutter-heads and tool holders for high-speed cutters. They are standard parts of the equipment of Rooksby Portable Boring Bars and are supplemented by other special devices applying to the particular purposes of each type of bar, securing to each a maximum of accuracy and time saving.

Construction

The bar is made of the best grade of open-hearth steel and is accurately finished. The steel feed-screw is inserted in the side of the bar and is provided with bronze thrust bearings.

The completely encased driving gear and automatic feed, an exclusive feature of Rooksby Portable Boring Bars, furnish full protection to the operators as well as to the machines; and, the guards being cast integrally with the frame, add materially to the strength of construction.

Another distinctive Rooksby feature consists of the double-arm cutter-heads. Long experience has confirmed the correctness of the principle of placing the two tools on directly opposite sides of the Bar. Thus the best results are obtained with the Rooksby double-arm cutter-head when it is necessary to use more than one cutter at a time. The screw adjustment for setting out the tools has the endorsement of the best shop practice.

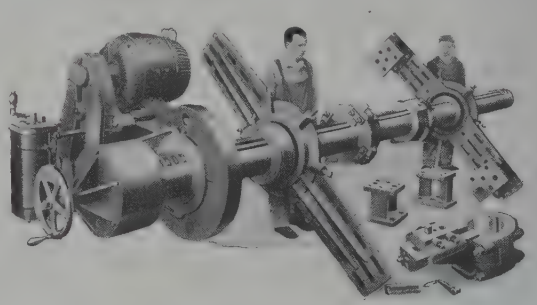


Bars for General Use

The tool holder is a special device obtaining an important advantage for Rooksby Portable Boring Bars in that it is designed for high-speed steel or Stellite cutters and thereby eliminates the necessity of using expensive, forged tools. A sample tool holder with high-speed cutters is included in the equipment of each bar.

An improved type of automatic feed consists of entirely enclosed sliding gears with feed changes controlled by a slip pin and includes a reverse gear when required. These gears operate the feed-screw recessed in the side of the bar and furnish a continuous and automatic feed to the cutter-heads.

A unique and highly important feature of Rooksby Portable Boring Bars of the best and pulley type is the two-speed, quick-change gear drive. The bars thus equipped are capable of operating at a wide range of speeds, permitting the same bar to be used for boring diameters that require a different range of speed than obtainable from the drive on the primary shaft. In this arrangement two shafts are provided for the driving gears—one for the primary pinion which drives the back gear, the other for the intermediate pinion which drives the direct gear. The quick change is accomplished by means of a slip pin.



Boring Stern Tube Bearing

These bars for general use are made in sizes from 2″ to 10″ diameter and up to 20′ 0″ long.

For Boring Stern Tube Bearings

The Rooksby Portable Boring Bar for boring and facing stern tube bearings and bulkhead doubles is equipped with a direct-connected motor which furnishes the drive through a train of enclosed spur gears, or is arranged for belt drive. Two or three changes of feed according to size of bar and reverse are provided.

Two crossheads of different lengths, together with their blocks, constitute the setting up fixtures. Stay pieces with bearings for the outboard crossheads can readily be made at shipyards to suit the requirements and are usually bolted through rivet holes in hull plates or frame, left open for the purpose. Two sleeve bearings are furnished—one with thrust collar—centered with the set screws in the crossheads.

The equipment includes facing arms for facing stern tube frame boss and bulkhead doubles.

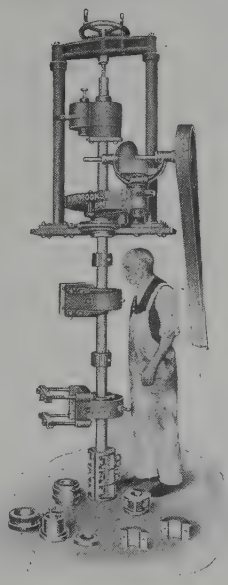
These bars are made in any diameter and length usually from 6″ to 10″ diameter and from 12′-0″ to 30′-0″ long.

E. J. ROOKSBY & CO.

ELEVENTH & NOBLE STS., PHILADELPHIA, PA.

Portable Boring Bars

For Boring Rudder Post Gudgeons



Boring Rudder Post Gudgeons

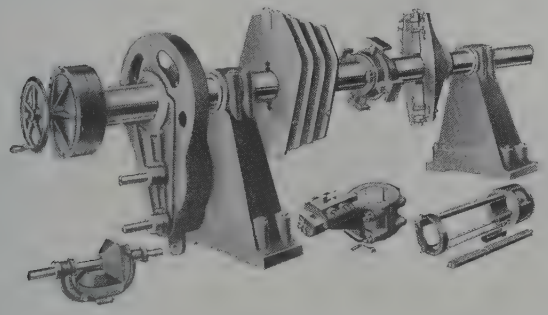
The Rooksby Portable Boring Bar for boring rudder post gudgeons is a highly developed special tool designed for convenience in setting up and operating as well as for accuracy of alignment. It is built in sections joined by standard couplings keyed to the bar.

The bar has two full length splines on diametrically opposite sides — one for keying the cutter-heads and the other for the cutting tools which project into it, and are set out by taper wedges to bore the required diameter. If necessary to bore holes of too small diameter to admit the cutter-heads, the bar will be slotted for double end cutters.

The Rooksby standard enclosed gear drive is fitted with bevel-gear universal drive, for pulley and belt.

A three-change feed controlled by a slip pin, also is of the Rooksby standard enclosed type. Automatic feed is transmitted by the gears through a bronze nut, which they carry and which engages a square thread feed-screw in the top of the bar. Locking the hand wheel, located at the top of the machine, holds the feed-screw stationary and the nut revolving, causes the bar to feed downward. Raising the bar to its initial position is accomplished by turning the feed-screw by the hand wheel.

The thrust of the cut is taken by a strongback supported by two columns which are attached to a crosshead which in turn is bolted to the transom plate or deck.



Boring and Grooving Turbine Engine Casings

Three types of bearing brackets are furnished for setting up the bar—one for clamping with bolts around the rudder post when clear of plates, another for clamping with set screws to the rudder post when the plates are in place and bolting is precluded, and the third is a crosshead type for bolting to the transom plate or deck. The required number of either of the above types of brackets is furnished.

The bearings in the brackets are of "anti-dust" type, designed to prevent dirt and chips from working in between the bearing surfaces and cutting fast, a necessary provision in a vertical boring bar where the bearings are beneath the cutters.

These bars are made 3″ or 4″ diameter in sections of any length.

For Boring Turbine Engine Casings

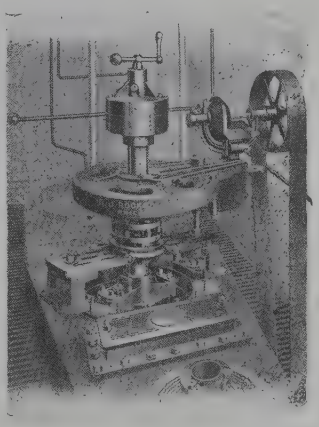
The Rooksby Portable Boring Bar for boring, grooving and facing turbine engine casings is equipped with the two-speed quick-change gear drive. Any form of power may be utilized and a bevel gear universal drive attachment, to enable the power to be applied from any direction, will be furnished if desired. Two or three changes of feed and reverse are supplied.

The cutter-heads and fixtures of the Rooksby Boring Bars are designed to produce the extremely accurate boring, grooving and facing demanded in turbine construction, with a maximum of time saving in preparation and operation.

These bars are made in sizes from 5½″ to 8″ diameter and from 12′-0″ to 20′-0″ long.

For Reboring Vertical Cylinders

The Rooksby Portable Boring Bar for reboring marine engine cylinders and valve seats is an efficient tool for a wide range of service. Included are the two-speed quick-change gear drive with bevel-gear attachment for vertical cylinders, double-arm cutter-heads with long and short tool holders.



Reboring Vertical Cylinders and Valve Seats

Rooksby cutter-heads are designed to use extra heavy tool holders. A tool holder, of special design for cylinders of the vertical type with a convex bottom cylinder head, is furnished.

In reboring vertical cylinders in position on board ship, the stuffing box end of the bar is centered and carried on a steel pin which fits into a bushed hole in the bottom end of the bar.

In large cylinders the steel chuck pin is centered in the stuffing box by a pair of chucking sleeves, which form a rigid bearing for the bar, insuring the reboring being in the original alignment. In smaller cylinders the expanding chuck as illustrated on the bar for general use is furnished.

These bars are made in sizes from 2″ to 10″ diameter and up to 16′-0″ long.

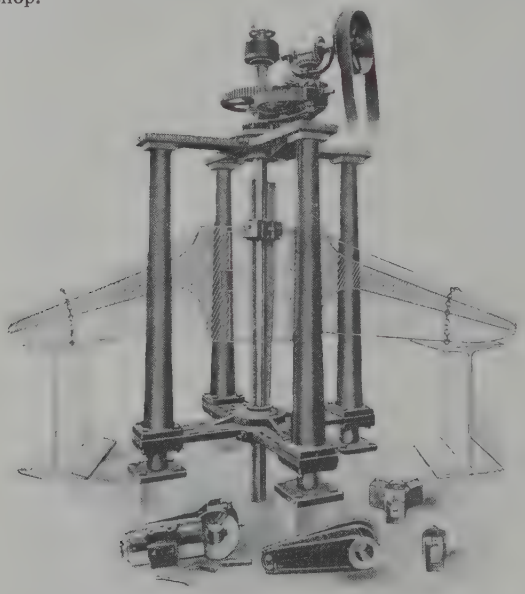
E. J. ROOKSBY & CO.

ELEVENTH & NOBLE STS., PHILADELPHIA, PA.

Taper and Stern Frame Gudgeon Boring Equipment

Taper Boring Equipment for Boring Propellers

The equipment illustrated below—for boring taper holes in propellers—is the latest addition to our line of Portable Tools. Its rigid construction makes it particularly adapted for heavy shipyard work. By removing the taper keys, and using our standard cutterheads, it becomes a regular straight boring outfit. It is a great time saver, and if located conveniently to the shipways, will eliminate the transportation of heavy castings, to the machine shop.



Taper Boring Equipment for 4 Bladed Propeller. Equipment for 3 Bladed Propeller Also Furnished

The Boring Bar is equipped with our Standard Feed Case, Spur Geared Power, Universal Driving Attachment, Patent sleeve in top crosshead, Plain sleeve, and anti-dust collar in bottom crosshead.

The Cutterheads are furnished with 1, 2, or 3 arms and tools, and contain Bronze Tool Holders, which are grooved and tapered to suit the steel taper keys on the Bar. These taper keys actuate the cutting tools as the Cutterhead is fed on the Bar, and can be furnished to bore up to and including ¾ inch taper per foot.

The Boring Bar supports, consist of: 4 Heavy Cast Iron Columns, with both ends flanged, 2-four arm cross heads and 4 cross-head blocks, all of which are usually mounted on a T-slotted Bed Plate, which is furnished by Customer.

The Facing Arm shown in the foreground of the above illustration is used for facing off the top and bottom of the propeller. It is so designed, that it travels up and down, over the taper keys, which pass through cored slots in the arm. The Split Cap is very convenient, as the Facing Arm can be removed without disturbing the Bar or the Propeller.

The Single Arm Cutterhead, also shown in the foreground, is used for tramming purposes, and is placed on the Bar and used before setting the Driving Power and Feed case in position.

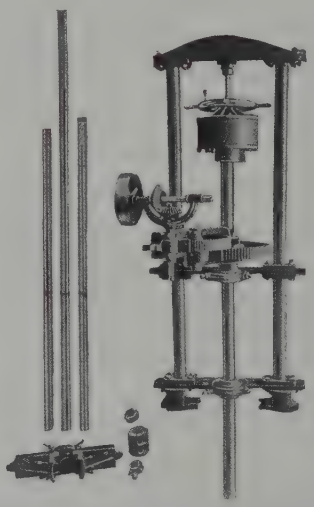
We are prepared to build any size of bars, to suit requirements for the purchasers, prices and full particulars of which will be given on application.

When making inquiries, please state bore, length of propeller hub, and taper per foot required, or better, send us prints of your propeller work.

Portable Boring Bar

The Portable Boring Bar shown below is designed for Boring the Gudgeons on Stern Frames and is more commonly termed our Travelling Bar. This equipment has been very popular during the past few years and has proven to be a great saver of time and labor. We have furnished the most prominent shipyards in the Country, with one or more of these bars, and find that these equipments are giving universal satisfaction.

The Bar, 4" x 8', which is of forged steel, accurately made, is supported by two Heavy Pipe Supports and



Portable Bar for Gudgeons on Stern Frames

Crossbar placed on deck, and is centered by sleeve in crosshead. The Bar is made in suitable sections joined with split couplings.

The Cutterheads are keyed fast to the Bar and are fitted with adjustable screws, so that cutting tool can be set out to the bore of the gudgeon.

The Feed Case is of the closed type and has two changes of feed, which can be changed from one to the other by a slip pin, as shown. The thrust is well taken care of, by three sets of Ball Thrust Bearings in Feed Case.

The Driving Power has a train of powerful cut gears, and is equipped with Belt Pulley. We also furnish a Universal Driving attachment, as shown, to allow power to be applied from any direction.

We are prepared to build any size of Bar—to suit the requirements of the purchaser, prices of which will be given on application.

Norton Ball-Bearing Self-Lowering Jacks

Advantages of Norton Jacks

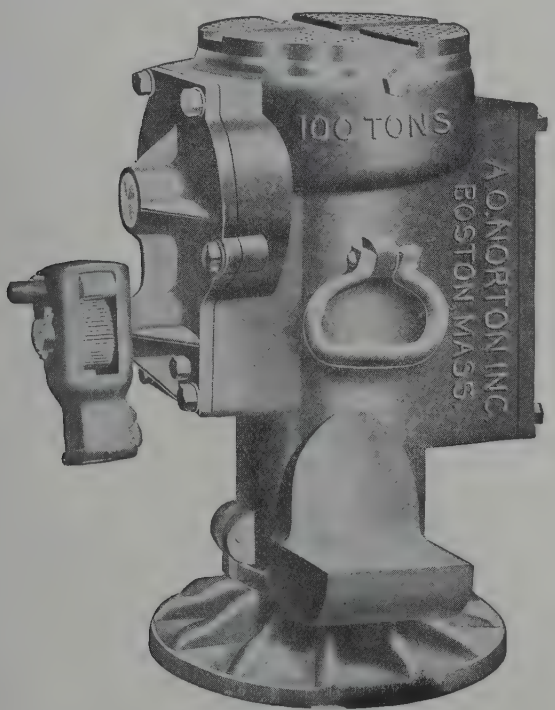
Norton Ball-Bearing Self-Lowering Jacks do not have to be pumped to lower the load. The Self-Lowering feature is so arranged that when the lowering cam is pressed with the thumb and forefinger, the jack automatically lowers its full rated capacity easily and steadily.

Automatic Speed Control makes this the last word in Jack construction.

Norton Self-Lowering High-Speed Jacks are the result of thirty years experience specialized in one line—making jacks. These jacks are positively the fastest jacks on the market of equal capacity. They are entirely different from other ball-bearing jacks.

They are absolutely safe—cannot slip or drop the load—are positive and reliable, and guaranteed in every respect.

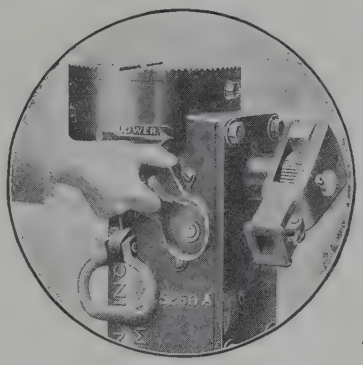
They are faster than the various makes of geared lever jacks, and, unlike other fast-working jacks, Norton Self-Lowering High-Speed Jacks, are absolutely safe. There are no intricate, exposed, or fast wearing parts as in geared lever jacks, and they raise the load faster and much easier.

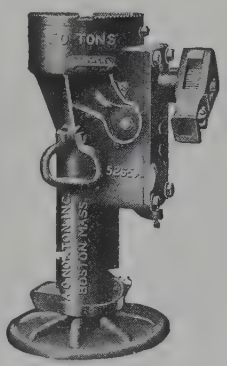


Self-Lowering High-Speed Jacks—Sizes 25-100 Tons

The Norton Ball Bearing Jack is superior to the Hydraulic Jack, and will do any and all work that can be done with the Hydraulic Jack.

The Norton Self-Lowering High-Speed Jack is the original self-lowering high-speed jack, and contains a number of patented features not found in any other jack. To protect the purchaser and user of genuine Norton Self-Lowering High-Speed Jacks, the name Norton is cast on every genuine Norton Jack.





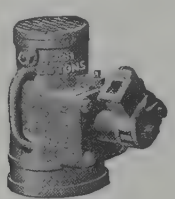
50-Ton Norton Jack
Showing Self-Lowering Cam

Uses in Shipyards

A few of the many uses of Norton Self-Lowering High-Speed Jacks on the Ways as well as in the Shipyard Shops are covered in the following paragraphs.

To jack up heavy loads so that lifting slings of cranes can be arranged.

To assist in installing, adjusting, and repairing heavy machinery.



15, 25 and 35 Ton Norton Jacks
Used Where a Small Powerful Jack Is Needed

To line up heavy casting for machining.

To assist in installing Marine Boilers.

To assist in lining up and setting in place heavy castings such as stems, stern frames and strut.

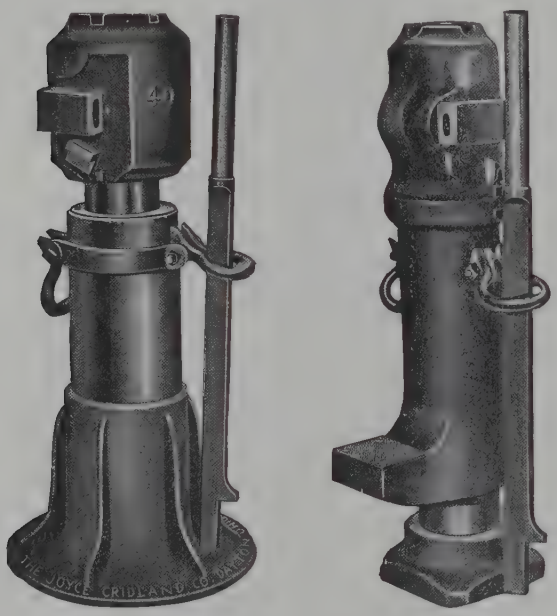
To spring beams or girders when installing stanchions.

To assist in launching.

A. O. NORTON, INC., BOSTON, MASS.

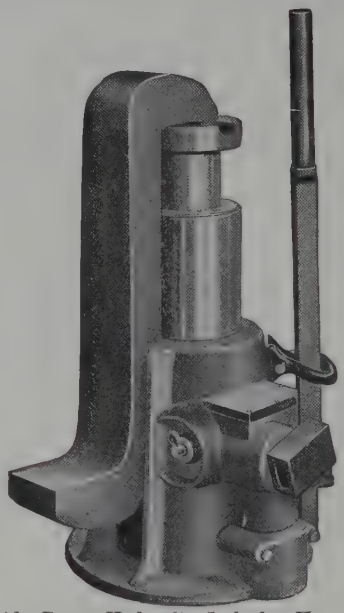
Inside Pump Hydraulic Jack

The Joyce Inside Pump type of Hydraulic Jack is made in all rises from 6 to 18 inches and in all capacities from 4 to 60 tons. This jack is furnished either with broad circular base, small square base or with ground lift, as illustrated below, to meet various service requirements, and will work in a vertical, horizontal or inclined position. It is exceedingly light and compact for its power, is absolutely reliable, and the best material and workmanship are employed in its manufacture. Every provision is made in its design to prevent leakage and undue wear, to provide easy access to the interior, and to place the parts so as to be secure from injury.



Inside Pump Hydraulic Jack

Broad Base Type **Ground Lift Type**

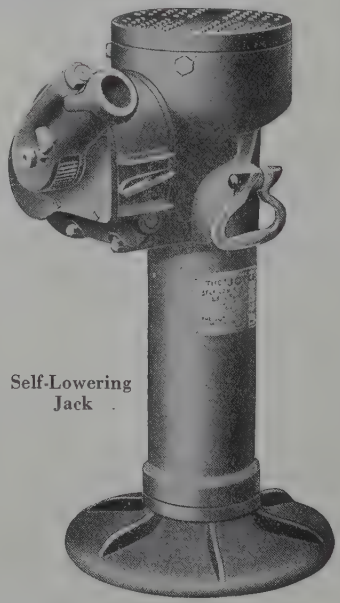


Outside Pump Hydraulic Jack for Heavy Duty

Self-Lowering Geared Screw Jack

The Joyce Self-lowering High-Speed Ball-Bearing Jack shown below is a mechanically operated jack designed to permit rapid raising and assure fully controlled lowering. It is made with large circular base or small square base with ground lift to meet various service requirements and is built in all standard heights from 20 to 36″ and in all capacities from 35 to 75 tons.

The special form of thread, materials used, and general design and construction, result in an efficient, strong, safe and speedy mechanism. The complete Roller Bearing High Speed Geared Screw line is also made without the self-lowering feature.



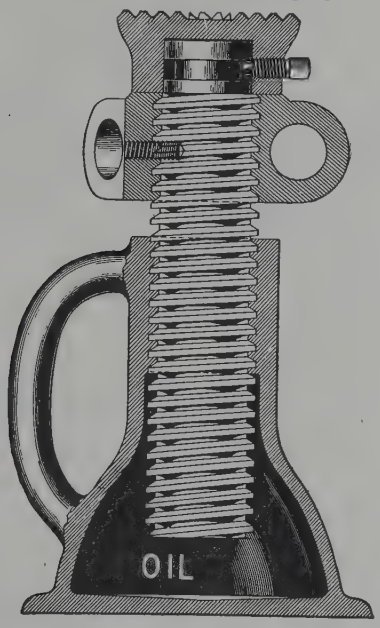
Self-Lowering Jack

Outside Pump Hydraulic Jack

The Joyce Outside Pump type of Hydraulic Jack is particularly suitable for use where a short jack is desired for a given lift, as the pump in this type is placed on one side of the jack, the ram being entirely free from internal working parts. The outside pump jacks are made in all rises from 6 to 18 inches and are of two types:—for light duty in capacities of 4 to 20 tons, and for heavy duty, as illustrated in the following column, in capacities of 30 to 200 tons. Either type can be furnished with ground lift, and will work in either a vertical or horizontal position. The light duty jacks are made with a single pump, permitting one speed of operation, while the heavy duty jacks are made with two pumps of different diameters, giving three operating speeds and an emergency trip.

Screw Jack

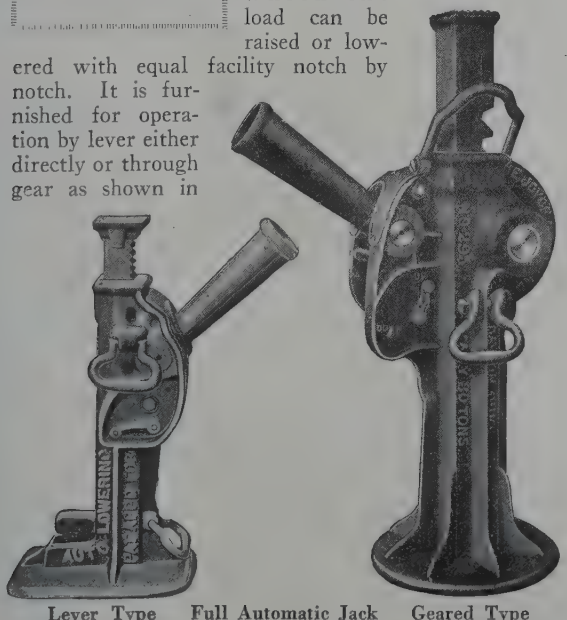
The Joyce Screw Jack is made either with six-way head for lever, or with ratchet head, in all rises from 3 to 23 inches, and in all capacities from 6 to 50 tons. This jack with bracket-shaped thread designed with proper reference to the shearing stresses, and broad bell base serving also as oil reservoir, as illustrated above, is superior in design and construction to other screw jacks.



Screw Jack

Automatic Lever Jack

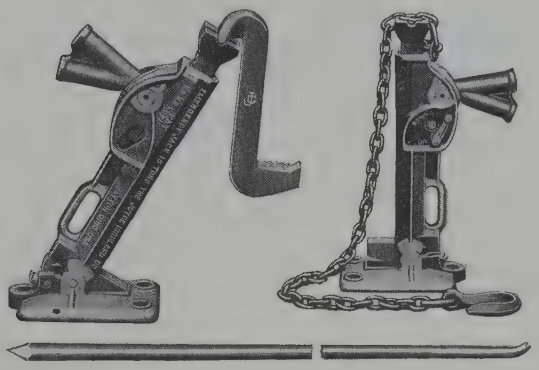
The Joyce Full Automatic Jack is a strong and reliable jack of few working parts, in which the load can be raised or lowered with equal facility notch by notch. It is furnished for operation by lever either directly or through gear as shown in the illustration. The lever jacks are made for all rises between 4 and 25 inches and all capacities between 5 and 15 tons, while the geared jacks are made for rises between 10 and 26 inches and for capacities from 25 to 50 tons.



Lever Type Full Automatic Jack Geared Type

Emergency Jack

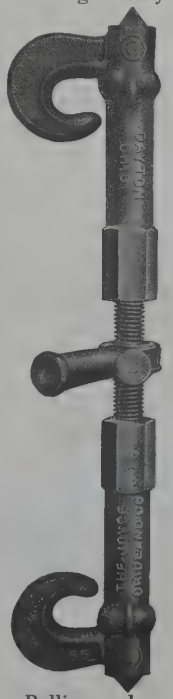
The Joyce Emergency Jack illustrated below is of the full automatic type, equipped with special pivoting base to permit lifting, lowering, pushing or pulling at any angle to within 20 degrees of the horizontal, with five feet of chain and grab hook, five foot steel lever of pinch bar construction, and detachable ground lift for use where chain cannot be employed. This jack weighs only 127 pounds complete with all equipment, is 2 feet high, has a rise of 12½ inches, and a capacity of 15 tons.



Emergency Jack

Pulling and Pushing Jack

The Joyce Pulling and Pushing Jack is arranged with pinned hooks which can be dropped back so as to present the heads for use of the jack in pushing. These jacks are rugged and strongly built and are provided with ratchet for permitting the most convenient form of operation, as it is simply necessary for the operator to pull on the lever to turn the screw, and push back on it to cause the pawl to enter another tooth on the ratchet wheel. This jack has a 19 inch run of screw, and a capacity of 10 tons. The length inside hooks when closed and set for pulling is 39½ inches and the weight is 68 pounds.



Pulling and Pushing Jack

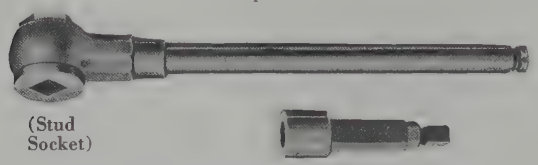
Ratchet Stud Drivers, Drills and Wrenches

Keystone Ratchet Stud Driver

The Keystone Reversible Ratchet Stud Driver is the only tool of its nature on the market, and is used by the largest builders of machinery in the country.

The reversible ratchet feature makes it of special value in close quarters on board ship, for setting and removing studs on stern tube stuffing boxes, sea connections, manholes, and propelling and auxiliary machinery.

The Keystone Ratchet Stud Driver is a valuable time-saver over old methods. Studs can be driven quickly and released instantly. Furthermore, the threads are never damaged by this method and are all driven to uniform depth.



Keystone Ratchet Stud Driver

The Keystone Ratchet Stud Drivers are furnished with one nut for any size stud and with handles ranging in length from 10 inches to 28 inches. Extra parts are furnished on order.

When ordering specify size of Studs to be driven. For size of Stud Driver suitable for the various sizes of studs see table below.

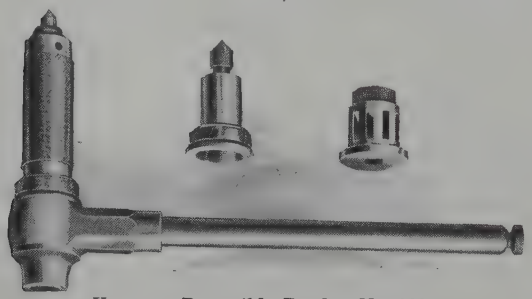
KEYSTONE RATCHET STUD DRIVER

Style No.	Length of Handle	Size of Stud
161	10 inch	¼ inch to ⅝ inch inclusive
162	14 inch	⅜ " " ⅞ " "
163	16 inch	½ " " 1⅛ " "
164	18 inch	¾ " " 1¼ " "
165	22 inch	⅞ " " 1⅜ " "
166	24 inch	1 " " 1½ " "
167	28 inch	1¼ " " 1½ " "

Keystone Reversible Ratchet No. 300

The Keystone Reversible Ratchet No. 300 has interchangeable parts making four complete ratchets in one. These interchangeable parts make possible both long and short feed for any style of Morse Taper or Square Taper Shank Drills.

This type of combination ratchet is of practical value in the construction of vessels, due to the fact that it will accommodate any type of drill for use in tight places.



Keystone Reversible Ratchet No. 300

The Keystone Reversible Ratchets No. 300 are furnished complete with four interchangeable parts in four standard sizes. Separate parts are furnished on order. For the length of handle and size of shank to which each size is adapted see following table.

KEYSTONE REVERSIBLE RATCHET NO 300

Style No.	Length of Handle	Shanks which Sockets will accommodate
50M	8½ inch	No. 1 Morse or Bit Stock Drills
51M	10 inch	No. 2 Morse or No. 1 Sq. Shank
52M	14 inch	No. 3 Morse or No. 1 Sq. Shank
53M	16 inch	No. 3 Morse or No. 1 Sq. Shank

Keystone Reversible Combination Ratchet No. 400

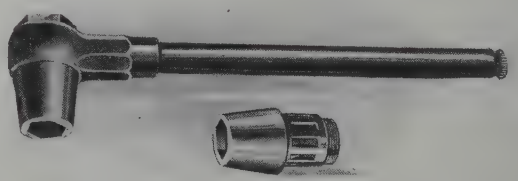
The Keystone Reversible Combination Ratchet No. 400 is made to conform with the latest specifications of the United States Navy. It is arranged to accommodate three types of collets or sleeves, square collet, taper collet or reducing collet. By means of these three types of collets the Keystone Reversible Combination Ratchet No. 400 will accommodate Bit Stock Drills, Morse Taper Drills, and Square Shank Drills, up to 1¼ inches.

Keystone Reversible Combination Ratchet No. 400

Keystone Ratchet Reversible Socket Wrench

The Keystone Ratchet Reversible Socket Wrenches are made for both Square and Hexagon United States Standard nuts.

The body of these wrenches is made of drop-forged steel; the handle is made of cold-drawn tubing, thereby insuring the greatest possible strength. These wrenches are made with handles from 10 inches to 28 inches long. To accommodate nuts for various bolt sizes as listed in table below.



Keystone Ratchet Socket Wrench

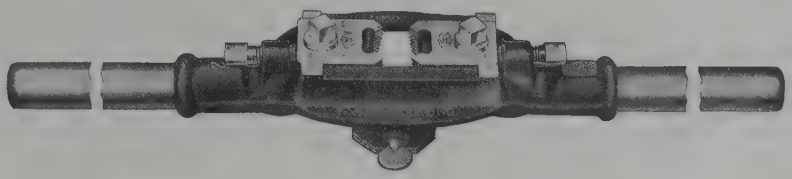
When ordering, specify size of Bolt which Socket shall accommodate. Special Sockets made on special order, but it is advisable when ordering special Sockets to send sample of nut to insure accuracy.

One Socket is furnished with each wrench, but extra Sockets will be furnished on order.

KEYSTONE RATCHET SOCKET WRENCH

Size of Wrench in Inches	U.S. Standard Bolt Sizes, the Nuts of which the Sockets will accommodate							
10	¼	⅝	⅜	7/16	½	⅝	⅝	—
14	⅜	⅝	½	½	⅝	¾	⅞	—
16	⅜	⅝	½	½	⅞	1	1⅛	—
18 to 28	½	¾	⅞	1	1⅛	1¼	1⅜	1½

Armstrong Pipe Cutting and Threading Tools



Armstrong Pipe Stocks and Dies

The durability and ease of handling of Armstrong Stocks and Dies adapts them particularly for use in the shipyard and aboard ship. They cut clean threads rapidly and stand up under hard usage. The standard sizes, which can be supplied promptly, are given in the table opposite.

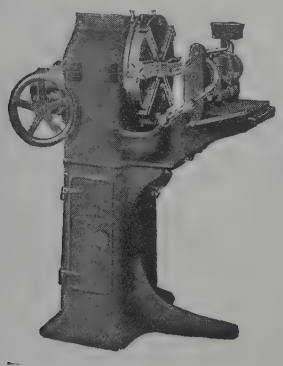
SIZES OF ARMSTRONG STOCKS AND DIES

Number of Stock	Sizes of Pipe Dies Taken	Sizes of Bolt Dies Taken
1	⅛″ to ½″	¼″ to ¾″
2	⅛″ to 1″	¼″ to 1½″
2½	¼″ to 1¼″	
3	½″ to 2″	½″ to 1½″
6	2½″ to 3″	
7	2½″ to 4″	

All dies can be furnished in either right or left threads and either American or English threads.

Armstrong Pipe Machines

Many years of experience in the manufacture of pipe cutting and threading equipment have developed Armstrong Pipe Machines to the highest degree of durability and efficiency. The many sizes in which they are made offer a machine exactly suited for practically any requirement of ship or shipyard use.

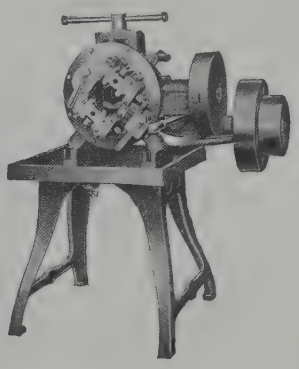


Armstrong No. 1½ Pipe Machine

SIZES OF ARMSTRONG PIPE CUTTING AND THREADING MACHINES

No. 0	Machine handles pipe	¼″	to	2″
No. 00	" " "	1″	to	4″
No. 1	" " "	½″	to	3″
No. 1½	" " "	1″	to	4″
No. 3	" " "	1″	to	6″

These machines either hand or power. All dies can be furnished either right or left hand.



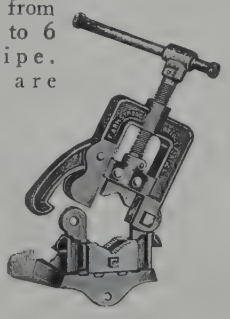
Armstrong No. 00 Pipe Machine

Armstrong Pipe Cutters

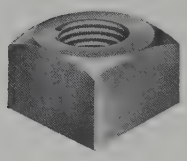
Armstrong Pipe Cutters are made in three sizes cutting from ⅛ inch to 4 inch pipe. The danger of springing has been eliminated by the use of the steel tie that binds the frame together. The blocks of malleable iron allow an extra long bearing. For cutting pipe by hand, these tools are invaluable.

Armstrong Hinged Pipe Vises

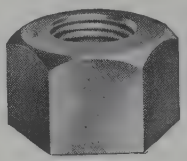
Armstrong Hinged Pipe Vises are made in five sizes, taking from ⅛ inch to 6 inch pipe. They are manufactured of malleable iron, with hardened steel jaws, insuring long life. Where pipe is to be cut or threaded by hand, the quickness with which it can be clamped in an Armstrong Hinged Vise saves time on every job.



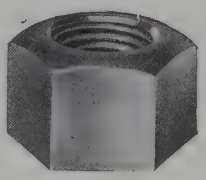
ARMSTRONG MANUFACTURING CO., BRIDGEPORT, CONN.



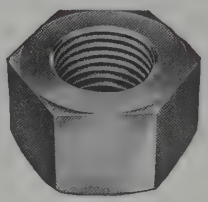
Square, Chambered



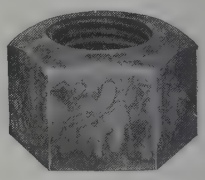
Hexagon, Chamfered



Hexagon, Cold Punched



Hexagon, Semi-finished



Hexagon, Case-Hard

Milton Cold Punched Nuts

Cold Punched Nuts

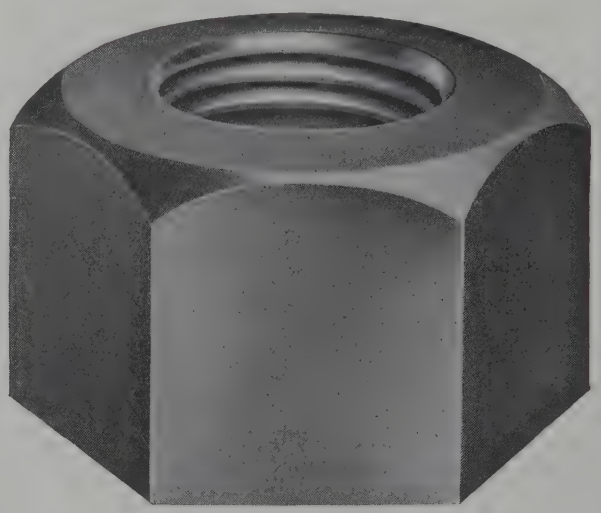
Milton Cold Punched Nuts are made in all regular styles and sizes, also to special sizes according to specification or blue print.

The Milton product is made from all selected raw materials, by men of long practical experience and by the best process that human ingenuity has so far been able to devise, that the highest efficiency possible may be obtained in the use of cold punched nuts. Milton product enjoys a very high reputation for quality finish, accuracy and efficiency and is specified exclusively by many critical buyers.

Of late years there has been a demand for steel nuts. The excellent facilities of the Milton Manufacturing Co. for turning out nuts of this character, enables them to offer to the trade both iron and steel nuts in sizes ¼" to 2¼".

UNITED STATES STANDARD SIZES OF COLD PUNCHED NUTS

Width	Thickness	Dia. Hole	Size Bolt	Width	Thickness	Dia. Hole	Size Bolt
3/8	5/16	7/32 set	5/16	2 9/16	1 5/8	1 11/16	1 5/8
7/16	1/4	11/32	1/4	2 3/4	1 3/4	1 13/16	1 3/4
1/2	5/16	1/4	5/16	2 15/16	1 7/8	1 15/16	1 7/8
9/16	3/8	5/16	3/8	3 1/16	2	2 1/16	2
5/8	7/16	3/8	7/16	3 5/16	2 1/8	2 3/16	2 1/8
11/16	1/2	13/32	1/2	3 1/2	2 1/4	2 5/16	2 1/4
3/4	9/16	7/16	9/16	3 11/16	2 3/8	2 7/16	2 3/8
13/16	5/8	33/64	5/8	3 7/8	2 1/2	2 9/16	2 1/2
1 1/16	3/4	41/64	3/4	4 1/16	2 5/8	2 11/16	2 5/8
1 1/4	3/4	49/64	3/4	4 1/4	2 3/4	2 13/16	2 3/4
1 7/16	7/8	57/64	7/8	4 5/8	3	2 15/16	3
1 5/8	1	1 1/64	1	5	3 1/4	3 5/16	3 1/4
1 13/16	1 1/8	1 9/64	1 1/8	5 3/8	3 1/2	3 5/32	3 1/2
2	1 1/4	1 5/16	1 1/4	5 3/4	3 3/4	3 3/32	3 3/4
2 3/16	1 3/8	1 13/64	1 3/4	6 1/8	4	3 3/16	4
2 3/8	1 1/2	1 5/32	1 1/2				



Large Nuts

The Milton Large Nut, as illustrated above, is the only large nut of its kind and finish.

Believing there was a demand for the large nut that would more satisfactorily meet the requirements of engine builders, etc., the Milton Manufacturing Co. after considerable effort developed a product now recognized as being superior in both finish and efficiency to any nut heretofore placed on the market.

These nuts are made in any size from 2½" diameter bolt up to 8" diameter bolt and larger.

Other Products

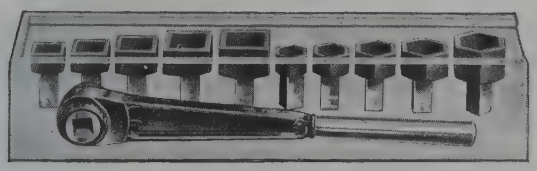
The Milton Manufacturing Co. also make a large number of other products of equal efficiency and finish to their cold punched and large nuts.

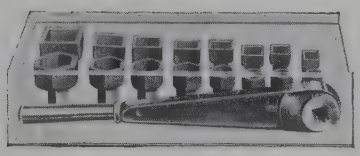
Special nuts of all kinds, such as jam nuts, slotted nuts, castle nuts, collars or round nuts, check nuts, cupped nuts, etc., are made in all standard and special sizes.

Bolts of all kinds such as standard and special machine bolts can also be furnished.

Washers of all types, such as riveting, square, cast or wrought iron or steel, are also made.

Lowell Reversible Ratchet Wrenches





"Multiplex" Socket Reversible Ratchet Wrench Sets

Time Saving and Money Making Tools

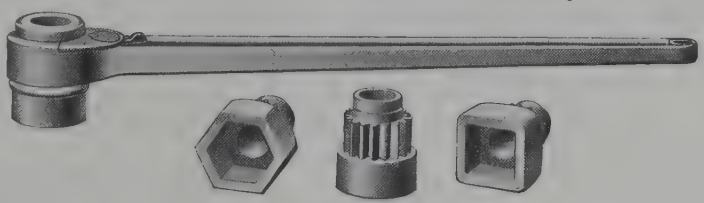
Lowell Reversible Socket Wrenches, as demonstrated in actual service, are time saving and money making tools.

They are indispensible on board ship for working in close quarters where the reversible feature of these wrenches not only saves time but ensures the proper tightening of bolts in places inaccessible to the ordinary wrench.

Every Tool Guaranteed to Give Satisfaction

Since Lowell wrenches have been designed to meet every need of a reversible wrench, every Lowell wrench is guaranteed to give complete satisfaction for the work for which it is adapted.

Write us regarding your requirements and we will send you our catalog with recommendations for the tool best suited for your needs.



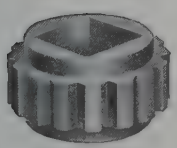
Steel Socket Bridge Wrench

Single Socket Wrenches

Lowell Reversible Ratchet Wrenches are made in a large variety of patterns and sizes to suit all service requirements. The 1916 Pattern shown below is particularly serviceable for general use and can be furnished in 7 sizes with either square openings from ⅝ to 1¾ inches, or with hexagonal openings from ¼ to 1½ inches.

This wrench can be changed to a right or left hand motion at will by rotating the knurled nut at the end of the handle. The reversing operation is remarkably quick as only one-half of a complete turn of the knurl at the end of the handle will reverse the action from right to left hand.

1916 Pattern Reversible Ratchet Wrench



Square Gear

Set of Sockets

Multiplex Socket Wrenches

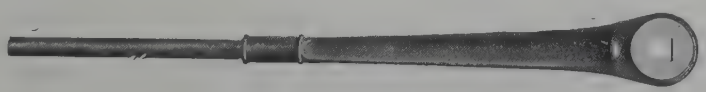
Lowell Multiplex Socket Reversible Wrenches are furnished for both square or hexagonal openings up to 2 inch. These wrenches are furnished with complete sets of sockets as shown in the illustrations and are of the same high grade construction as the single ratchet wrench.

Bridgebuilders Reversible Ratchet Wrench

Lag Screw Wrench

Special Wrenches

Special Reversible Ratchet Wrenches can be furnished to any requirements. Some of the many types that have been made for special purposes include wrenches with bent handles to go around corners in confined places, wrenches with special long sockets, bob-tail wrenches and wrenches with special short handles, etc.

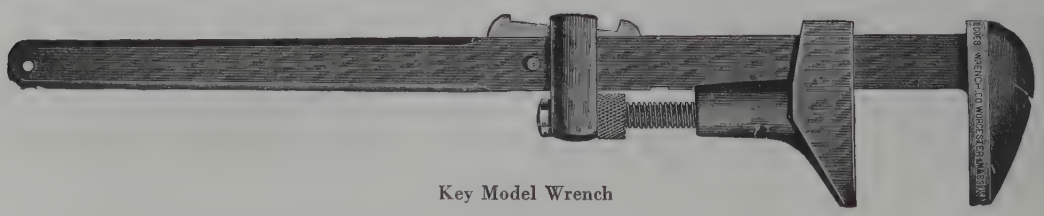


No. 12345 Reversible Ratchet Wrench

LOWELL WRENCH COMPANY

54 COMMERCIAL ST., WORCESTER, MASS.

Coes Wrenches



Key Model Wrench

Key Model Wrench

The Coes Key Model Wrench, shown in cut on this page, is the finest engine room tool on the market today. It is made of heavy steel forgings, fully hardened, and carefully tested to assure freedom from flaws.

This wrench, which was designed to fill the gap between the 21-inch wrench and the heavy spanner wrench for large work, will not batter and jam a nut as will the chain wrench. It will not slip and make trouble, and will take any nut, square or hexagonal, within its opening capacity.

The key feature makes possible the setting of the jaw strap in two positions, thus assuring the jaws going into corners readily. The key cannot come off, and it holds the jaw strap rigidly.

The wrench is hardened by a special process and like all other "Coes" products is warranted free from mechanical defects.

The Coes Key Model Wrench is made in the following four sizes:

28 inches long, opens 5⅛ inches, weighs 19 lbs.
36 inches long, opens 6¼ inches, weighs 28 lbs.
48 inches long, opens 9½ inches, weighs 62 lbs.
*72 inches long, opens 12¼ inches, weighs 165 lbs.
*Made on order only.

Knife Handle Model Wrench

The Coes Knife Handle Model Wrench is a strong all-around serviceable wrench. Experiment and tests have enabled us to improve nearly every feature of the first and original Knife Handle Wrench. Tests have proved this wrench to be 10 to 15 per cent stronger than imitations and substitutes made by others.

Handle—Cast semi-steel frame, hard wood sides, secured at both ends by insertion under metal and riveted up under pressure. The soundest and strongest wood handle made.

Screw—Steel, hardened and in one piece. Imitations are in two and sometimes three parts.

Jaw—Semi-steel casting-hardened.

Bar—Steel, specially imported material fully hardened.

The Coes Knife Handle Model Wrench is made in the following sizes:

6 inches long, opens ⅞ inches, weighs 12 ozs.
8 inches long, opens 1¼ inches, weighs 1⅜ lbs.
10 inches long, opens 1⅝ inches, weighs 2 3/16 lbs.
12 inches long, opens 2¼ inches, weighs 3 5/16 lbs.
15 inches long, opens 2½ inches, weighs 5 lbs.
18 inches long, opens 3 inches, weighs 6¾ lbs.
21 inches long, opens 4⅛ inches, weighs 9 lbs.

Comparative Tests Prove Superiority

The strength of Coes Wrenches as compared to other wrenches on the market is shown by a typical test on a number of 12-inch wrenches made at the Harvard University Testing Laboratory. The wrenches tested were closed tight on a square block and pressure applied downward until the wrench set or rupture showed. The comparative testing strains required to permanently set the wrenches and the results were then noted as tabulated in the table below. It will be observed that in each case the Coes wrench was superior.

TEST OF 12-INCH WRENCHES.
From Test Blanks of Harvard University Testing Laboratory

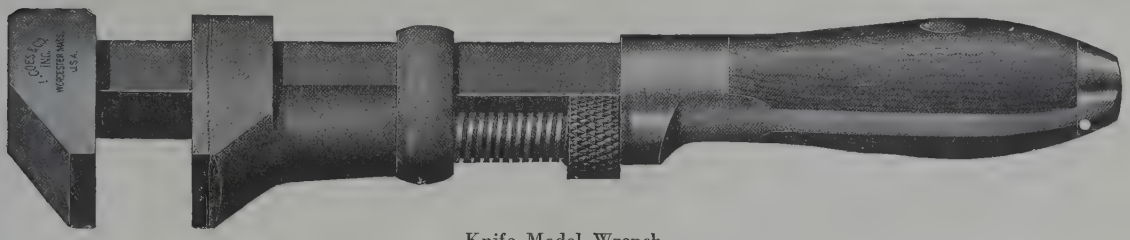
	Load	Result	Part Broken
12" K. H. Imitation	460 lbs.	Fell to pieces	Bar pulled from handle.
12" K. H. Imitation	1070 lbs.	Broken	Jaw broken, Bar bent.
"Railroad Special" 12" Steel Handle Imitation	1075 lbs.	Pulled apart	Handle shell forced off of bar.
12" K. H. Imitation	1190 lbs.	Broken	Jaw broken, thread in Jaw stripped Jaw broken Head bent back.
Coes Mechanics Model 12" Black	1365 lbs.	Crippled	Bar bent
Coes Genuine K. H. 12" Black	1410 lbs.	Crippled	Jaw bent, Bar set. Nothing broken.
Coes Steel Handle 12"	1790 lbs.	Crippled	Bar set so screw and jaw would not move. Nothing broken.

Shipments

Besides the care taken to protect the users of Coes Wrenches by inspecting all goods 16 times during the process of manufacture and a guarantee of freedom from mechanical defects, additional pains are taken to prevent damage during shipment. Each wrench is oiled to prevent rust and wrapped up individually in paper and the package is tied and labeled with size and model. All goods are packed carefully and protected by lined shipping cases, and the cases are well strapped and clearly marked for identification.

COES WRENCH CO., WORCESTER, MASS.

Coes Wrenches



Knife Model Wrench

Manufacturing Facilities

The factories of the Coes Wrench Company, located at Worcester, Mass., are the largest in the world devoted exclusively to the manufacture of Screw Wrenches. These factories are equipped with the most complete and modern equipment which together with an efficient organization of skilled mechanics makes possible the consistent high quality of "Coes" Wrenches.

The excellent manufacturing facilities permit the filling of large orders promptly as well as the building up of large stocks for prompt deliveries, and a convenient location and excellent railroad connections assure quick shipments to all points.

Quality

The high quality of the material used in all the "Coes" wrenches is the result of long and earnest experiment. The methods of manufacture have been continually improved with a view of subordinating the matter of selling price to the maintenance of highest quality. The result of this consistent policy is the production of wrenches that by every test made have proven to be higher enough in quality to more than offset any difference in cost.

As a single indication of the efforts made to assure the consistent high standard of quality, each wrench manufactured by the Coes Wrench Company is inspected eleven times before assembling, and five times after assembling.

Important Features

"Coes" wrenches are designed for quick adjustment, severe and dependable service. When the "Coes" wrench grips a nut it holds. The firm square jaws will grasp a nut firmly from any angle and will not spread apart—the jaws remain square in service, there is no lost motion in them.

Purpose of Design

Wrenches are used in damp places, in places where they are subjected to heat, for heavy work, for large work, and for ordinary machine work. The following models of the "Coes" wrenches are designed to fulfill the above requirements.

The Steel Handle Model, which is the strongest wrench made, was designed for very heavy work and for use in damp places and places where it is subjected to heat.

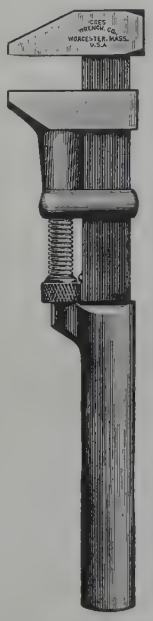
The Key Model was designed to fill the gap between the 21-inch and the heavy spanner wrench for large work.

The Knife Handle Model was designed to be a strong all-around serviceable wrench for machine work, etc.

Steel Handle Model Wrench

The Coes Steel Handle Model Wrench, which is the strongest wrench made is particularly adapted for heavy work in damp places, for extra difficult service or where exposed to heat, water or insects.

This wrench has been tested and found 35 per cent stronger than any wrench made by competitors, and is 15 per cent stronger than the Coes Knife Handle Model, owing to the heavier construction.



Steel Handle Model

Bar—Made of Steel fully hardened and cold swaged, is the stiffest bar of any wrench made.

Jaw—Made of extra heavy semi-steel and hardened.

Screw—Made of steel, fully hardened. In sizes 12 inches long and larger, the screw has a polished hardened ball race.

Ball—(In sizes 12 inches long and larger). Made of first quality standard bearing ball. Fully hardened.

Handle—Made of semi-steel casting. (Design and method patented). Internally supported and retained by cross riveting and by extension of bar through handle and riveting same.

The Coes Steel Handle Model Wrenches are made in the following sizes:

6 inches long, opens 7/8 inches, weighs 13 ozs.

8 inches long, opens 1¼ inches, weighs 1½ lbs.

10 inches long, opens 1 11/16 inches, weighs 2 5/16 lbs.

12 inches long, opens 2⅜ inches, weighs 3 15/16 lbs.

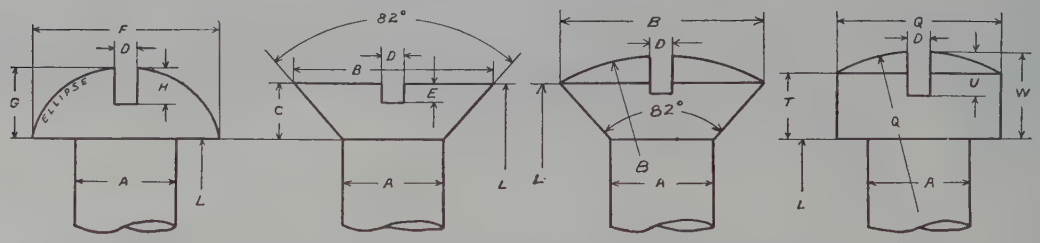
15 inches long, opens 2⅝ inches, weighs 5¼ lbs.

18 inches long, opens 3 inches, weighs 7¾ lbs.

21 inches long, opens 4⅛ inches, weighs 10 lbs.

Machine Screws and Rivets

SPECIFICATIONS FOR STANDARD MACHINE SCREWS
Head measurements for all sizes shown below



Round Flat Oval Filister

Dimensions in Ten-thousandths of an Inch—Maximum Diameters Are Standard

Mach. Screw No.	Thr'd Per Inch	THREAD MEASUREMENTS Outside Dia. Min.	Outside Dia. Max.	Pitch Dia. Min.	Pitch Dia. Max.	Root Dia. Min.	Root Dia. Max.	HEAD MEASUREMENTS B	C	D	E	F	G	H	Q	S	T	U	W
2	64	0828	0860	0743	0759	0624	0657	1640	0450	0300	0150	1540	0600	0400	1320	0270	0548	0360	0725
*2	56	0825	0860	0727	0744	0591	0628												
3	56	0955	0990	0857	0874	0721	0758	1900	0520	0320	0170	1780	0690	0440	1530	0320	0633	0420	0838
*3	48	0952	0990	0836	0855	0677	0719												
4	48	1082	1120	0966	0985	0807	0849												
4	40	1078	1120	0937	0958	0747	0795	2160	0600	0340	0200	2020	0780	0490	1747	0360	0719	0480	0953
*4	36	1076	1120	0918	0940	0707	0759												
4	32	1073	1120	0894	0917	0657	0714												
5	44	1210	1250	1082	1102	0910	0955	2420	0670	0370	0220	2260	0870	0530	1960	0400	0805	0530	1068
*5	40	1208	1250	1067	*1088	0877	0925												
6	40	1338	1380	1197	1218	1007	1055												
6	36	1336	1380	1178	1200	0967	1019	2680	0750	0390	0250	2500	0970	0580	2170	0440	0890	0590	1180
*6	32	1333	1380	1154	1177	0917	*0974												
8	36	1596	1640	1438	1460	1227	1279												
*8	32	1593	1640	1414	1437	1177	1234	3200	0900	0430	0300	2980	1150	0670	2599	0530	1062	0710	1410
8	30	1592	1640	1400	1424	1147	1207												
10	32	1853	1900	1674	1697	1437	1494												
10	30	1852	1900	1660	1684	1407	1467	3720	1050	0480	0350	3460	1330	0760	3026	0620	1234	0820	1639
*10	24	1848	1900	1603	1629	1288	1359												
12	28	2111	2160	1904	1928	1633	1696	4240	1200	0520	0400	3940	1510	0850	3452	0700	1405	0930	1868
*12	24	2108	2160	1863	1889	1548	1619												
14	24	2368	2420	2123	2149	1808	1879	4760	1350	0570	0450	4430	1696	0940	3879	0790	1577	1050	2097
*14	20	2364	2420	2067	2095	1688	1770												
16	22	2626	2680	2358	2385	2014	2090												
16	20	2624	2680	2327	2355	1948	2030	5280	1500	0610	0500	4910	1880	1040	4305	0870	1748	1160	2325
*16	18	2622	2680	2290	2319	1869	1958												
18	20	2884	2940	2587	2615	2208	2290												
*18	18	2882	2940	2550	2579	2129	2218	5800	1640	0660	0550	5390	2060	1130	4731	0960	1920	1280	2554
18	16	2880	2940	2504	2534	2030	2128												
20	20	3144	3200	2847	2875	2468	2550												
*20	18	3142	3200	2810	2839	2389	2478	6320	1790	0700	0600	5870	2240	1220	5158	1040	2092	1400	2783
20	16	3140	3200	2764	2794	2290	2388												
24	18	3662	3720	3330	3359	2909	2998	7360	2090	0790	0700	6830	2600	1400	6010	1220	2435	1620	3240
*24	16	3660	3720	3284	3314	2810	2908												
28	14	4178	4240	3745	3776	3204	3312	8400	2390	0880	0800	7790	2970	1580	6860	1390	2780	1850	3700
28	16	4180	4240	3804	3834	3330	3428												
30	16	4440	4500	4064	4094	3590	3688	8920	2540	0930	0850	8280	3150	1680	7290	1480	2950	1960	3930
*30	14	4438	4500	4005	4036	3464	3572												
*34	13	4957	5020	4488	4520	3905	4020	9960	2840	1020	0950	9240	3510	1860	8140	1650	3290	2190	4380
34	12	4955	5020	4447	4479	3816	3938												

Note.—Sizes and threads per inch marked * are the more common and should be used in preference to all other sizes shown.

Standard Machine Screws Kept in Stock

We constantly maintain a stock of standard machine screws with proportions as shown in the table above from which we are prepared to make immediate delieveries.

Other Products

We also manufacture special screws of all types as well as a great variety of high grade rivets, cold headed products and special turned parts.

KEYSTONE SCREW CO., PHILADELPHIA, PA.

Air and Gas Compressors

Manufacturing Scope

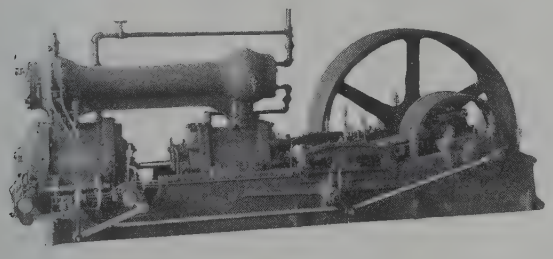
The Norwalk Iron Works Company builds compressors of any capacity and any pressure for air, oxygen, hydrogen, acetylene gas and carbonic acid gas, and stands ready to meet all compressing requirements. Where standard sizes do not fill the need compressors are built to specifications.

Service

Our Engineering Department is prepared to give prompt and practical co-operation wherever special compressing problems exist, applying the experience gained in 40 years of compressor building for all lines of work. Inquiries are invited without obligation.

Proven Reliability

Every Norwalk compressor is rigorously inspected and tested as it is assembled, and its reliability for the full specified pressure proven in a thorough run on the testing stand before it leaves the factory.



100-lb. Air Compressor

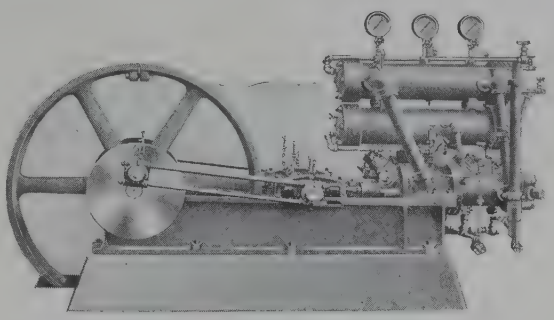
Size of Intake Cylinder, 10 Inches; Stroke of All Cylinders, 12 Inches; Displacement Capacity, Cubic Feet, 260; Speed, R. P. M., 240; Horsepower, 46

Points of Advantage

Norwalk air and gas compressors are featured by the following characteristics: High speed, light weight, operating economy, greatest capacity, small floor space, automatic regulation, full load, part load or no load as required; inexpensive foundations, central balanced stresses, balanced loads, accessibility of all parts, mechanically actuated valves, complete and efficient cooling system. The combination of these qualities results in maximum reliability of operation, economy of up-keep and long life.

Materials and Workmanship

Materials are the best obtainable for the various uses. Every feature of design has demonstrated its merit. All phases of construction are in the hands of compressor experts.



Three-Stage Belt-Driven Compressor for Acetylene Gas

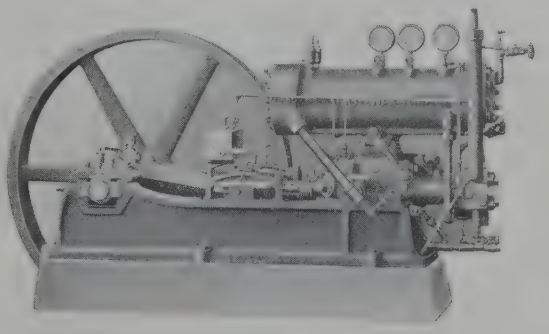
Size of Intake Cylinder, 8 Inches; Stroke of All Cylinders, 8 Inches; Displacement Capacity, Cubic Feet of Free Gas Per Minute, 29; Speed, R. P. M., 63; Horsepower Motor, 10

Equipment

Foundation drawings and foundation bolts and anchor plates are furnished with compressor; also safety valves and pressure gauges for each stage, as well as complete set of wrenches. Every Norwalk compressor is shipped with full protection against damage in transit, and in shape for quick and trouble-free installation. These precautions are of special value to patrons in foreign markets, where delay in installation would be costly.

Quotations

We will gladly quote prices and supply detailed specifications. Illustrated bulletins on Norwalk Compressors for air, oxygen, hydrogen, acetylene gas and carbonic acid gas will be sent promptly on request. They describe distinctive Norwalk features and give tabular data on types and sizes for all branches of service. Our long experience with export business equips us to handle overseas orders most satisfactorily.



Three-Stage Belt-Driven Oxygen Compressor

Size of Intake Cylinder, 5¾ Inches; Length of Stroke, 6 Inches; Displacement Capacity, Cubic Feet of Free Gas Per Minute, 25; Speed, R. P. M., 150; Horsepower, 15

THE NORWALK IRON WORKS COMPANY

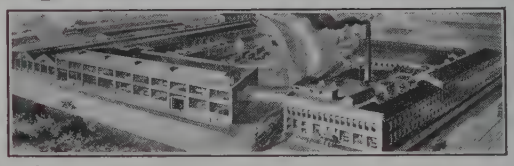
SOUTH NORWALK, CONN.

Boyer Pneumatic Hammers

BOYER HAMMER PLANT—DETROIT

COMPRESSOR AND ENGINE PLANT NO. 1—FRANKLIN, PA.

LITTLE GIANT AIR DRILL PLANT—CLEVELAND



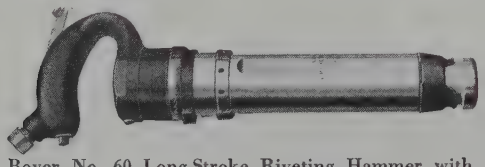
LITTLE GIANT ELECTRIC TOOL PLANT—ERIE, PA.

Chicago Pneumatic Products

Chicago Pneumatic products include:—Boyer Riveting Chipping, Calking and Scaling Hammers; Boyer Pneumatic Holder-Ons, Yoke and Jam Riveters, Combination Hammer Holder-Ons, Little Giant Air Drills, Air Grinders, Tapping and Wood Boring Machines; Little Giant Electric Drills and Grinders; Little Giant Pneumatic Geared Hoists, Air Motors and Winches; Chicago Pneumatic Simplate Valve Air Compressors and Vacuum Pumps; Giant Semi-Diesel Oil, Gas and Steam Engines; Rock Drills; Air and Electric Coal Drills; Accessories including rivet sets, chisel blanks, lubricants, air hose, hose couplings, safety throttles for air drills, chucks, etc.

Boyer Riveting Hammers

In shipyards the world over, the "Boyer" is the accepted standard riveting hammer. The operator with a "Boyer" drives more and better rivets, does more and earns more for both his employer and himself, than with any other riveting hammer yet built.



Boyer No. 60 Long-Stroke Riveting Hammer with Standard Open Handle

Thus men supplied with "Boyers" invariably feel that from the standpoint of rivet-driving equipment their welfare has been properly considered. And it has, for the patented features of the "Boyer," responsible for its unique popularity, are procurable in no other riveting hammer made.

Famous Boyer Features

Divided into three distinct members, cylinder, handle, and valve, the "Boyer" principle of construction provides for quick examination and economical upkeep and repairs. In each of its three unit members is a moving part subject to wear, but in varying degrees. It is, therefore, frequently possible to replace but one of these members and obtain a comparatively new hammer as a result.

"Boyer" materials and workmanship are in keeping with the perfection of its design. All duplicate parts

Sectional View, Boyer Long-Stroke Riveting Hammer

are made absolutely interchangeable on jigs and templates and under precise manufacturing standards. All materials used pass rigid inspection and physical tests made by trained metallurgists.

The "Boyer" valve is so designed that the piston passes through it thus shortening the overall hammer length and at the same time securing a speedy, powerful action.

All Moving Parts in the Boyer Function in the Same Plane and in Direct Alignment with the Operator's Arm. Result—More and Better Work with Less Fatigue.

Made in Five Standard Sizes

Boyer Riveting Hammers are made in a variety of sizes which provide the right tool for any riveting hammer operation.

The No. 50 Boyer Riveting Hammer has a stroke of 5″ and is best adapted for driving 3/8″ cold or 1/2″ hot rivets.

The No. 60 Boyer Riveting Hammer has a 6″ stroke and will drive cold rivets up to 1/2″, or hot rivets or cold staybolts up to 7/8″ in diameter.

The No. 80 Boyer Riveting Hammer has an 8″ stroke and will drive hot rivets up to 1 1/8″ in diameter, or cold staybolts up to 1″.

The No. 90 Boyer Riveting Hammer has a stroke of 9″ and will drive hot rivets up to 1 1/4″ in diameter, or cold staybolts up to 1 1/8″.

The No. 80-X Boyer Riveting Hammer has a 1/8″

Boyer Pneumatic Hammers and Holder-Ons

larger cylinder diameter than the No. 80 size, an 8" stroke, and will drive hot rivets up to 1 3/8" in diameter. Recommended for extremely heavy and water or steam-tight work.

SPECIFICATIONS
BOYER RIVETING HAMMERS

Type	Size No.	Diam. Piston	Length Stroke	Capacity Rivets	Blows per min.	Cu. ft. free air per min.	Shipping Weight Lbs.
Standard	50	1 1/16"	5"	3/4"	1000	25	24
	60	1 1/16"	6"	7/8"	760	25	29
	80	1 1/16"	8"	1 1/4"	700	25	32
	90	1 1/16"	9"	1 1/4"	620	25	33
	80-X	1 3/16"	8"	1 3/8"	800	28	32

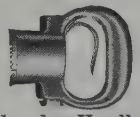
May be equipped with safety device for preventing accidental shooting out of piston or rivet set, when so ordered.

Special Handles

Open type handles with outside triggers are furnished as standard equipment with Boyer Riveting Hammers unless otherwise ordered. When desired any of the three special handles here illustrated can be supplied. They are interchangeable on all sizes of Boyer Hammers excepting the No. 80-X which has an extra large cylinder diameter.

Closed Handle Outside Trigger

Inverted Handle



Closed Handle Inside Trigger

Boyer Rivet Sets

An operator provided with a dependable rivet set can obviously drive better rivets in greater quantities than one subject to exasperating delays incident to the breakage of sets, which frequently result in costly damage to the hammer itself. Boyer Rivet Sets are made from forged blanks. They are uniform in chemical and physical characteristics, and give uniformly long, dependable service. Five standard types, in all standard sizes, are made as follows:—Button, Cone, Flush, Pan and Liverpool. Ask for special bulletin. Specific recommendations as to proper designs for various kinds of work, gladly given.

Boyer Chipping and Calking Hammers

Boyer Chipping and Calking Hammers possess the same inherent and distinctive features of design, construction and operation—the same built-in quality—as Boyer Riveting Hammers. They are made in a most complete line, the following particular types and sizes being those most widely used for shipyards and general manufacturing purposes:—

Boyer "BK" Type Chipping Hammer

Boyer "K" Type Chipping Hammer

The BK-1 Boyer Chipping Hammer is especially designed for light chipping, releading old flues and light calking.

The BK-1-X Boyer Chipping Hammer is built for heavier work than the BK-1. It has become invaluable in many shipyards for calking seams, trimming flush head rivets, etc. Also useful for medium chipping in gray iron and steel castings.

The BK-2 Boyer Chipping Hammer is a popular size for leading flues and general chipping and calking.

The BK-3 Boyer Chipping Hammer is built for heavy chipping and calking, and general repair work, or for heading small hot or cold rivets.

The BK-4 Boyer Chipping Hammer (stroke 4") is useful for extra heavy calking and chipping heavy castings and forgings. Also used for light riveting.

The Boyer "K" Type Chipping Hammer is made in several sizes, four of which are listed below. It is a popular style hammer wherever closed handle type chippers are preferred (although if desired it can be supplied with the standard Boyer open type handle.)

SPECIFICATIONS — BOYER CHIPPING AND CALKING HAMMERS

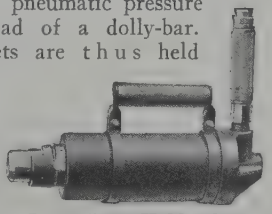
Size	Diam. Piston	Length Stroke	Blows per Min.	Net Weight Lbs.	Length Overall	Size Hose Conn.
BK–1	1 1/16"	1"	3200	11 1/2	11 1/2"	1/4"
BK–1-X	1 1/16"	1 1/2"	3000	12 1/2	12 1/2"	1/4"
BK–2	1 1/16"	2"	2800	13	13 1/2"	1/4"
BK–3	1 1/16"	3"	2400	14 1/2	15 1/2"	1/4"
BK–4	1 1/16"	4"	1600	15 1/2	17 1/2"	1/4"
K–1	1 1/16"	1"	3200	12	11	1/4"
K–2	1 1/16"	2"	2800	13 1/2	12 3/16"	1/4"
K–3	1 1/16"	3"	2000	15	14 3/16"	1/4"
K–4	1 1/16"	4"	1300	16	16 3/16"	1/4"

Note.—Boyer Chipping Hammers are supplied with either a "Round" or a "Hexagon" bushing. In ordering state which is desired.

BK Type Hammers are furnished only with standard Boyer Open type handles. K Type Hammers are supplied standard with closed type handles and outside triggers. When so specified, however, they can be supplied with standard Boyer Open handles.

Boyer Pneumatic Holder-Ons

In driving rivets beyond average size, it is invariably desirable to back them up with pneumatic pressure instead of a dolly-bar. Rivets are thus held tightly against the heaviest blows. In addition to securing more and better driven rivets, the use of Boyer Pneumatic Holder-Ons relieves the operators of all heavy physical effort incident to "bucking up." Boyer Pneumatic Holder-Ons are built in three styles for varying service conditions, as follows:



Boyer Long Holder-On

SPECIFICATIONS—BOYER PNEUMATIC HOLDER-ONS

Style	Length Stroke	Length Overall Inc. Set	Distance, center of set to side of Holder-On	Size Hose Conn.	Net Wgt.
*Long	4"	13 5/16"	1 3/4"	3/4"	26
**Short (Center Piston)	4"	8 7/8"	2 1/16"	3/4"	26
***Short (Offset Piston)	4"	9 3/4"	1"	3/4"	25

*Recommended for use wherever cramped quarters do not make its over-all length prohibitive.

**For use where rivets must be backed up in close quarters requiring a tool of minimum over-all length.

***Especially designed for use in cramped corners where clearance interfere with the use of Holder-Ons of the center piston type. A useful Holder-On for universal service.

Boyer Riveters and Little Giant Drills

Boyer Jam Riveters

Boyer 1¾ x 3⅞ Short Jam Riveter

Boyer Jam Riveters are of inestimable value wherever rivets must be driven in close quarters. They are particularly adapted for riveting between channels on ship work and for flue expanding or crown sheets cleaning on boiler work. They may be depended upon to drive tight rivets speedily and require but little physical effort to operate. Five sizes are built, as follows:

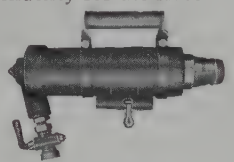
SPECIFICATIONS—BOYER JAM RIVETERS

Size	Dia. Cyl.	Length Stroke	Blows per Min.	Travel of Riveter	Space Req'd to Operate	Size Rivet will drive	Net Wgt. Lbs.
1 5/8x2"	1 5/8"	2"	1150	2 3/8"	8"	5/8"	20
1 5/8x5"	1 5/8"	5"	800	5 7/8"	20½	3/4"	37
1 5/8x2"	1 3/4"	2"	1125	2 3/8"	8"	3/4"	30
1 3/4x3 7/8"	1 3/4"	3 7/8"	1100	3 3/8"	16"	7/8"	50
1 3/4x6"	1 3/4"	6"	775	4 1/8"	24"	1"	69

Note.—All above sizes have ¾" hose connection.

Boyer Combination Hammer Holder-On

This tool, unique in the field, is designed for use in backing up rivets which must undergo minute inspection. By combining the riveting action of the Boyer Riveting Hammer and the holding pressure of the Boyer Pneumatic Holder-On, it absolutely overcomes all tendency for the rivet to "unseat" or "upset" itself between the plates due to the percussive effect of the hammer on the riveting end. Practically automatic in operation and extremely rugged in construction. Built only in one size—No. 5. Strikes 1,000 blows per minute; length overall including set is 15 3/4"; net shipping weight, 31 lbs.



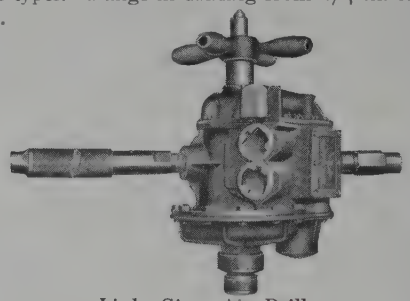
Boyer Combination Hammmer Holder-On

Little Giant Air Drills and Wood Boring Machines

Little Giant Air Drills are of the balanced piston type, and consist of four single acting cylinders arranged in pairs, each pair of pistons being connected to opposite wrists of a double crank shaft. The pistons of each pair travel in opposite directions at all parts of the stroke, insuring smooth operation at all speeds. Other unique features of construction are: the use of a patented toggle connection equipped with renewable split crank-pin bearings which may be quickly changed when worn, at a fraction of the expense involved in replacing a complete toggle; and the use of annular ball bearings at three points on the crank shaft thus eliminating breakages and operating friction.

All "Little Giant" drills are made after a standard design, varying only in size and construction necessary to adapt them to particular uses; and in reversible and non-reversible types. Range in drilling from 1/4 in. to 2 ins. in steel.

The Toggles in Little Giant Drills Are Now Equipped with Replaceable Split Crank-pin Bearings.



Little Giant Air Drill

"LITTLE GIANT" DRILLS, REVERSIBLE AND NON-REVERSIBLE

Size	Diam. Piston	Length Stroke	Free air consumption per min., 80 lbs.	Speed light r.p.m.	Size Socket	Drilling capacity	Net Wgt. Lbs.
No. 10F	5/8"	1 3/4"	11	2400	No. 00 Chuck	1/4"	8
No. 10S	5/8"	1 3/4"	7	1200	No. 0 Chuck	3/8"	8¾
No. 3	1¼"	2 1/8"	15	1050	No. 0 Chuck		
				2025	or No. 1 M.T.	1/2"	12
No. 4	1½"	1¼"	20	700	No. 2 M. T.	7/8"	22
No. 2	1 5/8"	1 5/8"	25	480	No. 3 M. T.	1¼"	40
No. 1	2"	1 5/8"	35	340	No. 4 M. T.	2"	58

No. 10F fitted with pistol grip handle; the others fitted with feed screw or grip handle, as desired. Nos. 10S, 3 and 4 may be fitted with breastplate.

Nos. 3, 4, 2 and 1 "Little Giant" drills may be furnished in reversible style and known as 3R, 4R, 2R and 1R. Specifications practically the same. They reverse by means of a reversing handle at the side.

When so ordered Little Giant Drills can be suppied with the patented "Safety Grip" Throttle.

"LITTLE GIANT" REVERSIBLE REAMING AND TAPPING MACHINES

(Also used for flue rolling)

Size	Speed light r.p.m.	Wgt. Lbs.	Capacity		
			Reaming	Tapping	Flue rol'ng
12	310	44	1"	1"	2"
11	240	60	2"	2"	2½"

"LITTLE GIANT" WOOD BORING MACHINES

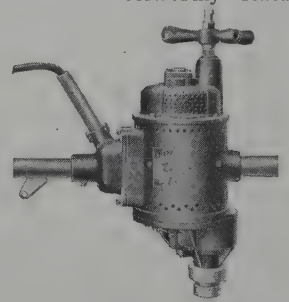
Size	Speed light r. p. m.	Wgt. Lbs.	Capacity
10	1200	8	¾"
3	750		
3	and	12	1"
	1400		
5	650	24	2"

"LITTLE GIANT" CLOSE QUARTERS DRILLS

Size	Size Socket	Capacity drilling	Air Consumption per min.	Speed light, r. p. m.	Wgt. Lbs.	Distance side to center of spindle
81	No. 3 M. T.	1¼"	25	315	45	1 7/16"
91	No. 4 M. T.	2"	35	190	50	1½"

Little Giant Electric Drills

These machines, the most extensively used line of portable electric tools in the world, are of rugged mechanical and electrical construction throughout. Noteworthy features include:



Little Giant Electric Drill (D.C. Type)

high grade ball bearings, stub tooth gears, efficient ventilation and cooling system, high overload capacity without undue temperature rise, and patented non-arcing handle switch control.

Little Giant Electric Drills are built in the following capacities, and as indicated, in direct, alternating, and "Universal" current types:

CAPACITIES OF "LITTLE GIANT" ELECTRIC DRILLS.

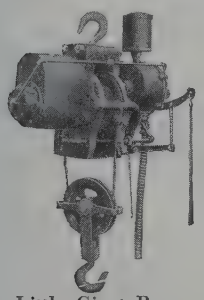
Drilling Capacity (in metal) inches.

Size	*Universal Electric Drills for 110 and 220 volts	Heavy Duty D. C. for 110 and 220 volts	**Heavy Duty A.C. for 2-phase and 3-phase	Heavy Duty D.C. for street railway work 600 volts
000	5/16"	—	—	—
000X	1/4"	—	—	—
00	5/16"	—	—	—
0	3/8"	3/8"	3/8"	—
1B	1/2"	1/2"	1/2"	1/2"
2B	7/8"	7/8"	7/8"	3/4"
3B	1 1/4"	1 1/4"	1 1/4"	1"
4B	—	2"	2"	1 1/2"

*For connection to ordinary lamp socket. D. C. or A. C. of 60 cycles or less, single-phase, interchangeably.

**Furnished in side spindle style only. Standard winding are for 60 cycles, 110 or 220 volts. Nos. 2, 3 and 4 can be wound for 440 volts.

Little Giant Pneumatic Geared Hoists



Little Giant Pneumatic Geared Hoist

Little Giant Pneumatic Geared Hoists are of sturdy all-steel construction; compact, extremely powerful and safe and efficient in operation. The air motor used in "Little Giants" is of the valveless reversible type, consisting of two double-acting oscillating cylinders set at right angles.

Lubrication of operating parts is accomplished by an automatic splash and flood system. All gears are cut from solid stock, accurately machined and case hardened. Operation is controlled with chairs within easy reach from the floor and an automatic air brake is supplied which locks the motor against operation when the valve is at "neutral." An automatic limit-stop provides absolute protection against overhoisting and "jamming" the load.

Little Giant Hoists are built in five sizes, capacities from 1 to 10 tons, as follows:

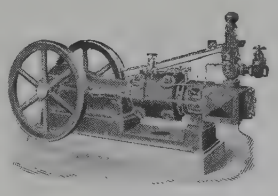
SPECIFICATIONS—LITTLE GIANT PNEUMATIC HOISTS

Size	Capacity Tons	Height of Lift	Lifting Speed per Min.	Shortest Distance Between Hooks	Cu. ft. Free Air Used per ft. lift, 80 lbs. pressure	Net Weight Lbs.
10	1	9	28′	39″	3	355
11	1½	9′	16′	39″	4	360
12	3	11′	10′	45″	8	465
13	5	12′	7′	53½″	15	820
14	10	12′	4′	61½″	27	1080

When desired, Little Giant Pneumatic Geared Hoists can be supplied in any of the above sizes, equipped with either a plain trolley, geared single track trolley, or a geared double track trolley. When ordering always state size and make of channels on which trolley must operate.

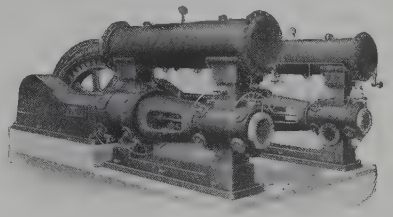
Chicago Pneumatic Air Compressors

"Chicago Pneumatic" — the Compressor with the Simplate Valve—is built in over 300 distinct sizes and types, a fact which emphasizes this Company's ability to supply an air plant of correct design and proportions, regardless of capacity required or operating conditions. Noteworthy features which contribute to the high mechanical and volumetric efficiencies of all Chicago Pneumatic Compressors, include the following:

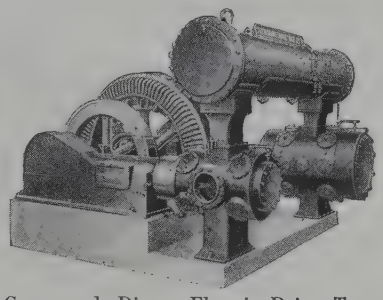


Single Stage Steam Driven Type

Simplate flat disc, indestructible valves which automatically adjust themselves to all load conditions; totally enclosed frame construction with automatic splash lubrication; automatic regulation which secures ideal power economy under varying loads; simple, modern construction throughout.



Compound Tandem, Duplex, Direct-Connected Electric Drive Type



Compound, Direct, Electric Drive Type

Standard sizes are built for steam, belt, electric, oil, gas, or gasoline engine drive in single, duplex and duplex-tandem types. Complete data and literature sent gladly upon request.

Branch Stocks and Service

Users of all Chicago Pneumatic Products, regardless of location, are assured prompt and intelligent Service on complete tools, compressors, renewal parts, and equipment in need of overhauling, through a nation-wide chain of Branch Offices and Service Stations operated in the cities indicated below, where large stocks are maintained in accordance with the demands of each territory. In establishing this broad Service System Chicago Pneumatic has gone one step farther towards assuring its customers that they may truly Depend Upon that Name for quality, satisfaction and service.

SALES AND *SERVICE BRANCHES

DOMESTIC

*Birmingham	*Detroit	*New York	*Salt Lake City
*Boston	El Paso	*Philadelphia	*San Francisco
*Buffalo	Joplin	*Pittsburg	*Seattle
*Chicago	Los Angeles	*Portland	*St. Louis
*Cincinnati	*Minneapolis	*Richmond	Tucson
*Cleveland	*New Orleans		

FOREIGN

Bombay	Honolulu	Milan	Seoul
Brussels	Johannesburg	Montreal	Sydney
Fraserburgh	Christiania	Osaka	Tokyo
Havana	London	Paris	Toronto
	Vancouver	Winnipeg	

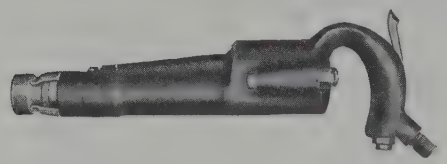
CHICAGO PNEUMATIC TOOL CO.

NEW YORK, N. Y.

Address nearest office. For list of offices see above

Riveting Hammers, Sizes and Capacities

"Little David" Riveting Hammers are supplied in 5 sizes according to the table below. They are used in over 175 shipyards in the U. S. A. Their maintenance cost is very low.



"LITTLE DAVID" RIVETING HAMMERS

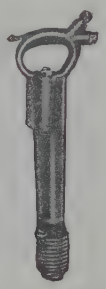
Size No.	Piston Stroke	Piston Diam.	Length Exclusive of Set	Standard Piston	Weight (Without Set)	Size Hose Connection	Size of Hose Recommended	Air Consumption Cu. Ft. Free Air Per Min.
5	4"	1½"	14¾"	3"	14 lbs.	¼"	½"	19
50	5"	1⅝"	16¼"	3"	18 lbs.	½"	½"	20
60	6"	1⅝"	17¼"	3"	20 lbs.	⅜"	½"	20
80	8"	1⅝"	19¾"	3"	22 lbs.	⅜"	½"	21
90	8"	1M	19¾	3½"	24½lbs.	⅜"	½"	21

Riveting Hammers Styles of Handle

The standard open handle is supplied on all riveting hammers unless one of the other styles shown is specified.

Closed Handle Inside Trigger

Inverted Handle



Closed Handle

"Little David" Jam Riveters

A sturdy tool for use in confined spaces.

"LITTLE DAVID" JAM RIVETERS

Size No.	Piston Stroke	Piston Diam.	Length Exclusive of Set	Standard Piston	Weight (Without Set)	Size Hose Connection	Size of Hose Recommended	Air Consumption Cu. Ft. Free Air Per Min
0	4"	1¾"	10"	2½"	30 lbs.	⅜"	½"	35
1	5"	1¾"	11⅜"	3"	32½ lbs.	⅜"	½"	35

"Little David" Holder On

For backing up rivets; uses very little air and relieves operator of strain.

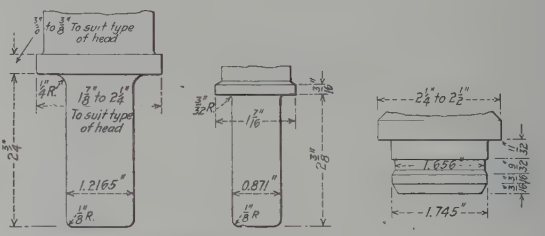
"LITTLE DAVID" HOLDER-ON

Size No.	Piston Stroke Inches	Piston Diam. Inches	Length Exclusive of Set	Weight (Without Set) Pounds	Size Hose Connection Inches	Size of Hose Recommended Inches	Length Closed Inches	Distance from Side to Center of Rivet Set
2	3	3⅛	7¼	13½	⅜	½	9	1¾
4	4½	3⅛	12¼	26	⅜	½	14½	1⅞
5	4½	3⅜	12¼	25	⅜	½	14½	1⅞

Dimensions of Rivet Set Shanks

The drawings below give dimensions for rivet set shanks for all "Little David" Hammers, for the convenience of those purchasers who desire to make their own rivet sets.

We can supply complete rivet sets for any type of work.



Standard Dimensions of Rivet Set Shanks for "Little David" Riveters

"Little David" Chipping and Calking Hammers

These sturdy tools are used in shipyards and foundries throughout the country. Their low maintenance cost and sturdiness make them standard where they are once used.

"LITTLE DAVID" CALKING AND CHIPPING HAMMERS

Size No.	Piston Stroke	Length Over-all	Weight Pounds	Size Hose Connection	Size Hose Recommended	Air Consumption Cu. F. Free Air Per Min.
NI	1¼"	10⅝"	7	¼"	½"	7
1S	1"	11¼"	11¾	¼"	½"	15
2S	2"	12⅛"	12¾"	½"	½"	16
2SS	2"	12⅛"	12⅞"	½"	½"	14
3S	3"	13⅛"	13	½"	½"	17
4S	4"	14⅛"	13¾	½"	½"	18
5	4"	14½"	14¼	¼"	½"	19

"Little David" Calking Machine

The "Little David" Calking machine affords a great saving over hand work and is especially useful in deck-calking on steel ships.

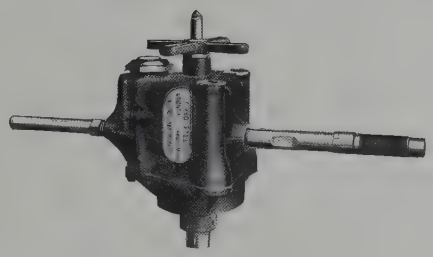
"LITTLE DAVID" CALKING MACHINE

Size No.	Speed Tacks per Minute	Weight Lbs.	Length	Air Consumption Cu. Ft.
23	1500	13½	22"	20

Pneumatic Tools

"Little David" Drills

The unusually small number of parts used in this drill and their wide interchangeability have created for the "Little David" a large and growing demand. The maintenance cost is very low and the air economy remarkably high. The wide range of sizes and gear ratios is listed below.



"LITTLE DAVID" NON-REVERSIBLE DRILLS

Size No.	Average Free Speed 90 lbs. Pressure R.P.M.	Weight Lbs.	Length of Feed Inches	Reaming Inches	Tapping Inches	Flue Rolling Inches	Standard Twist Drill will Drive	Length over-all Inches	Morse Taper Socket	Hose Inches	Cu. Ft. Free Air per Min.	Distance from Side to Center of Spindle
1B	240	55	5½	2	2		2¼	16	4	¾	55	4⅜
1C	210	55	5½	2½	2½		3	16	4	¾	55	4⅜
1SE	100	68	5½	Extra Heavy Drilling, Reaming and Tapping				19⅛	5	¾	55	4⅜
2	450	41	4⅞	1	1		1¼	14½	3	¾	50	3⅝
2S	450	43	4⅞	1	1		1¼	15	4	¾	50	3⅝
2SC	310	43	4⅞	1¼	1¼		1½	15	4	¾	50	3⅝
3AA	900	23	4⅜	¾	¾		11/32	11¾	2	¾	55	3
3SAA	900	24	4⅜	¾	¾		11/32	12½	3	¾	55	3
3	700	23	4⅜	¾	¾		11/32	11¾	2	¾	30	3
3S	700	24	4⅜	¾	¾		11/32	12½	3	¾	30	3
3SB	325	25	4¾	1	1		1¼	13⅝	3	¾	30	3
3SC	200	25	4¾	1	1		1¼	13⅝	3	¾	30	3
5	900	15	2½				9/16	14¾	1	½	25	1½
44	1400–3000	10					5/16 Chuck	14⅝		½	17	2⅞

"LITTLE DAVID" CLOSE QUARTER DRILL

9	170 250	37 32	3¾ 2⅝	2 1¼	2 1¼		3 1¼	9 8	4 3	¾	35	1⅝

"LITTLE DAVID" REVERSIBLE DRILLS

11B	240	55	5½	2	2	3½	2¼	16	4	¾	55	4⅜
11C	210	55	5½	2½	2½	4	3	16	4	¾	55	4⅜
11SE	100	68	5½	Extra Heavy Reaming, Tapping and Flue Rolling				9⅛	5	¾	55	4⅜
22	400	41	4⅞	1	1	2½	1¼	14½	3	¾	50	3⅝
22S	400	43	4⅞	1	1	2¼	1¼	15	4	¾	50	3⅝
22SC	275	43	4⅞	1¼	1¼	3	1½	15	4	¾	50	3⅝
33	575	23	4⅜	¾	¾		11/32	11¾	2	¾	30	3
33S	575	24	4⅜	¾	¾		11/32	12½	3	¾	30	3
33SC	175	25	4⅜	1	1		1¼	13⅝	3	¾	30	3

"LITTLE DAVID" GRINDER

7	3000	22		Diam. of Wheel-end of crank shaft 5/8"				20½		¾		3¼
601	4200	14		" " " " 1/2"				18⅜		½		2⅝

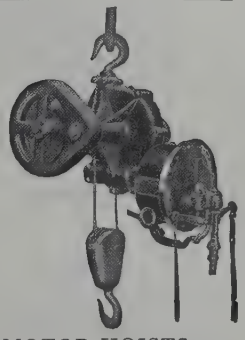
"LITTLE DAVID" PNEUMATIC SAW

7	3000	21		Diameter of Saw-End of crank shaft 5/8"				20⅜		¾		3¼

"Little David" Wood Borers

These are similar in construction to the drills and are equipped with wood bit chuck and spade handle or breastplate.

"Little David" Air Motor Hoists



Sure and safe, quick acting, and air cushioned. The air consumption is low. Made in 5 sizes as listed.

"LITTLE DAVID" WOOD BORERS

Size No.	Average Free Speed 90 lbs. Pressure R. P. M.	Weight Lbs.	Size of Wood Bit will Drive	Length Over-all	Hose	Cu. Ft. Free Air per Min.	Dist. from Side to Center of Spindle
22WB	400	41	4	17⅛"	¼"	50	3⅝
13	900	20	2	15¾"	¾"	30	3
15	900	15	1	14½"	½"		1½

"LITTLE DAVID" AIR MOTOR HOISTS

Size No.	Capac. Lbs.	Feet Lift per Min, 80 lbs. Pressure	Maxim. Lift, Feet	Size and Length Wire Rope	Size of Motor	Cu. Ft. Free Air per Min.	Net Weight Lbs.
1	1000	32	20	¼" x 42'-10"	4	45	270
2	2000	16	20	¼" x 42'-10"	4	45	270
4	4000	8	20	¼" x 42'-10"	4	45	395
7	7000	8	20	⅜" x 96'- 6"	10	80	785
10	10000	7	20	⅜" x 96'- 6"	10	80	785

In General

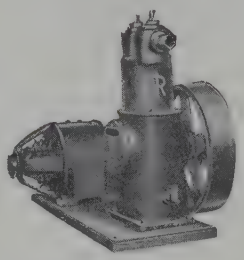
The type of air compressing equipment favored in different shipyards varies widely, but among the many compressor types of Ingersoll-Rand manufacture you will find just the machine for your individual requirement. Each unit is designed and built to supply some one demand most efficiently and economically. Designs are of time-proven soundness, materials selected with care and workmanship the best obtainable.

Ingersoll-Rand Compressors have, built into them, a remarkable service-giving ability. Their dependability fully justifies the oft heard expression—"When you choose Ingersoll-Rand the risk in buying is past."

For constructional details ask for the catalogs listed.

"Imperial 14" Compressors

Vertical, single acting, single stage, belt driven. With or without motor and short belt drive. Bulletin 3039.



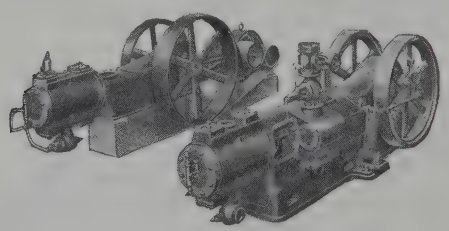
"IMPERIAL 14" COMPRESSORS
60-100 Lbs. Air Pressure

Piston Displace. cu. ft. per min.	Speed	B. H. P. 100 lb. press.	Floor Space	Height	Cooling
6	700	1.3	12x12″	16″	Air
6	700	1.3	12x12″	17.5″	Water Reser.
12.2	550	2.5	14x16″	23″	" "
23	500	4.35	17x30″	30″	" "
44	450	8	21x24″	46″	" "
44	450	8	21x24″	38″	Circ. Water.

Class "ER" and "FR" Compressors

Horizontal, double acting, single stage; belt, short belt with electric motor or piston valve steam engine driven.

Bulletins 3230 and 3131.



CLASS "ER" COMPRESSORS
Belt Drive

Piston Displace. Cu. ft. per min.	Pressure lbs. per sq. in.	Speed R.P.M.	B. H. P. Inc. belt loss	Floor Space
28	100–150	500	4 –4.3	4′- 7″ x 1′-6″
44	20–100	500	3.8–6.5	4′-10″ x 1′-6″
44	100–150	400	6.5–7	6′-2″ x 1′-9½″
64	45–100	400	7.3–9.3	6′-6″ x 1′-9½″
67	100–140	350	10–10	6′-6″ x 1′-11″
92	45–100	350	11–13	6′-7″ x 1′-11″
113	100–130	250	19–21	7′-11″ x 2′-6¼″
145	65–100	250	21–24	8′-1″ x 2′-6¼″
223	100–120	250	39–42	9′-9″ x 3′-2¼″
324	50–100	250	43–57	9′-5″ x 3′-2¼″
340	100–115	220	60–62	11′-0″ x 4′-1¼″
464	40–100	220	53–74	11′-3″ x 4′-1¼″

Data on standard machines for low pressures on request.

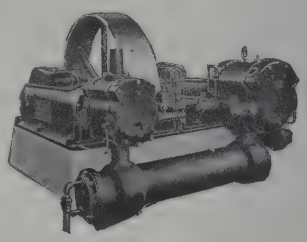
CLASS "FR" COMPRESSORS—STEAM DRIVE
Air Pressures to 125 Lbs.—Steam Pressures 80-175 Lbs.

Piston Displace. Cu. ft. per min.	Pressure Lbs. per sq. in.	Speed R.P.M.	I. H. P. in steam cyl.	Floor Space
67	80–125	350	9–10	8′- 2″ x 2′-8″
92	55–100	350	11–13	8′- 3″ x 2′-8″
136	80–125	300	21–25	10′- 2″ x 2′-8″
173	65–100	300	24–29	10′- 3″ x 2′-8″
245	80–125	275	39–46	12′- 0″ x 3′-2″
355	60–100	275	51–62	11′-10″ x 3′-2″
386	80–125	250	61–70	13′- 8″ x 4′-1″
528	45–100	250	66–88	13′- 9″ x 4′-1″

Data on standard machines for low pressures on request.

"Imperial XB" Duplex Units

Single and two-stage, belt driven machines. Can be had complete with short-belted electric motor. Bulletin 3312.



"IMPERIAL XB-2" COMPRESSORS
80-100 Lbs. Air Pressure

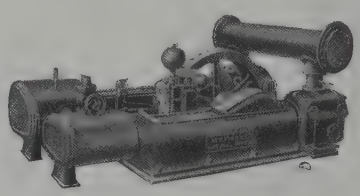
Piston Displace. Cu. ft. per min.	Speed R..P.M.	B. H. P. at 100 lbs.	Belt Wheel	Floor Space
203	225	36	54″ x 8½″	7′-8″ x 2′- 3″
327	210	57	60″ x 10½″	8′-4″ x 2′- 7″
446	210	76	72″ x 12½″	9′-9″ x 2′- 1″
599	185	104	84″ x 16½″	11′-0″ x 7′- 8″
888	170	152	96″ x 20½″	12′-6″ x 8′- 9″
1190	170	206	96″ x 28½″	13′-0″ x 9′- 2″
1482	155	254	108″ x 31½″	15′-1″ x 9′-11″

Data on standard machines for low pressures on request.

"Imperial XPV" Steam Driven

Duplex, single and two stage air, simple and compound piston valve steam cylinders.

Bulletin 3033.



"IMPERIAL XPV" COMPRESSORS—STEAM DRIVE

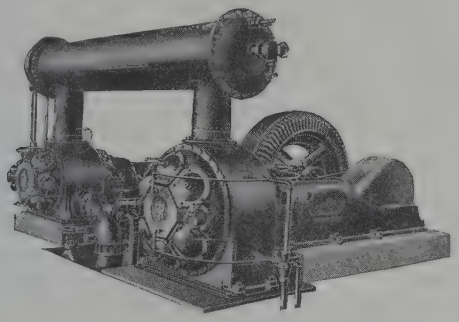
Air Pressures 80-100 Lbs.—Steam Pressures from 80 Lbs. up

Piston Displace. Cu. ft. per min.	Speed R.P.M.	I. H. P. in steam cyl.		Floor Space
		80 lbs.	100 lbs.	
648	200	102	120	12′-0″ x 7′-8″
940	180	148	174	13′-6″ x 8′-9″
1260	180	200	235	14′-0″ x 9′-2″
1531	160	242	284	17′-4″ x 10′-3″

Data on standard machines for low pressures on request.

Class "PRE" Electric Compressors

Duplex, single and two-stage, direct connected motor drive, automatic, 5 step, clearance control.



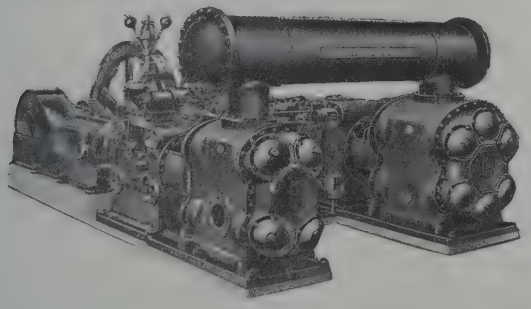
CLASS "PRE" COMPRESSORS
90-115 Lbs. Air Pressure

Piston Displace. Cu. ft. per min.	Pressure Lbs. per sq. in.	B. H. P. inc. belt loss	Floor Space
1173	100–115	176–187	12′-9″ x 11′-9″
1302	90–100	201–210	12′-9″ x 11′-9″
1433	100–115	228–242	14′-3″ x 13′-0″
1574	90–100	251–264	14′-3″ x 13′-0″
1873	100–115	284–302	15′-6″ x 15′-6″
2033	90–100	309–324	15′-6″ x 15′-6″
2480	100–115	390–414	17′6-″ x 17′-9″
2678	90–100	417–438	17′-6″ x 17′-9″
3190	100–115	497–528	19′-9″ x 18′-0″
3633	90–100	567–596	19′-9″ x 18′-0″
4482	100–115	671–712	21′-6″ x 19′-0″
5011	90–100	752–787	21′-6″ x 19′-0″
5378	100–115	886–940	29′-3″ x 20′-0″
5967	90–100	972–1020	29′-3″ x 20′-0″
6770	100–115	1024–1084	32′-0″ x 24′-6″
7440	90–100	1120–1179	32′-0″ x 24′-6″

Data for standard machines for lower pressures on request.

Class "ORC" Corliss Engine Driven

Duplex, single and two-stage air, simple and compound Corliss steam cylinders.



CLASS "ORC" COMPRESSORS—STEAM DRIVE
Air Pressures 90-125 Lbs.—Steam Pressures 90-180 Lbs.

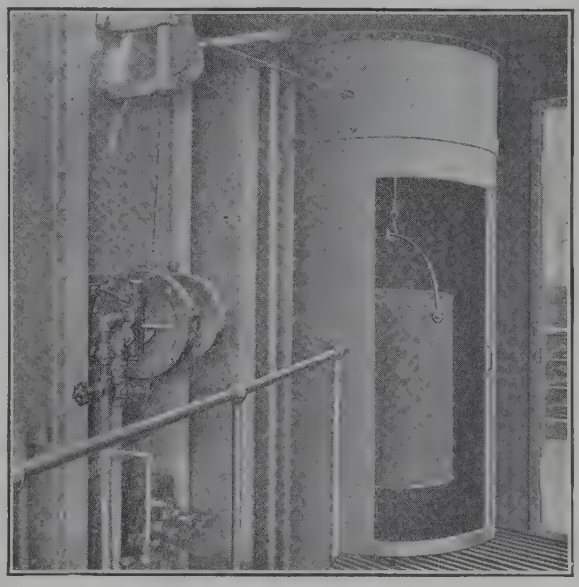
Piston Displace. Cu. ft. per min.	Pressure Lbs. per sq. in.	I. H. P. in steam cyl.	Floor Space
2376	110–125	413–437	23′-11″ x 15′-6″
2550	90–100	419–439	23′-11″ x 15′-6″
2847	110–125	475–503	26′- 5″ x 17′-0″
3242	90–100	516–540	26′- 5″ x 17′-0″
3906	110–125	623–659	28′- 8″ x 19′-0″
4384	90–100	670–702	28′- 8″ x 19′-0″
5153	110–125	901–953	33′- 1″ x 19′-0″
5715	90–110	941–987	33′- 1″ x 19′-0″
6650	110–125	1109–1168	39′- 8″ x 21′-8″
7310	90–100	1151–1207	39′- 8″ x 21′-8″

Data for standard machines for lower pressures on request.

"Little Tugger" Ash Hoist

A compact, self contained drum hoist that can be operated on either steam or compressed air. It is extensively employed as an ash hoist aboard ship and has decided advantages for such service. It economizes space, has no projecting levers, fly wheels or reciprocating parts and will hold its load at any point without application of the brake. It is self lubricated, has renewable bushings for all bearings and is a first class machine in all respects.

Bulletin 4333.



"Little Tugger" Installed on the Bulkhead of an Engine-room Deckhouse, Hoisting Ash Buckets Through Ventilator

"Little Tugger" in the Shipyard

In and around the shipyard are a hundred and one jobs of hoisting, handling and hauling that can well be left to "Little Tuggers." Erecting and tear-out scaffolding, hauling timbers, handling light plates, placing light machinery, cleaning holds and the like are accomplished at least cost when hand work is abandoned and "Little Tuggers" installed. Models for wire and manilla rope.

Bulletin 4333.

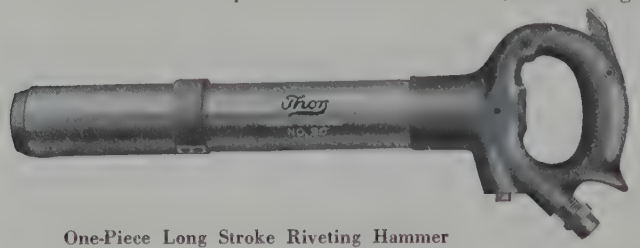
"LITTLE TUGGER" HOISTS

No.	Capac. Lbs.	Rope Speed Ft. per min.	Rope Capacity Feet	Weight	Inlet Connection
1-H Air operated	1000	85	700–½″ wire 450–⅝″ wire	285	¾″
1-HS Steam operated	1000	85	700–½″ wire 450–⅝″ wire	285	¾″
11-H Air operated	600	85	300–⅝″ manil.	358	¾″
11-HS Steam operated	600	85	300 ⅝″ manil.	358	¾″

"Thor" Pneumatic Riveting Hammer

The main feature and the great advantage of this long-stroke riveting hammer is in its one-piece construction, the handle, barrel and valve chamber being a one piece steel forging. This obviates the necessity of using couplings, clamps, keys, lock-nuts, and other complicated mechanism, which frequently break, become loose and cause considerable delay, annoyance and expense by the necessity of their having to be renewed or tightened.

The main valve lies parallel with the main bore, but



One-Piece Long Stroke Riveting Hammer

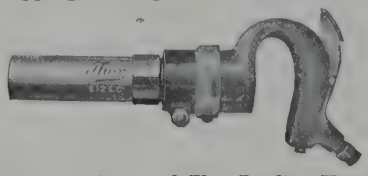
is not directly operated with the air on the downward stroke. When the piston returns, it opens an auxiliary valve which admits a slight amount of air. After the piston has started downward, the main valve opens. Therefore, the piston from a gentle start gets an extremely forceful and quick acting blow and a quick return.

ONE-PIECE LONG-STROKE RIVETER FOR DRIVING 1⅛" RIVETS

Size	Stroke	Piston Diam.	Blows per min.	Weight Lbs.	Air Used	Length	Use Hose I. D.
90	9"	1⅛"	700	22	23	20½"	¾"

"Thor" Chipping and Calking Hammer

The A, B, C, and D Chipping, Calking and Flue Beading Hammers are made with a single valve and have been designed for every purpose for which this class of tools is used such as chipping, calking, flue beading, and light riveting. Special attention has been given to making a hammer that would stand up under all conditions, and at the same time be simple in construction and develop the maximum power.



Chipping, Calking and Flue Beading Hammer

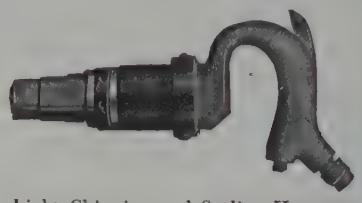
CHIPPING, CALKING AND FLUE BEADING HAMMER FOR GENERAL CHIPPING AND CALKING

Size	Stroke	Piston Diam.	Blows per min.	Weight Lbs.	Air Used	Length	Use Hose I. D.
C	3"	1⅛"	1600	12½	15	14¾"	½"

"Thor" Light Scaling Hammer

The size M. Light Chipping and Scaling Hammer is made with a ¾ inch stroke and a ¾ inch piston diameter. It weighs 5½ pounds. Size N has a 1¼ inch stroke and a 15/16 inch piston diameter, and weighs 7 pounds. These types are adapted for very light chipping and scaling and for cleaning paint or rust.

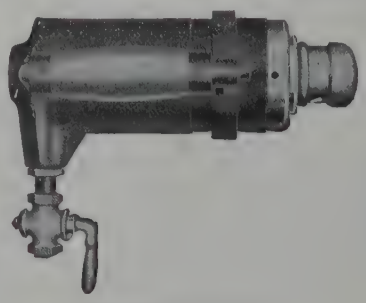
The principal feature of Thor Chipping Hammers consists of an entirely new valve mechanism, the valve block consisting of two solid cylindrical parts, hardened and ground. The valve is a cylindrical shell (hardened and ground) on the outside of the valve block, with wearing surface covering practically the entire block. When the handle is on, the valve is entirely protected. The wearing surface is many times larger in proportion to its weight than any other hammer made, and all the wearing surfaces are hardened.



Light Chipping and Scaling Hammer

"Thor" Pneumatic Holder-On

Thor Pneumatic Holders-On are of the single piston type made with a heavy case—hardened steel plunger, with ample area to hold a rivet against the work and provided with a spring pressed plunger to hold the rivet set. The air inlet between throttle and holder-on plunger is provided with check valve to admit air under the plunger slowly and prevent the plunger from shooting out too fast and, at the same time, relieve the air quickly. The cylinder is cast steel in one piece, which absolutely prevents leakage of air or the center shifting.



Pneumatic Holder-On

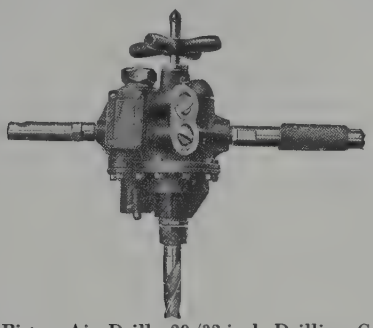
PNEUMATIC HOLDER-ON—LONG

Size No.	Length Over-all With Set and Center	Length Over-all Without Set or Center	Diam. of Piston	Length of Stroke	Outside Diam.	Distance from Center to Outside	Weight Pounds
1	11⅜"	8¾"	3⅛"	4"	3½"	1¾"	19

"Thor" Piston Air Drill

Thor Piston Air Drills are equipped with Thor Pressed Steel Connecting Rods and Pistons fabricated from Vanadium Steel. The Rods, Pistons and Straps are formed from blanks cut from sheet Vanadium Steel.

The Corliss Valves used in Thor Drills are so placed that the live air, which is magazined in the large chamber to the rear of the valves, is admitted over the full width of the edge which is a distance of but the thickness of the valve bushing and cylinder wall from the

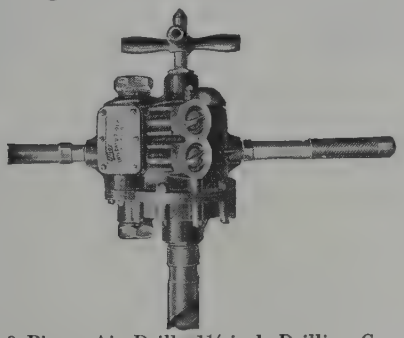


No. 2 Piston Air Drill—29/32-inch Drilling Capacity

piston. This distance is equal on all four cylinders. Extremely smooth action results from this construction.

The eccentric and eccentric straps are made with exceptionally large bearings. Oil holes are provided for lubrication purposes.

The crank-shaft and roller bearings are made from the highest grade material obtainable. The roller re-



No. 3 Piston Air Drill—1¼-inch Drilling Capacity

tainers are now made in one piece. Friction has been reduced by the most practical means possible—roller bearings. The strength of rollers as compared with other anti-friction bearings permits smaller diameters, which results in greater compactness and reduces the speed under which the larger bearing must operate.

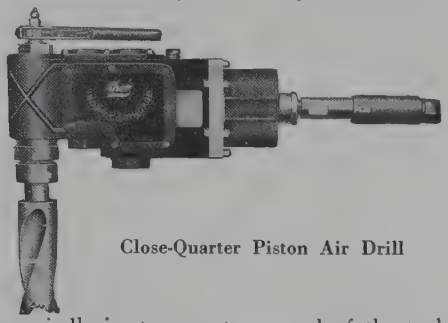
The Telescopic Feed Screw is compact and has a large range of adjustment because the inner sleeve is threaded both inside and out allowing of approximately twice the range of a simple feed screw. Drills, reamers or taps may be forced from the spindle socket by means of the ejecting pin by simply screwing down the feed screw.

The No. 2 Thor Piston Air Drill is non-reversible and equipped with the Telescopic Screw-Feed, or Grip Handle when ordered. No. 2 Morse Taper Socket is used for drills up to 29/32 inch. This machine weighs 24 pounds. Speed, 575 R.P.M.

The No. 3 Thor Piston Air Drill is non-reversible and equipped with the Telescopic Screw-Feed, or Grip Handle when ordered. No. 3 Morse Taper Socket is used for drills up to 1¼ inch. This machine weighs 40 pounds. Speed, 280 R.P.M.

"Thor" Close-Quarter Air Drill

These Close-Quarter Piston Air Drills, non-reversible, are designed for use in extremely close places where the ordinary drill cannot be operated. They are built in two sizes—No. 8, equipped with a No. 3 Morse Taper Socket, and No. 9, equipped with No. 4 Morse Taper Socket.



Close-Quarter Piston Air Drill

The spindle is at one extreme end of the tool, and the motor is at the opposite end. A poppet valve throttle controls the speed and power.

Branch Offices

The Branch Offices of the Independent Pneumatic Tool Company are located at 1463 Broadway, New York, N. Y., 1208 Farmers Bank Building, Pittsburgh, Pa.; 1103 Citizens Building, Cleveland, Ohio; 61 Fremont Street, San Francisco, Cal.; 1721 Jefferson County Bank Building, Birmingham, Ala.; 736 David Whitney Building, Detroit, Mich.; 334 St. James Street, Montreal, Quebec; 209 First Avenue, South, Seattle, Wash.; 409-411 East Third Street, Los Angeles, Cal.; 109 West Second Street, South, Salt Lake City, Utah; 1621-1639 Seventeenth Street, Denver, Col.; 1142-1144 Homer Street, Vancouver, B. C.; 32 Front Street, W., Toronto, Ontario; London; Paris; Berlin; Tokio; Yokohama.

PNEUMATIC DRILLS

Cylinder Standard	Size No.	Description	Capacity		Morse Taper Socket	Free Speed R.P.M.	Air Used per min. Cu. ft.	Length Over-all	Weight Pounds	Distance from Side to Center of Spindle
			Drill	Ream						
4 Cylinders 1½" Diam. x 1¼" Stroke	42	Non. Rev. Over-Size Spindle	1"	29/32"	No. 3	650	18	12¼"	28	2¾"
4 Cylinders 1⅝" Diam. x 1⅜" Stroke	43	Non. Rev. Over-Size Spindle	1 5/16"	1⅛"	No. 4	280	24	13¼"	42	3⅜"
2 Cylinders 1⅜" Diam. x 1⅝" Stroke	8	Non. Rev. Close Corner	1¼"	1"	No. 3	225	25	7⅞"	37	1½"

Duntley Pneumatic Tools

The New Duntley "Sleeve Valve Riveting Hammer"

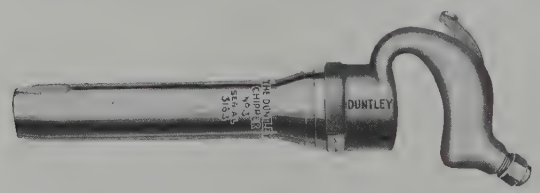
New Features

The New Duntley Riveting Hammer is the result of efforts to correct a weakness which has existed in pneumatic hammers since the present type of standard hammer secured universal adoption in 1905. This weakness has been the item of excessive upkeep cost due to exposure of frail valve construction to piston contact. The Duntley hammer protects the valve by operating the same on a sleeve giving a continuous smooth bore by which the piston has no contact whatever with the valve.

Interchangeability

The new Duntley Riveter is interchangeable in parts to standard riveters now in use and all parts are made subject to standard jigs and gauges insuring absolute accuracy and interchangeability. Stocks of spare and replacement parts are maintained at all branch offices for prompt delivery. The use of specially processed steel and an improved hardening treatment insures durability which together with the new features preventing breakage of parts, provides a hammer of long life and low up-keep cost.

Another important feature of the new Duntley Sleeve Valve lies in the fact that old, worn or broken valves of standard hammers can be reclaimed and equipped with this new improved valve construction.



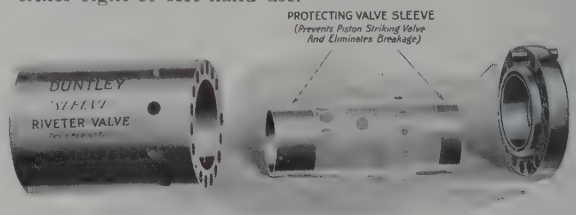
The Duntley Chipping Hammer

Cost-Saving Methods of Rivet Cutting

The Duntley Rivet Cutter is popular in ship yards. It avoids the slow, expensive work of sledge and hammer. It cuts rivets cold, avoiding damage to plates by excessive heat. It reduces cost. In punching out countersunk rivets from ship bottoms, three men with a Duntley will do the work of a dozen. In removing rivets in ship interiors, twelve to twenty rivets can be cut per minute. It is also extremely valuable in digging concrete in ships, straightening or loosening jammed or warped plates. In this general use it will save ninety per cent in labor and time.

Valve and Cylinder Breakage Up-Keep Reduced

In hammers commonly used in shipyard and structural iron work, a short piston is generally used by the workman which, by being shorter than originally intended, has a tendency to flutter or vibrate, thereby hitting the valve, causing breakage and high cost of up-keep. In the Duntley hammer either a short or standard piston can be used without danger to the valve because of the valve operating on a sleeve providing a double wearing surface and a continuous bore giving a full stroke of the piston, thereby developing greater power, prolonging the life of the valve and securing greater service from the hammer. In the Duntley hammer the cylinder has also been strengthened by eliminating the exhaust ports from the usual location which tended to weaken the cylinder at its vulnerable point. The exhaust is made direct from the valve and can be instantly adjusted to throw the exhaust in any direction, making its use convenient for either right or left hand use.



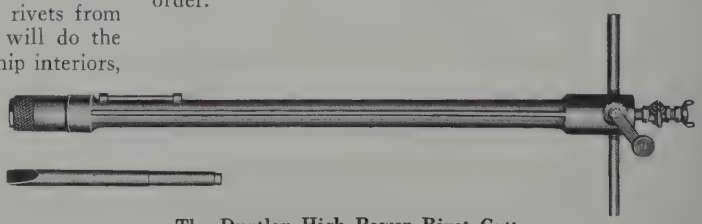
The Duntley "Sleeve Valve" for Riveting Hammer Equipment

Chipping and Caulking Efficiency

The Duntley Chipping Hammer represents both the highest achievement in hard-hitting effectiveness and an extraordinary durability under the severe conditions of usage to which tools of this character are subjected.

The simplicity of construction of this tool and its easy accessibility for inspection, cleaning and repair are added factors of efficiency, economy and durability.

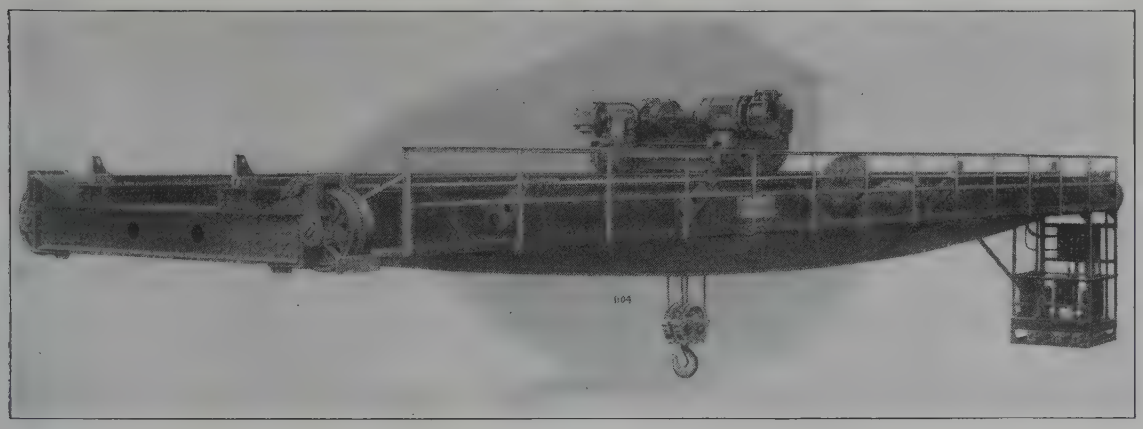
Duntley Chipping Hammers manufactured in one, two, three and four inch strokes, can be furnished with closed or open handle, with the piston type of throttle valve and round or hexagon bushing as specified in the order.



The Duntley High Power Rivet Cutter

DUNTLEY PNEUMATIC TOOL COMPANY
FISHER BUILDING, CHICAGO, ILL.

Cranes and Hoists



Type H Crane

Types

P & H Electric Overhead Traveling Cranes are built in all types: standard overhead traveling, heavy mill type, grab bucket, gantry, wall jib, pillar jib, extension cranes, transfer, and lattice girder type.

P & H Design and Construction

The design of P & H Cranes embodies the accumulated experience of thirty years of crane building, during which time P & H Cranes became established as a standard for Industry, over 6000 being in successful operation. P & H Cranes though built to meet specific dimensions and requirements are completely standardized in their component wearing parts: gears, gear cases, brackets, couplings, shafts, axles, bearings, truck wheels, sheaves, and braking equipment. Crane standardization is of the utmost importance because it lessens the hazard of even temporary disablement, wearing parts being easily and quickly replaced. The P & H Crane, from girders to motors, is fabricated entirely in the P & H Plant; we are manufacturers not assemblers. Standardized construction gives great speed in crane building since we are not dependent upon outside sources for component parts.

The following distinctive features of construction indicate the superiority of P & H Cranes:

For Accessibility—Each shaft is removable without disturbing another.

For Durability—All parts are proportioned most liberally: All gears are of steel with cut teeth: All pinions are of forged steel: Bearings are bronze bushed: Truck bearings are of the M. C. B. type: All gears except bridge gears run in enclosed oil-tight cases: Drum and running sheaves are not less than thirty times the diameter of ropes: Hoist motor and bridge travel brakes are of the heavy clamshell type.

For Safety—No gears or pinions are overhung: Guards are provided for bridge truck gears: All other gears are enclosed in cast iron cases: Substantial platform with a handrail is provided: Strictly foolproof and self-setting automatic limit switch is furnished.

Interesting bulletins on the design and construction of P & H Standard Cranes are:

Bulletin 401-B Standard P & H Cranes (for machine shop, foundry, yard, and general service) Bulletin 403 Standard P & H Mill Type Cranes (for steel mills, shipyard, and general heavy duty).

Write or wire our district offices for further information:

New York—50 Church Street.
Chicago—1241 Monadnock Block.
Philadelphia — 704 Stephen Girard Building.
Pittsburgh—47 Fidelity Building.
New Orleans—926 Whitney Central Building.
Portland, Ore.—Pittock Block.
Los Angeles—1125 Central Building.
San Francisco—821 Monadnock Building.

Monorail Hoist

P & H Monorail Hoists

The adaptations of a monorail hoist are manifold. Material of every size and weight, loose or units, ponderous or fragile, boxes, bales, bundles, and castings of varying size and bulk can be carried into the irregular areas with ease and dispatch and at a cost that would encourage the most skeptical of engineers.

Complete information on monorail hoists in our bulletins 301-B, 303, and 304.

Hyatt Roller Bearings for Cranes

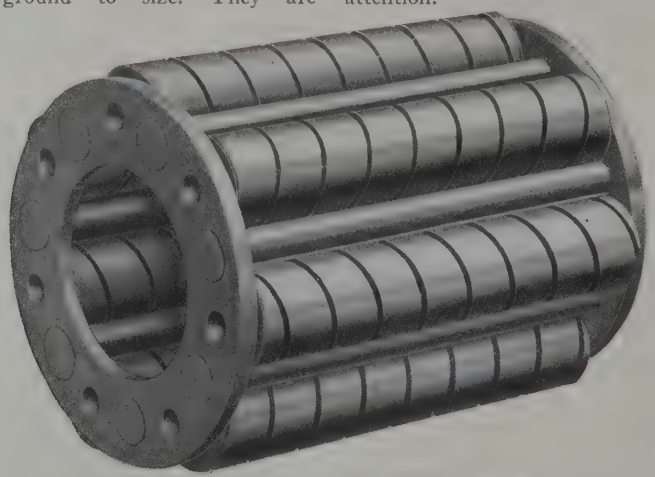
Crane Service

Cranes in ordinary every day use are subject, more than any other type of machinery, to neglect and abuse. They are frequently overloaded, and only in exceptional circumstances are they lubricated after they have once been installed. Ordinary plain bearings will not stand up under such treatment for any length of time. A plain bearing crane is bound to be out of service more or less frequently for bearing repairs, often when it is most needed to speed up the work.

The construction of Hyatt Roller Bearings enables them to stand up under this severe service. The use of these bearings insures dependable crane operation.

The Hyatt Roller Bearing

The rollers composing the Hyatt Roller Bearing are wound from a flat strip of special alloy chrome vanadium steel, heat treated and carefully ground to size. They are mounted alternately right-hand and left-hand in a rugged retaining cage, giving a substantial, compact bearing unit. The rollers operate directly on the shaft and against a steel outer race which is pressed into the housing.



Power Saving

Hyatt Roller Bearings are first of all antifriction bearings. Rolling action is substituted for the sliding friction of ordinary journal bearings. The elimination of this friction makes possible a considerable saving in power consumption.

A recent test, made on two 10 ton bridge cranes, one equipped with plain bearings and the other with Hyatt Roller Bearings, showed a Power Saving during acceleration of 22.1% and an average saving in power required at normal travel speed of 48.5% in favor of the Hyatt equipped crane.

The power saving effected by the use of Hyatt Roller Bearings makes possible a 30% reduction in the size of motor required to operate the crane, carrying with it a corresponding reduction in the size of transmission line, starting and controlling apparatus. These savings are more than sufficient to pay for the installation of Hyatt Bearings.

Ideal Lubrication

A positive self-oiling action is one of the fundamental principles of the construction of the Hyatt roller. Each of the hollow, helical rollers of the Hyatt bearing acts as its own oil container and oil distributor.

As mentioned before, the rollers are assembled in the cage alternately right hand and left hand. As the rollers revolve, the lubricant is distributed through the helical slots back and forth over the entire rolling surfaces of the bearing. This action takes place automatically, insuring positive lubrication at all times, as long as a drop of oil remains in the bearing.

Due to their inaccessible location, the lubrication of crane bearings is particularly likely to be neglected. The Hyatt Roller Bearing is therefore ideal for this service. When Hyatt bearings are properly housed there is practically no oil leakage. It is only necessary to replenish the lubricant one or twice a year. Hyatt Bearings operate with a minimum of lubrication and attention.

Long Life

Hyatt Roller Bearings in actual use on all types of cranes show no perceptible wear even after years of the hardest kind of service. The slight flexibility of the rollers, combined with the durability which is built into every Hyatt bearing, enable them to stand up under shocks, vibrations and overloads.

The large reduction in friction results in greatly reduced wear of the bearings and surrounding parts, thus eliminating play and lost motion. Experience shows that the vibration resulting from play and lost motion is the main cause of poor operation and is responsible for rapid deterioration of even the best equipment. Durable Hyatt Roller Bearings, operating for years with no appreciable wear, lengthen the life of the crane on which they are used.

Hyatt Roller Bearings will not only cut down your power, oil and maintenance costs from the moment they are installed, but will continue to do so throughout years of dependable, money-saving operation. They are an investment paying big dividends in dependable crane operation.

HYATT ROLLER BEARING COMPANY

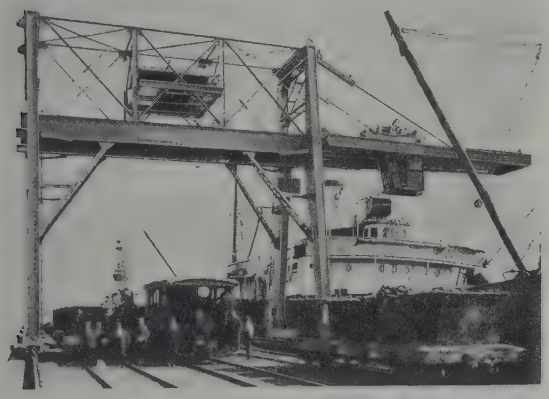
NEW YORK, N. Y.

Cleveland Cranes

Cleveland Crane Installed at Porto Rico
Capacity 180 Tons Per Hour—Span of Bridge 127 Feet—Cantilever 95 Feet

Uses and Sizes

Cleveland Cranes are built in types and sizes from 5 to 250 tons for every possible requirement of either inside or outside service.



5-Ton Bucket Handling Crane

Service

We have devoted our entire energy and equipment for over twenty-five years to the design and manufacture of cranes.

Many of the largest and most complete crane installations in this country and abroad are Cleveland Cranes.

Our plant is located near Cleveland, Ohio, on the main line of New York Central and Nickel Plate Railroads, which gives us the very best shipping facilities.

Data Required for Quoting

All inquiries for traveling cranes should give the following particulars:

1—Load: Maximum load in net tons to be lifted.

2—Speed: If special speed for any functions is preferred.

3—Electric Current available:
Whether A. C. or D. C.
If D. C. give voltage
If A. C. give voltage, phase and cycle.

4—Style: type of crane desired, and if an auxiliary hoist is desired, give capacity.

5—Clearance dimensions as follows:
Span of Crane
End Clearance
Distance from top of runway rail to floor
Overhead Clearance

Upon receipt of the above information we shall be glad to quote promptly.

Products

The products of the Cleveland Crane and Engineering Company include Electric Traveling Cranes, Gantry Traveling Cranes, Hand Power Traveling Cranes and Ore and Coal Handling Machinery.

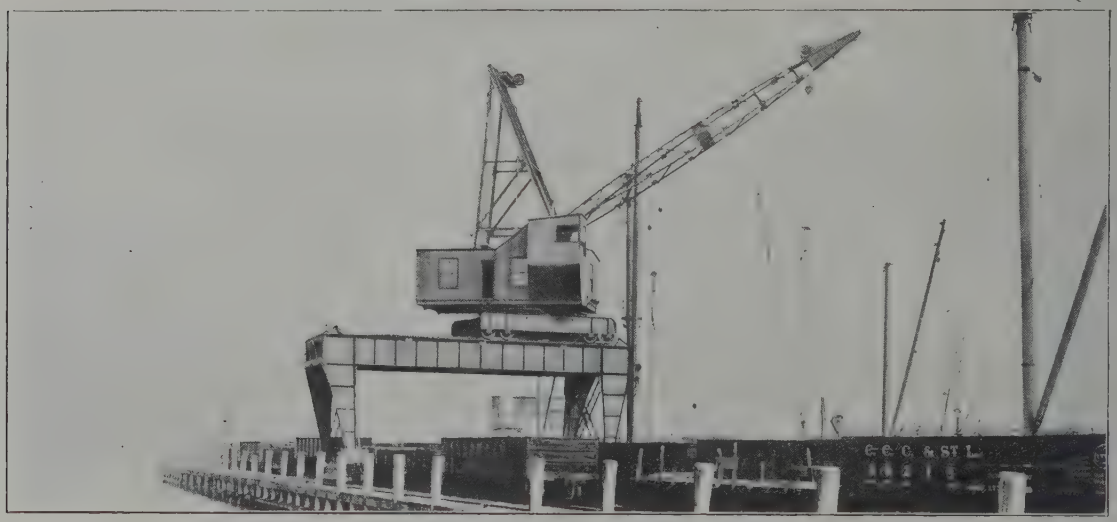
Home of Cleveland Cranes

The Branch Offices of the Cleveland Crane and Engineering Company are located at 50 Church Street, New York, N. Y., and the First National Bank Building, Pittsburgh, Pa.

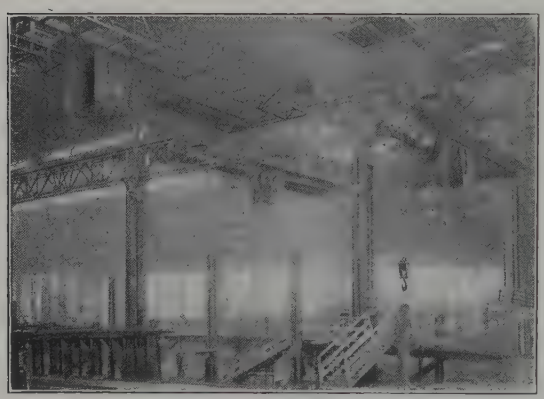
THE CLEVELAND CRANE AND ENGINEERING CO.

WICKLIFFE, OHIO

McMyler Interstate Cranes



Electrically Operated Gantry Crane



Overhead Traveling Cranes

Cranes for Every Shipyard Purpose

The McMyler Interstate Cranes illustrated show some of the types widely used throughout the shipbuilding industry.

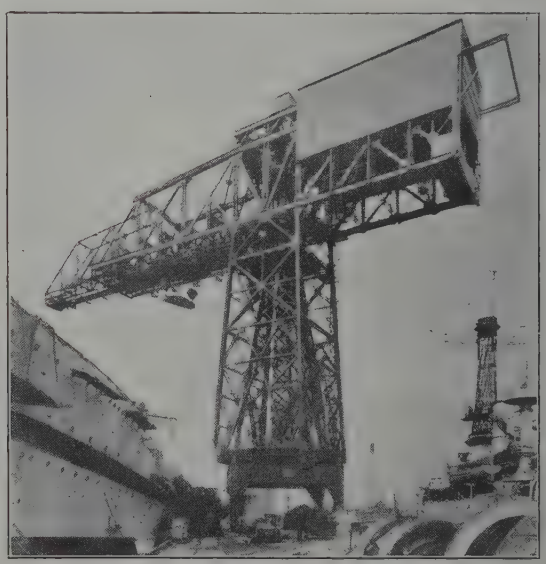
The electrically operated Gantry Crane show above spans several railroad tracks, and as the crane proper may travel from end to end of the gantry, the operation of this machine covers a very large area.

The Overhead Traveling Cranes illustrated are equipped with man trollies and are designed for use in connection with enclosed shipways.

Due to the flexibility of the Standard Locomotive Crane shown below it is particularly adapted for use in connection with the shipbuilding industry.

The 392 net tons capacity Hammerhead Shipbuilding Crane shown below, which is installed in the Phila-

Standard Locomotive Crane

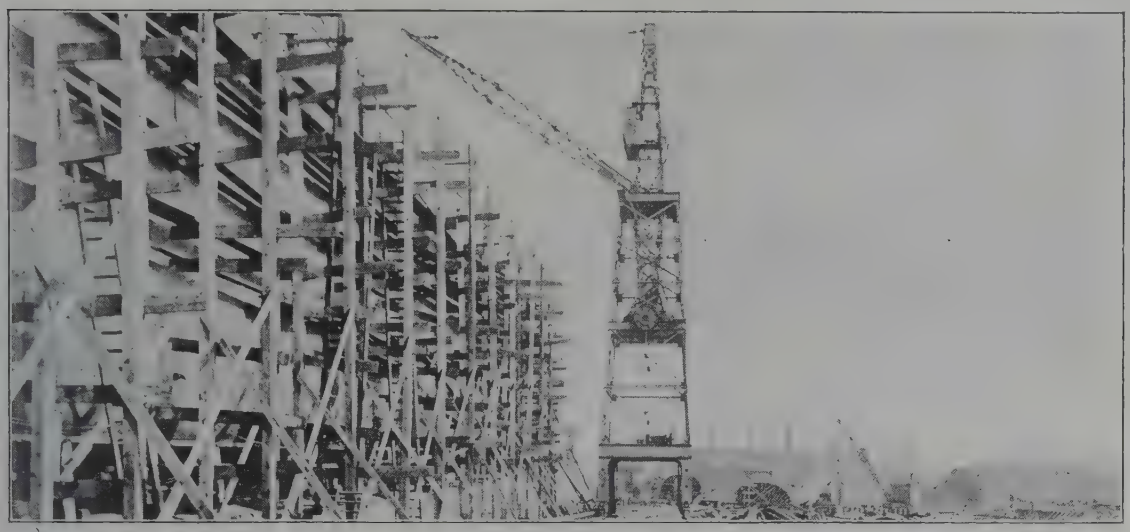


392-Ton Hammerhead Shipbuilding Crane

THE McMYLER-INTERSTATE CO.

CLEVELAND, OHIO

McMyler Interstate Cranes



Boom Jib Pintle Design Crane

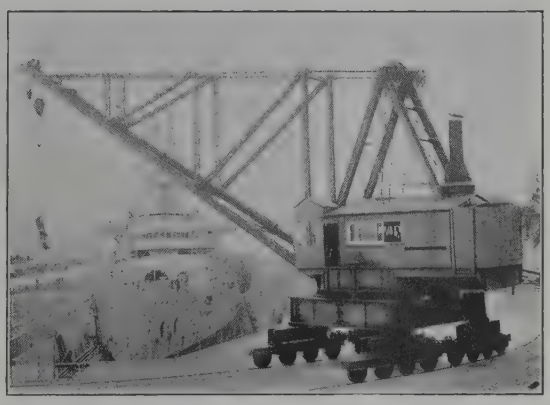
delphia Navy Yard, is considered to be the largest capacity machine ever constructed up to the present time.

The Boom Jib Pintle Design Crane shown above, is electrically operated and has the advantage of working high above the false work.

The Special Dry Dock Crane illustrated is equipped with compensating gear arrangement permitting it to travel around the sharp curve at the end of the dry dock.

The Locomotive Gantry Cranes shown below, are steam operated and are equipped with oil burners. Twenty-eight machines of this type were installed in the Hog Island Shipyard.

The motive power for operating the cranes described, is either steam or electricity. Either may be used for some types of cranes, where as in some instances it is only practical to use electricity. Electricity may be used in every case.



Special Dry Dock Crane

Locomotive Gantry Crane

THE McMYLER-INTERSTATE CO.

CLEVELAND, OHIO

Electric Traveling Cranes

Products

The Champion Electric Traveling Cranes have been designed to meet every possible requirement in the crane field, especially Shipyard Cranes of the type illustrated above, which are called upon to perform all classes of service.

Description

Simplicity, accessibility and perfect interchangeability of the parts are predominant features of Champion Cranes. Even the most severe requirements are fulfilled without any change in design. These machines are cranes of high efficiency as the parts, such as trolleys, hoisting elements, bridge, platform and cage, are carefully made of the best materials available.

Features

Champion Cranes can receive any standard crane hoist motor, or any motor brake, using either alternating or direct current.

They are provided with all steel Gears, Forged Steel Pinions, Flanged Bronze Bushings, Rolled Steel Wheels, Plate-Type Lower Blocks, M.C.B. Pattern Axle Bearings, Box Girders for long span cranes, Lattice Girders for shipyard work, as shown in the above illustration, and Safety Limit Stops of the closed circuit type.

Champion Cranes are so constructed that they are adapted to receive both grease and oil lubrication.

All the standard safety devices heretofore adopted by local or state requirements are furnished with Champion Cranes.

All Champion Cranes are wired in accordance with the National Board of Fire Underwriter's rules. All the wiring is done in rigid conduit and condulets.

Branch Offices

Following is a list of the Branch Offices of the Champion Crane and Engineering Company, where Bulletins and other information describing and illustrating the advantages of Champion Cranes can be obtained.

New York, J. W. Spensley, 149 Broadway.
Toledo, W. C. Lloyd & Co., Ohio Building.
Los Angeles, L. G. Henes, Title Insurance Bldg.
San Francisco, L. G. Henes, Monadnock Bldg.
Seattle, Hallidie Machinery Company.
Portland, Portland Machinery Company.
Philadelphia, Williams & Thomas Mchy. Co., 892 Commercial Trust Bldg.

THE CHAMPION ENGINEERING COMPANY

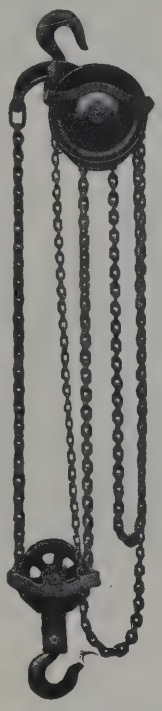
KENTON, OHIO

Ford Chain Hoists

The Ford Tribloc

Because of its rugged yet simple construction and its speed and efficiency in handling loads, the Ford Tribloc is exactly adapted for shipyard use. It lowers smoothly and rapidly; it holds the load securely.

A distinctive feature is the patented Loop Hand-Chain Guide standard equipment of Ford Triblocs. This guide is an endless malleable iron loop having fixed guiding strips adjacent to the flanges of the wheel, extending from one guide to the other and conforming to the circumference of the wheel.



The Loop Hand-Chain Guide has many advantages over the old style strap guide. It prevents injury to the block by protecting the hand wheel and preventing the hand chain from buckling in the guide, even when the hoist is operated at very high speed. It permits rapid travel of the hand chain without overriding the flange of the hand wheel.

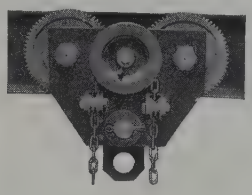
Durability is still further insured by making all working parts of steel and covering the cut gears by a dust proof pressed steel case. Hooks are of drop-forged steel. For ease of handling all hooks swivel.

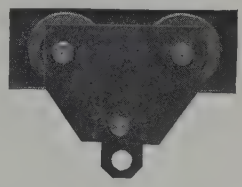
Widely Used

This chain hoist is the ultimate development of many years' experience. Its wide use, not only in shipyards, but in many other industries, demonstrates conclusively its superiority for quick and efficient service.

Ford I-Beam Trolleys

We carry in stock roller-bearing, steel plate, I-beam trolleys, in both the plain and geared types. Standard sizes are given in table below. Trolleys may be widened to suit larger than the standard I-beam without extra charge.





CAPACITIES, I-BEAM DATA, ETC., FOR FORD TROLLEYS

Capacity in Tons	Standard size of I-Beam in Inches	Diameter of Wheel in Inches		Smallest Radius for I-Beam Curve	
		Plain	Geared	Plain	Geared
¼	4	3	..	18	..
½	5	3¾	..	21	..
1	6	4¾	4¾	21	21
1½	7	5½	5½	30	30
2	8	6½	6½	36	36
3	9	7¼	7¼	42	42
4	10	8¼	8¼	48	48
5	12	10	10	54	54
6	15	10	10	60	60
8	20	12	12	60	60
10	24	13	13	60	60
12	24	13	13	60	60
15	24	18	18	96	96
20	24	18	18	120	120

*Can be altered to suit larger beams.

Screw and Differential Hoists

Where the highest speed and efficiency are not required, the Ford worm gear hoist is frequently used. Because of its lighter weight, this type is well adapted for portable use.

Simplest of all chain hoists is the Ford Differential Hoist. It is recommended for work where a hoist is used but occasionally, and high efficiency and speed are not essential.

CAPACITIES, WEIGHTS, ETC., OF FORD TRIBLOCS

Capacity in Tons	Regular Hoist in Feet*	Reach in Feet and Inches	Minimum Distance Between Hooks in Inches	Net Weight in Pounds	Chain Pull in Pounds to Lift Full Load	Feet of Chain Handled to Lift Load One Foot
½	8	9′ 3″	15	53	62	21
1	8	9′ 5″	17	80	82	31
1½	8	9′ 7½″	19½	124	110	35
2	9	11′	24	188	120	42
3	10	12′ 8″	32	200	114	69
4	10	13′ 1″	37	290	124	84
5	12	15′ 9″	45	380	110	126
6	12	15′ 10″	46	390	130	126
8	12	16′ 3″	51	470	135	168
10	12	16′ 9″	57	570	140	210
12	12	16′ 9″	57	800	130†	126†
16	12	17′ 1″	61	1000	135†	168†
20	12	18′ 5″	77	1375	140†	210†
32 40	Prices and full particulars upon request.					

*Figures denote height in feet which blocks with regular lengths of chain will hoist above level on which operator stands.
†For each hand chain.

FORD CHAIN BLOCK CO., PHILADELPHIA, PA.

Bolts, Nuts and Rivets

Pemberwick Plant

Rock Falls Plant

Port Chester Plant

A History of Pioneering

When you look at the history of the bolt and nut industry, with the revolutionary improvements in methods of manufacture that the last few decades have witnessed, you see the history of Russell, Burdsall & Ward.

For this house was the first to make cold punched steel nuts. It was the first to make cold headed bolts. It was the first to standardize and market its products under a trade-marked name—"Empire"—for the protection of its customers; a name that means an unreserved guarantee of quality, from an institution of international repute.

Where Empire Products Are Made

Out of this long career of pioneering has grown an organization occupying three huge plants, devoted exclusively to the production of bolts, nuts, rivets and washers. Among the mechanical facilities of these plants are ingenious automatic nut machines that have no duplicate anywhere in the industry. These machines cold punch, champfer, trim and burnish in one operation, where in another plant five separate machines would be required. Not only does this method make for speedier production, but for a sounder and more uniform quality of product.

Thorough Inspection

A staff of trained inspectors, under the expert guidance of a famous toolmaker, keep a close watch over the work of each department. No goods not flawlessly perfect can pass muster.

For there is a reputation of 75 years' honorable dealing bound up in the quality of Empire Bolts, Nuts and Rivets.

Better Than Their Job

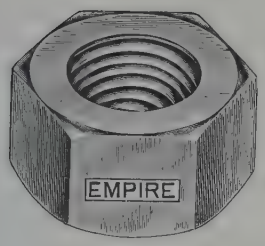
You can exact as much service as the hardest job can demand, and yet find Empire Bolts and Nuts capable of much more. The more important the work—the greater the need for accuracy and strength—the more you need Empire.

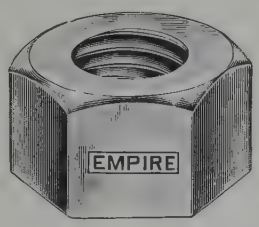
What greater assurance of quality can you ask than the knowledge that you can devise no job so difficult as to test the full capacity of Empire Bolts and Nuts?

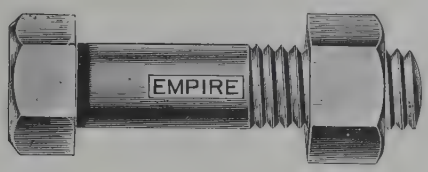
RUSSELL, BURDSALL & WARD BOLT & NUT COMPANY

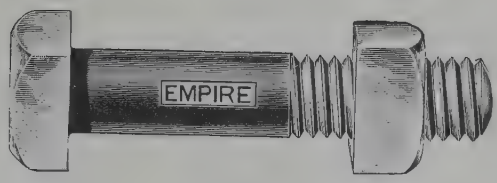
PORT CHESTER, NEW YORK

Bolts, Nuts and Rivets









The Factor of Safety

There are times when the loosening of a nut or fracturing of a bolt would involve dread consequences. The slightest toleration of risk here is unthinkable.

In such stern requirements Empire Bolts and Nuts have found the fullest expression of their quality. They can be trusted wherever there is anything for a bolt or nut to do. There is something worth while behind them—a tradition of honesty that has been an uplifting influence through seventy-five years of unbroken progress.

WEIGHTS AND DIMENSIONS OF BOLT HEADS

Diam. of Bolt	Square				Hexagon			
	Short Diam.	Long Diam.	Thick-ness	Weight per 100	Short Diam.	Long Diam.	Thick-ness	Weight per 100
Inches	Inches	Inches	Inches	Pounds	Inches	Inches	Inches	Pounds
¼	⅜	.530	5/32	.7	⅜	.433	5/32	.6
5/16	7/16	.664	15/64	1.4	7/16	.541	15/64	1.2
⅜	9/16	.795	3/8	2.5	9/16	.670	3/8	2.2
7/16	21/32	.928	21/64	4.0	21/32	.758	21/64	3.4
½	¾	1.061	9/16	5.9	¾	.866	9/16	5.1
9/16	27/32	1.193	27/64	8.4	27/32	.974	27/64	7.3
⅝	15/16	1.326	15/32	11.5	15/16	1.083	15/32	10.0
¾	1 1/16	1.591	9/16	19.9	1 1/16	1.299	9/16	17.3
⅞	1 5/16	1.856	21/32	31.1	1 5/16	1.516	21/32	27.4
1	1 1/16	2.122	¾	47.3	1 1/16	1.733	¾	42.0
1 1/16	1 15/16	2.386	27/32	67.3	1 15/16	1.944	27/32	58.3
1 1/8	1 7/16	2.652	15/16	92.3	1 7/16	2.166	15/16	80.0
1 3/16	2 1/16	2.917	1 1/32	122.8	2 1/16	2.383	1 1/32	106.5
1 1/4	2 1/4	3.182	1 1/16	159.5	2 1/4	2.599	1 1/16	138.2
1 5/16	2 7/16	3.447	1 3/32	202.7	2 7/16	2.818	1 3/32	175.7
1 3/8	2 5/8	3.712	1 5/16	253.2	2 5/8	3.032	1 5/16	219.5
1 7/16	2 15/16	3.977	1 13/32	311.5	2 15/16	3.349	1 13/32	269.8
2	3	4.243	1 1/2	378.0	3	3.464	1 1/2	327.6

WEIGHTS AND DIMENSIONS OF NUTS

HEXAGON NUTS

Diam. of Bolt	Short Diam.	Long Diam.	Thick-ness	Diameter of Rough Hole	Plain		Cupped	
					Weight per 100	Number in 100 Pounds	Weight per 100	Number in 100 Pounds
Inches	Inches	Inches	Inches	Inches	Pounds		Pounds	
¼	½	.578	¼	7/32	1.3	7800	1.2	8500
5/16	⅝	.722	5/16	11/32	2.3	4440	2.1	4790
⅜	¾	.866	⅜	13/32	4.3	2330	4.0	2510
7/16	⅞	1.011	7/16	15/32	7.0	1430	6.3	1580
½	⅞	1.011	½	17/32	7.5	1330	6.9	1440
½	1	1.155	½	17/32	9.9	1010	9.2	1090
½	1	1.155	9/16	19/32	10.8	930	10.2	980
9/16	1 1/16	1.299	9/16	⅝	13.7	730	12.5	800
9/16	1 1/16	1.299	9/16	19/32	15.9	630	15.2	660
9/16	1 1/16	1.299	¾	19/32	17.9	560	17.0	588
⅝	1 1/4	1.444	⅝	21/32	19.5	514	18.5	541
⅝	1 1/4	1.444	¾	21/32	23.0	435	21.7	460
¾	1 1/4	1.444	¾	23/32	22.2	450	20.6	485
¾	1 3/8	1.588	¾	23/32	26.6	376	25.4	394
¾	1 3/8	1.588	⅞	23/32	30.3	330	28.8	347
¾	1 1/2	1.733	¾	23/32	34.5	290	32.3	310
¾	1 1/2	1.733	⅞	23/32	40.0	250	37.6	266
⅞	1 1/2	1.733	⅞	25/32	37.7	265	35.3	283
⅞	1 1/2	1.733	1	25/32	45.9	218	43.5	230
⅞	1 5/8	1.877	⅞	25/32	45.3	221	42.6	235
⅞	1 5/8	1.877	1	25/32	50.8	197	47.6	210
1	1 3/4	2.021	1	⅞	57.5	174	53.8	186
1	1 3/4	2.021	1 1/8	⅞	63.7	157	59.5	168
1 1/8	2	2.309	1 1/4	15/16	100.0	100	90.9	110
1 1/4	2 1/4	2.599	1 3/8	1 1/16	138.9	72	126.6	79
1 3/8	2 1/2	2.888	1 1/2	1 3/16	185.2	54	169.5	59
1 1/2	2 3/4	3.176	1 5/8	1 7/16	243.9	41	222.2	45
1 5/8	3	3.464	1 3/4	1 5/16	333.3	30	303.0	33
1 3/4	3 1/4	3.754	1 7/8	1 1/2	408.2	24 1/2	370.4	27
1 7/8	3 1/2	4.043	2	1 5/8	493.8	20 1/4	459.8	21 3/4
2	3 1/2	4.043	2	1 5/8	487.8	20 1/2	454.5	22
2	3 1/2	4.043	2 1/4	1 13/16	512.8	19 1/2	487.8	20 1/2

SQUARE NUTS

Diam. of Bolt	Short Diam.	Long Diam.	Thick-ness	Diameter of Rough Hole	Plain		Cupped	
					Weight per 100	Number in 100 Pounds	Weight per 100	Number in 100 Pounds
Inches	Inches	Inches	Inches	Inches	Pounds		Pounds	
¼	½	.707	¼	7/32	1.5	6750	1.4	7200
5/16	⅝	.884	5/16	11/32	2.8	3540	2.5	4000
⅜	¾	1.061	⅜	13/32	4.8	2100	4.2	2380
7/16	⅞	1.237	7/16	15/32	7.5	1330	6.8	1460
½	⅞	1.237	½	17/32	8.9	1120	8.1	1230
½	1	1.414	½	17/32	11.9	840	10.8	930
9/16	1 1/8	1.591	9/16	½	15.4	650	14.3	700
9/16	1 1/8	1.591	9/16	19/32	17.3	575	16.1	620
9/16	1 1/4	1.768	9/16	19/32	23.0	435	21.1	475
⅝	1 1/4	1.768	⅝	21/32	27.8	360	25.0	400
⅝	1 3/8	1.945	⅝	21/32	31.7	315	29.0	345
¾	1 1/2	2.122	¾	23/32	41.0	244	37.0	270
⅞	1 1/2	2.122	⅞	25/32	46.5	215	41.7	240
⅞	1 5/8	2.298	⅞	25/32	55.6	180	48.8	205
⅞	1 3/4	2.475	⅞	25/32	61.3	163	54.6	183
1	1 3/4	2.475	1	⅞	70.9	141	64.1	156
1	2	2.828	1	⅞	95.2	105	87.0	115
1 1/8	2	2.828	1 1/8	15/16	102.0	98	94.3	106
1 1/8	2 1/4	3.182	1 1/8	15/16	135.1	74	123.5	81
1 1/4	2 1/4	3.182	1 1/4	1 1/16	156.3	64	142.9	70
1 1/4	2 1/2	3.536	1 1/4	1 1/16	192.3	52	175.4	57
1 3/8	2 3/4	3.889	1 3/8	1 5/16	250.0	40	227.3	44
1 1/2	3	4.243	1 1/2	1 5/16	307.7	32 1/2	285.7	35
1 5/8	3 1/4	4.597	1 5/8	1 7/16	454.5	22	400.0	25
1 3/4	3 1/2	4.950	1 3/4	1 9/16	555.6	18	500.0	20
1 7/8	3 3/4	5.303	1 7/8	1 11/16	666.7	15	625.0	16
2	4	5.657	2	1 13/16	816.3	12 1/4	784.3	12
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RUSSELL, BURDSALL & WARD BOLT & NUT COMPANY

PORT CHESTER, NEW YORK

Spikes and Bolts

Types of Boat Spikes

As shown in above cut, a standard boat or barge spike is made from a square bar, and has either a diamond, button or nail type of head, with a chisel point. Most shipbuilders prefer a diamond head spike, although some of the yards require one of the other types.

We are manufacturing spikes by the hot forged process, and call particular attention to the cut points. These are preferable to the pressed points in that they give a sharp cutting edge, being uniform with the body of the spike, instead of being spread as when pressed.

Advantage of Iron Spikes

Many buyers when ordering ship spikes do not specify either iron or steel, and we would call attention to the advantage of iron for spikes. They will better withstand corrosion, and the head is less apt to break off, owing to the tough and fibrous quality of wrought iron.

As an extra protection against corrosion, the spikes are frequently galvanized. There is only one method of galvanizing that is satisfactory, viz.: the hot process. This increases the weight of the spike by about 3% to 5%.

TABLE OF BOAT SPIKES

Size	Usual Lengths in inches	Extra Per 100 lbs.
¼"	3½, 4, 4½, 5, 6, 7, 8	1 00
5/16"	4, 4½, 5, 6, 7, 8	70
⅜"	4, 4½, 5, 6, 7, 8, 9, 10	30
7/16"	6, 7, 8, 9, 10	20
½"	6, 7, 8, 9, 10, 12, 14	15
⅝"	8, 9, 10, 12, 14, 16	15

Packed in 200 lb. Kegs.

TABLE OF DOCK SPIKES

Size	Usual Lengths in inches	Extra Per 100 lbs.
¾"	8, 10, 12, 14, 16, 18, 20, 22, 25, 26	Base
⅞"	10, 12, 14, 16, 18, 20, 22, 24, 26	Base
1"	20, 22, 24, 26, 28, 30	Base

Manufacturing Facilities

We are operating our own bar mill in connection with the spike and bolt plant in order to avoid delays in getting delivery of spike and bolt rods, and so are in a position to effect prompt shipments of both standard and special material.

Bolts

Our range of sizes in machine bolts is 6 inches and longer. Although many of the smaller sizes of bolts are required in the construction of steel ships, we are able to be of service in making up bolts with the various types of heads to be used in connection with the construction of wooden vessels, and also drydocks and barges. Our output also covers bolt ends, drift bolts, blank bolts, etc.

Other Products

We also offer bar iron in sizes 1/2" to 2" rounds; 5/16" to 1-1/4" squares, 1 x 1/4 to 4 x 1/2" flats.

Standard round wrought and square washers, and cast iron washers.

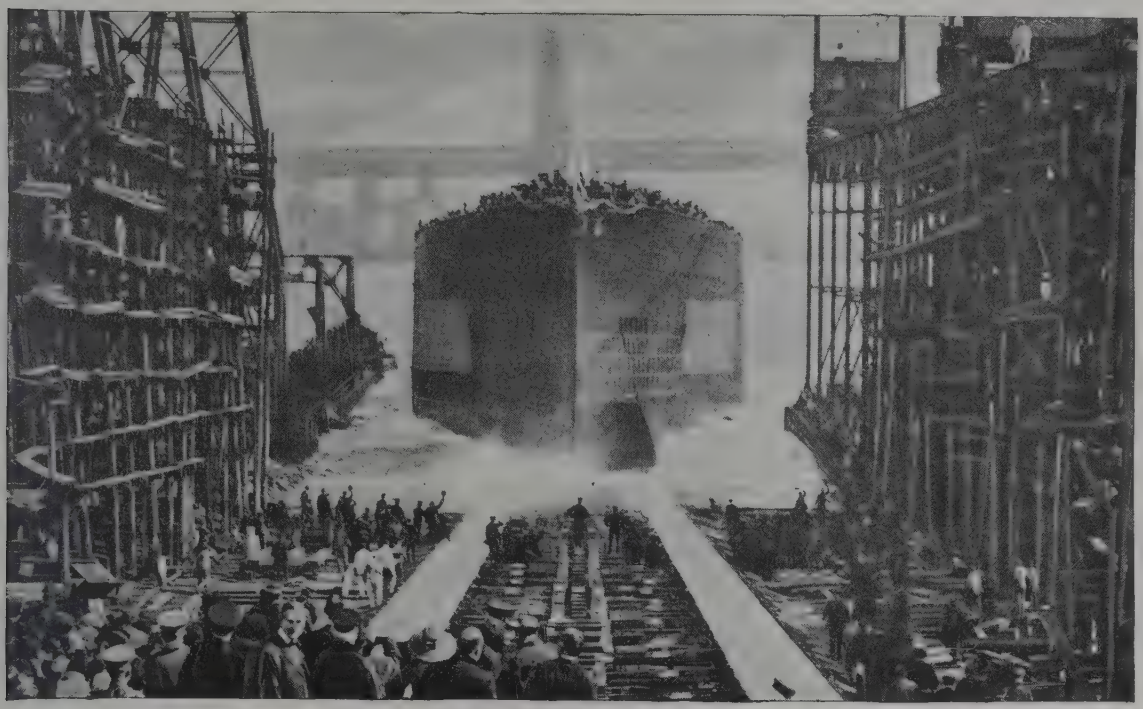
Tie rods, hot pressed nuts, track spikes, track bolts, rail joints, dock spikes and round countersunk head guard spikes.

Carried in Stock

We have in stock, at all times, a full line of spikes, both black and galvanized; bar iron, washers, rail joints, track bolts, and the more active sizes of machine bolts.

As our Factory and Warehouse are located in Jersey City, N. J., immediate delivery, by truck, can be made to the steamship lines and railroad terminals in and around New York Harbor.

Launching Grease



Launching of the U. S. S. "Tennessee"

Purpose and Specifications

In order to ease the work and to overcome the friction caused by the enormous pressure of the hull on the ways while gliding into the water, it was necessary to develop a material that possessed special characteristics required for this work. The points that must be considered are these:—

The product must withstand great pressure.

It must not be affected by atmospheric conditions.

It must be uniform at all times.

Its application must be made as easy as possible, considering the class of labor that does this work.

Results of Investigation

After many carefully detailed investigations and much experimental work, Neptune Launching Grease was developed. When found that it would more than meet the necessary requirements its introduction into the various shipyards followed with immediate success.

Characteristics

Neptune Launching Grease will withstand a pressure upwards of 5,000 pounds per square inch. It is impervious to water. Temperature changes have no effect on it, therefore its uniformity is established, aside from the fact that greatest care is exercised in its make-up. Neptune Launching Grease can be easily applied.

Application

The following practice in the preparation of the ways has been found to be the only universally successful method, despite recommendations made to the contrary. First the ways should be treated with hot Neptune Launching Stearine either by mopping or pouring it on. After cooling apply Neptune Launching Tallow heated so that it can be mopped. These products are made of most carefully selected stock.

Then follows the application of Neptune Launching Grease, just as it is, by means of a trowel, applying it about ¼" thick.

Results

By the use of these simple formulæ there is no question but that only the best results will be obtained and there will be no embarrassment of having the hull stick to the ways.

Other Products

Other high quality lubricants necessary in shipyards are Climax Pneumatic Drill Lubricant, Fiske's Pneumatic Hammer Oil, Fiske's Ferrol Economizer for Ropes, Gears and Magic Soluble Oil and Cutting Compound, etc.; also Fiske's Cutting Agents for Iron and Steel.

FISKE BROTHERS REFINING CO., 24 STATE ST., N. Y.

Marine Paints

Marine Paints for Ships and Marine Buildings

Cheesman-Elliot Co., Inc. National Marine Paints comprise paints for every part of a ship above the water line, made in all colors, on formulas of proved reliability backed by many years of experience. Many of the large steamship lines, towing and barge companies as well as the United States Navy and the United States Shipping Board, Emergency Fleet Corporation have used our paints with extremely satisfactory results. Cheesman-Elliot Company's Preservative Marine Paints are also used extensively on piers, pier sheds and other structures exposed to marine conditions.

Special Requirements of Marine Plants

Marine conditions are very severe on paint. All weather conditions are extreme, including very hot sun, intense light, high winds and salt spray. To endure, the paint must not only be moisture proof and able to withstand the action of salt water, but also very elastic to withstand expansion and contraction, and also vibration and shock caused by the winds and waves.

Some of Our Marine Specialties

The following Marine Specialties are made by Cheesman-Elliot Co., Inc., expressly for the purpose mentioned.

For Ships—Marine Paints in all colors for hulls, stacks and superstructures. Deck Paints. Washable Paints and Enamels for cabins and other interior work. Engine Enamels. Preservative Paints for holds. Barge Paints, Etc.

For Pier Sheds and Other Structures—Steel and Wood Preservative Paints in all colors. Galvanized Iron Paint for sheds.

Suspended Red Lead

The Ready Mixed Suspended Red Lead Paint manufactured by Cheesman-Elliot Co., Inc., can be furnished with any percentage of red lead up to 80%. This paint is particularly adapted for the base coating of metal surfaces exposed to marine conditions.

Experience

This corporation was founded in 1876 on the scientific principle that any one paint is not suited for all materials, climates and exposures; and to obtain best painting results, the coating should be specially made, after proper consideration of the conditions to be met. The test of time has proved the soundness of the idea which has contributed so largely to the success of this company.

Facilities and Service

Everything this company produces is specially made, thus insuring fresh stock and individual attention to each order. A large amount of raw material is constantly on hand, and shipments are guaranteed within 24 working hours after receipt of order.

Inquiries regarding any "C-E Co." product, or requests for prices, color cards, general information, technical advice or copies of our "Review of Technical Paints," "Technical Paints for Industrial Plants" should be addressed to our New York Office where they will receive prompt attention.

Information Required in Ordering

When writing to this company relative to an order try to give all the information available including:—

1. Character of surface to be painted.
2. Number of coats to be used
3. Time to be allowed for drying between coats
4. Whether painted before, and, if so, condition of old paint.
5. How is paint to be applied (brushed or sprayed).

Offices and Works

The Works of Cheesman-Elliot Co., Inc., Technical Paint Makers, are located in Brooklyn, New York, and Williamsport, Pa. The offices of the firm are at 100 William Street, New York, until May 1st, 1920, after that date at 23 Flatbush Ave., Brooklyn, N. Y.

CHEESMAN-ELLIOT CO., INC., 100 WILLIAM ST., N. Y.

Marine Paints

What a Marine Paint Should Be

A paint to qualify for efficient service in marine use must be able to withstand unusually severe conditions. The constant wearing and corrosive action of wind and water, added to the destructive effects of the salt air; the heavy mists and low temperature, often followed within a few hours by blistering heat—all these combine to test the strength and quality of the paint used.

It is without question therefore, that the painting of a ship is a very important problem. Upon the hull itself is the constant wear of the salt water, calling for resistance to chemical as well as abrasive effects; changes of temperature, requiring a high degree of elasticity and adhesiveness; barnacles and other destructive growths, which the paint, as the final outer surface, must resist. Above the waterline, the paint should hold its color in strong sunlight, and not be affected by rain or spray. It must also be of high elasticity and respond quickly to all variations of temperature. It must not flake, crack or blister, and should present a smooth, hard and permanently dry surface, capable of resisting severe wear.

25 Years in Particular Paint Making

Many years experience in the making of paints for particular purposes has enabled us to perfect and present a complete line of paint for every portion of the ship, from the tip of the mast or fighting top, to the bottom of the keel. Each requirement has been carefully studied, and the paint produced has been tested under the actual conditions for which it had been prepared. Ship Bottoms, Sides, Decks, Masts and Spars, Funnels, Ventilators, and throughout the interior as well have their proper Debevoise coatings, in a wide range of colors and of several qualities. For Shipyards, drydocks, wharfs and piers also, on iron, steel and woodwork, the Debevoise particular paint is prepared in each case for the service for which it is intended—and with years of success in that service to recommend it to you.

Debevoise Paints are known by two registered trademarks: "De-Pa-Co," under which are sold the paints for wood, canvas, concrete, piping, etc., and "Dereka," consisting of a line of metal pigment paints for both wood and iron.

Full information upon any of the paints briefly described will be gladly furnished upon request. If your requirements call for a special paint, enamel or varnish we shall be glad to prepare it for you. Our laboratory is able to co-operate toward the production of any desired pigment or vehicle for any peculiar condition.

De-Pa-Co Paints

The following De-Pa-Co Paints are prepared for marine work.

Standard Light Gray—for Topsides, U. S. Navy Specifications No. 4A.

Slate Color Boat-Topping—U. S. Navy Specifications No. 4.

Inside White—for Cabin Interiors, U. S. Navy Specifications No. 27.

Inside Enamel, Gloss White—for Finishing Cabin Interiors, U. S. Navy Specifications No. 30.

Interior Varnish—for Interior Varnished Surfaces, U. S. Navy Specification No. 52V3a.

Boat Bottom Paint—An Anti-fouling paint for Underbody, U. S. Navy Specification 52P2a.

Hard Drying Deck Paint—A quick drying, tough, durable and elastic paint for wood and canvas decks, cabin tops and all topside painting. Particularly efficient in the tropics. Made in ten colors.

Marine Flat White—"The White that Stays White." Easily scrubbed to remove all dirt. Leaves surface in smooth condition for repainting without necessity for burning and scraping. Will not blister, crack or peel.

Marine Gloss White—A very desirable high gloss paint for boats where a flat surface is not desired.

Fulton Copper Paint—For bottoms of wooden vessels. Absolutely the best preservative against barnacles, worms, grass and all marine growth. Particularly efficient in tropical waters. Made in brown, red and green.

Mill White—for Shop walls and ceilings.

Concote Primer and Concote—for concrete and brick walls.

Servicecoat Enamel—for the preservation and color identification of pipe lines. Made in twelve colors.

A complete line of paints for general use.

Dereka Paints

Dereka Metal Paints are recommended for use on all structural and sheet iron work, in shipyards, dry docks, wharves, and all places where a dielectric and rust-resisting coating for iron or steel is desired.

Only the finest materials are used. Pigments well known for their rust inhibitive qualities are carefully combined with a very high grade linseed oil, which has been specially treated to receive them.

Dereka Metal Paints have been in actual use for more than 25 years.

Prepared in Black, Red, Dark Green and Gray.

THE DEBEVOISE COMPANY, BROOKLYN, N. Y.

Bituminous Anti-Corrosive Coatings

Bituminous Anti-Corrosive Coatings-Uses

The application of a Bituminous Coating is the logical method of preventing the deterioration of ships' inner plating. It is the accepted protection for the bilges, cellular double bottoms, tank tops, machinery settings, ballast tanks, peaks, exposed decks, refrigerating spaces, chain lockers, etc., spaces which are both inaccessible to frequent inspection and constantly exposed to severe corrosion breeding conditions.

Advantages

Briggs Bituminous Coatings, unlike paint, afford many years of protective service in a single application. They are strongly adhesive, are ductile and expand and contract with the metal. They will neither chip or flake and form a permanently impervious coating.

Bituminous Coatings resist acid, alkali, smoke or chemical fumes, and are not affected by oil. The abrasive effect of ashes or other solid substance does no damage to a tough Bituminous Coating.

Different Coatings for Different Purposes

"Tenax" Bituminous Solution:—A liquid composition for use where a light protective coating will suffice. Used, also, as a priming coat for heavier protective compositions.

"Ferroid" Bituminous Enamel:—A solid composition, melted and applied hot. Specially suitable for vertical surfaces in ships' bunkers, ballast tanks, holds, etc., where corrosive influence are unusually severe.

"Tenax" Bituminous Cement:—Of a similar nature to "Ferroid" but for horizontal surfaces.

"Briggsonite" Enamel:—Likewise a substance to be melted and applied hot. This is especially prepared for coating the inside surfaces of fresh water tanks. It is to be applied over a coat of special priming oil.

It is odorless, tasteless and affords perfect protection for years.

Standard Specifications for Use

Bunkers:—The entire interior vertical surfaces, including shell plating, frames, beams, angles and bunker casing to receive one coat of Briggs' "Tenax" Bituminous Solution (applied cold); followed by one coat of Briggs' "Ferroid" Bituminous Enamel (applied hot), the floor of the bunker to be coated in like manner; the underside of deck to receive two coats Briggs' "Tenax" Bituminous Solution (applied cold).

Deep Tank:—The entire interior vertical surfaces of deep tank, including shell plating, bulkheads, frames, stringers, stiffeners, angles, etc., to receive one coat of Briggs' "Tenax" Bituminous Solution and one coat of Briggs' "Ferroid" Bituminous Enamel; tank top in deep tank to be coated in like manner; the underside of deck to receive three coats Briggs' "Tenax" Bituminous Solution.

Cellular Double Bottom:—All floors and intercostals in cellular double bottom to receive one coat Briggs' "Tenax" Bituminous Solution and one coat Briggs' "Ferroid" Bituminous Solution and one coat ship inside cellular double bottom to receive one coat Briggs' "Tenax" Bituminous Solution and one coat "Tenax" Bituminous Cement (applied hot) to a thickness of 1/4 inch.

Bilges:—The ship's shell in bilges, also the tank margin in bilges, and the bilge brackets to receive one coat Briggs' "Tenax" Bituminous Solution and one coat Briggs' "Ferroid" Bituminous Enamel.

Tank Top in Boiler Room:—To receive one coat Briggs' "Tenax" Bituminous Solution and one coat of "Tenax" Bituminous Cement (applied hot) to a thickness of not less than 1/4 inch.

Tank Top in Engine Room:—To receive one coat Briggs' "Tenax" Bituminous Solution, and one coat of "Tenax" Bituminous Cement (applied hot) to a thickness of 1/4 inch.

Steel Decks:—Exposed steel decks to receive three coats of Briggs' "Tenax" Bituminous Solution, each coat being allowed to dry thoroughly before the succeeding coat is applied.

Peak Tanks:—Entire internal surfaces of fore and after peak tanks to receive one coat of Briggs' "Tenax" Bituminous Solution and one coat of Briggs' "Ferroid" Bituminous Enamel.

Refrigerating Spaces:—All steel surfaces inside refrigerating spaces or cold chambers to receive one coat Briggs' "Tenax" Bituminous Solution and one coat Briggs' "Ferroid" Bituminous Enamel.

Deck Under Winches: Winch seats to receive one coat of Briggs' "Tenax" Bituminous Solution and one coat of "Tenax" Bituminous Cement (applied hot) to the thickness of 1/2 inch.

All surfaces must be carefully and thoroughly scraped and cleaned free of all loose scale, rust, paint, grease, or dirt, and must be perfectly dry before the application of Briggs' Bituminous Coatings.

Briggs' Bituminous Coatings must only be applied by men skilled in the application of such materials or under the direct and constant superintendence of a skilled man.

Marine Glue

Briggs "Tenax" Marine Glue is a composition of selected bitumens only. It contains no coal tar derivations, Stockholm or Archangel pitch. Despite its high quality it is low in cost.

"Tenax" Marine Glue is a very desirable material for calking the seams of decks, for waterproofing boats and for use by electricians as an insulating material.

It will neither melt in deck seams with tropical heat nor crack and become loose with wintry cold. It will not run nor stick to the feet, though exposed to high temperatures and is thus especially suitable for passenger vessels.

BRIGGS BITUMINOUS COMPOSITION CO., INC.

17 BATTERY PLACE, NEW YORK

Marine Paints for All Purposes

Why Federal Paints Are Preferred

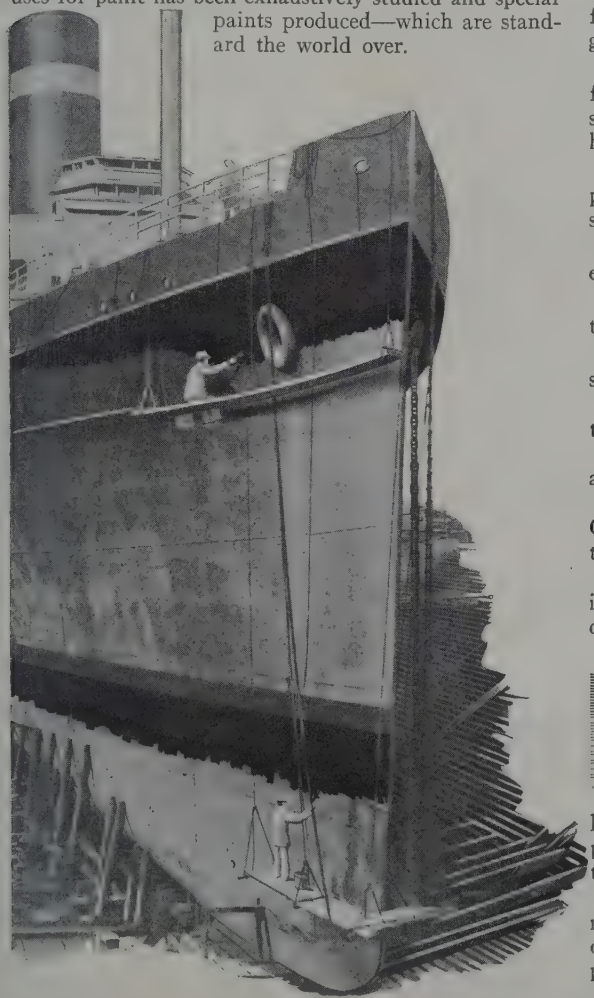
The manufacture of marine paints requires an experience widely different from that acquired in the manufacture of ordinary house paints.

The process of decay and destruction to which they are constantly subjected must be provided in a different manner than ordinary paints.

Special adaptability to meet certain conditions is an absolute requisite of paint for marine service and lengthy experimental experience is a necessity to develop a product of real value.

The Federal Composition & Paint Company has specialized on marine paints alone for many years. It commands every facility for the most searching investigation and experimental test, which fact has enabled it to make its products particularly suited to give satisfactory marine service.

Each particular requirement of the many marine uses for paint has been exhaustively studied and special paints produced—which are standard the world over.



Federal Paints for Marine Service

Anti-Corrosive Composition in brown or green, for the first or priming coat for ships' bottoms. Has all the properties necessary to prevent deterioration of the steel plating.

Anti-Fouling Composition in red, brown, green or any color desired for the second coat on ships' bottoms. As its name implies it is a strong repellant of marine growths.

Boot-topping, either a composition or oil paint for coating from light to deep load line. Gives much better service than paints not specially made for the purpose.

Copper Paint for the bottom of wooden ships. Proof against worms, will not wash or rub off and anti-fouling.

Racing Compound, a special high-grade product for the underwater surface of racing yachts. Cuts down friction to an absolute minimum, is lasting and altogether most satisfactory.

Topside Paint, white, gray, black and other colors, for the above water portions of ships' hulls and for superstructures. Weatherproof to an unusual degree, hence lasting and economical.

Hold Paints, in a complete range of colors for the painting of cargo spaces, bulkheads and like interior surfaces.

Deck Paints, in the usual colors, for service where exceptional wear resistance is an essential.

Mast Paints, specially compounded and superior for this particular duty.

Funnel Paints, in colors as desired, for long life on smokestacks, ventilators, etc.

Bunker Paints, made with abrasion resisting qualities that are not usually embodied in marine service paints.

Engine Paints, heat resisting, glossy enamels that are both of pleasing color and very serviceable.

Deck House Paints, in white, buff, and other colors. Oil paints for protection of above deck structures from the corrosive action of wind and water.

Tank Paints of special qualifications for long and unimpaired protection of the exterior or interior surfaces of tanks.

In General

Federal Paints have a world wide reputation for extreme durability. This lasting quality makes Federal products of superior economy for, instead of painting and repainting with low cost paint and high cost labor, you paint once and paint well. It saves money by eliminating much of the labor item.

The Company is prepared to make specific recommendations covering any particular painting problem or will contract to paint or to clean and renew the painting on any part of a vessel of any class.

BRANCH OFFICES

New Orleans	Key West	Havana	New London	Honolulu
Gulfport	Pensacola	Baltimore	Boston	Manila
Mobile	Jacksonville	Philadelphia	Bath	Newport News

San Francisco, Cal.—J. & R. Wilson, Inc.
San Pedro and Long Beach, Cal.—J. & R. Wilson, Inc.
Portland, Ore.—Portland Marine Supply Co.
Seattle and Alaska—W. H. Pierson & Co.

THE FEDERAL COMPOSITION & PAINT CO.

17 BATTERY PLACE, NEW YORK

Marine Paints

Colonial Marine Paints

Colonial Marine Specialties are made in a wide range of colors and for all purposes. For every marine use there is a Colonial Paint which is the result of years of laboratory and field experimentation, and which may be depended upon to meet successfully the severest service requirements. Colonial Marine Paints are tough and durable, capable of standing up in any climate and able to stand the hardest of knocks. They will not be affected by salt air or water and will last twice as long as the ordinary paint. Large factories at New York, and warehouses at Boston, Philadelphia and Chicago permit rapid deliveries to all points and assure the best service in filling requirements.

Deck Paint

Colonial Deck Paint is carefully prepared from specially selected pigments and vehicles, producing a paint which will give maximum service under the severe conditions that such a covering must necessarily meet. This paint produces a tough, elastic, rapidly drying coating, impervious to the elements, and not affected by heat, cold, rain, or salt water, and it is therefore particularly adapted for use on wood, canvas, or steel surfaces, which are subjected to severe exposure and constant wear.

Surfaces should be perfectly dry and clean before the paint is applied, and the first coat should be well brushed in.

This paint is made in the colors listed in the table.

Smokestack Paint

Colonial Funnel Paint is specially prepared to withstand the high temperatures met with on hot stacks. It bakes to an enamel-like surface which resists corrosion and is impervious to moisture and gases. This paint is furnished in the colors listed in the table.

Copper Paint for Woods Hulls

Colonial Copper Paint is the solution of the fouling problem, and has proved its superiority over many other brands by comparative tests. This product is the result of a careful analysis of the requirements for a paint of this type and the conditions under which it is used. In one case, on a log painted with four different brands, and left under water several months, the section painted with Colonial Copper Paint showed the least collection of grasses and barnacles.

This paint is composed of finely divided metallic copper mixed with a medium, usually oil and wax, and has great covering capacity. It works smoothly under the brush, giving an even finish, and is unsurpassed for durability and anti-fouling properties. It is made in the colors listed in the table.

Anti-Corrosive and Anti-Fouling Paints

Colonial Anti-Corrosive and Anti-Fouling Paints are special mixtures for use on steel ship bottoms, carrying a powerful insecticide which prevents the adhesion of barnacles, sea grass and other vegetable substances which may become attached to the hull.

Ship White

Standard Ship White is prepared to meet the demand for a highly decorative white for yachts, steamers and other craft. It is used by a number of the leading yacht associations at New York, Newport, and other points and satisfactorily meets all requirements of durability and appearance.

It is very elastic and easy to apply, and made for outside as well as inside use in either gloss or flat finish, withstanding the action of salt air and water, and capable of being cleaned and scrubbed.

Hull Paint

Colonial Hull Paint is made for both inside and outside use in the colors listed in the table. It is specially mixed for the purpose intended and forms a tough, durable, elastic covering, capable of withstanding the hardest usuage and impervious to the elements.

Other Colonial Marine Paints

Colonial Paste Paints are made in all colors and for all purposes. Colonial Engine Paints and Enamels are furnished in vermillion, carmine and dark green. Colonial Mast Paints are specially prepared to withstand the severe weather to which they will be subjected. Other Colonial Paints for marine uses include lighterage and tugboat paints for cabin and hull work, varnishes, leads, zinc, red lead, etc., for all purposes.

COLONIAL MARINE PAINTS

Marine Paint	Weight per Gallon in Pounds	Approximate Covering Surface Square Feet per Gallon
Deck Paint—		
Brown	10¼	250—300
Dust	11	" "
Gray	11	" "
Lead	11	" "
Spruce	10½	" "
Yellow	10½	" "
Drab	11	" "
Green	10¼	" "
Smokestack Paint—		
Black	9	250—300
Buff	15	" "
Aluminum	..	" "
White	14	" "
Copper Paint—		
Copper Green	11	250—300
Red	11¼	" "
Brown	12	" "
Anti-Fouling—		
Anti-Rust Brown	12	250—300
Anti-Fouling Red	12	" "
Anti-Corrosive	12¼	400
Ship White—		
Standard Yacht White	14	250—300
Hull Paint—		
White	14	250—300
Buff	15	" "
Gray	15¾	" "
Green	12	" "
Black	8½	" "
Mast Paint—		
Yellow	10¾	250—300
Brown	15	" "
Gray	15	" "
Lighterage and Tug Boat Paint—		
Maroon	11½	250—300
Green	12¾	" "
Gray	15	" "

Paint–Enamel–Caulking Pitch–Pipe Coating

Genasco

The excellence of the following marine products lies in the use of native bitumens, Trinidad Lake Asphalt, Bermudez Lake Asphalt and Gilsonite, created by nature and exposed to the elements for centuries.

Genasco products have proved their worth by years of service and are the standard by which all waterproofing materials are judged.

Trinidad Marine Paint

This paint is especially adapted for the painting of the inside of the hulls of metal vessels, water tanks, brine tanks, mine supports, etc. It is used by the United States Navy and others for such purposes.

It contains pigment (solid matter in suspension) and requires stirring before use. It is of two types. The first, known as "No. 1" contains pure turpentine as required by the United States Navy; the second, known as "No. 2" contains asphaltum spirits. A modified form of No. 2, of lighter consistency, is known as "No. 3."

It is frequently applied to metal ships as a primer and then covered with Trinidad Marine Enamel.

Covering capacity per gallon, approximately 150 square feet.

Trinidad Marine Enamel

A hard but tough asphaltic composition which is to be melted and spread with mops or brushes upon metal surfaces over a priming coat (see Trinidad Marine Paint).

It does not flake off when struck nor is it sticky in warm weather.

This enamel is used to protect the inside of hulls, bilges, etc., of steel ships, and is so employed by the United States and other navies.

Weight per cubic foot, approx. 81 pounds.

Weight per barrel, approx. 390 pounds.

Genasco Asphalt Caulking Pitch (Marine Glue)

This has been prepared to displace Pine Pitch or Coal Tar Pitch as generally used in caulking vessels as it is a superior article.

Ordinary caulking pitch is too brittle and scrapes off readily. Our Asphalt Caulking Pitch has met with great favor, owing to its lasting character, ready melting and the fact that it is not too brittle but stays where put. Caulking pitch is used for filling the seams in the hulls and decks of steamships, ferryboats, yachts, etc. Seams are first caulked with oakum, then filled with melted pitch. Shipped in barrels weighing approximately 300 pounds.

Genasco Acid Proof Paint

This is a fairly quick drying, glossy finish asphalt paint which will resist corrosion, gases, diluted acids and alkalies.

Suitable for use on metal, wood or concrete.

Approximate covering capacity of 1 gallon:

Over wood ..... 150 sq. ft.
Over metal ..... 200 sq. ft.

Genasco Boiler Paint

This material has been designed as a coating for hot metal surfaces such as boilers, stacks, steam pipes, stove pipes, stoves, etc.

Dries in about one hour with a glossy finish and covers 150 square feet per gallon.

Genasco Asphalt Pipe Coating

For coating steel water pipes. The pipe Coating should be brought to a temperature of about 400° F. in the dipping tank, whereupon the pipe is immersed and allowed to remain in the dip until the metal becomes of about the same temperature as the dip. The pipe is then lifted from the dipping tank, the excess coating drained back while the pipe is kept suspended vertically until cold.

Shipped in barrels, gross weight being about 290 pounds. Covering capacity per 100 square feet of pipe, about 16 pounds. Applying temperature 375 to 400° F.

Genasco Pipe Coating Flux is usually furnished with pipe coating to re-soften the material if it becomes too hard after standing under heat in the dipping tanks and will be especially prepared if desired.

Vulcanite Asphalt Mastic

For the decks of refrigerating rooms or wherever a waterproof condition is to be met.

This material is adapted to any surface that is subject to unusual traffic and furnishes a non-slippery, sanitary, waterproof and extremely durable flooring.

Three ingredients enter into mastic construction; mastic block, asphalt flux and mineral aggregate (of sand and gravel). Mastic is supplied in cylindrical blocks averaging in weight about 60 pounds each, consisting of calcareous dust and highly cementitious solid, but plastic, bitumen. These blocks are prepared by combining Trinidad Lake Asphalt with sufficient pulverized limestone to produce a mixture which will retain its form when cast into blocks.

Where acid conditions are to be met Vulcanite Acid proof mastic is furnished.

Genasco Ready Roofing

For shipyards on all types of buildings no better ready roofing can be obtained.

Furnished in three grades, light, medium and heavy, also smooth, slate or stone surface.

The "Genasco" line of ready roofings, in whatever type, have for their base, a better grade of felt than that usually employed in the manufacture of ready roofings, and secure their waterproofing qualities from the use of Trinidad Lake Asphalt. The experience of this Company, extending over a period of more than a third of a century, has proven the undoubted superiority of these asphalts.

Trinidad Lake Asphalt Built-Up Roof

Constructed with alternating layers of asphalt saturated felt and moppings of Trinidad Lake Roofing Asphalt.

Specifications furnished upon request.

Litosilo Decking

Litosilo Decking

Litosilo, when laid, is a continuous plastic mass, making a solid, resilient deck. Its first cost is its final cost. Litosilo is elastic—gives with the expansion and contraction of the steel foundation without cracking or losing its strength. It is a magnesite composition; its ingredients are carefully selected and tested to withstand wear and tear.

Litosilo is not an experiment. It has been used for over ten years, and has been subjected to the most severe conditions of service, climatic and otherwise, and the fact that it has met these severe tests with uniform success has made it preeminent as a deck sheathing as proved by the fact that there have been more square feet of Litosilo laid than of all other composition decking combined.

Litosilo is used in dining-rooms, smoking-rooms, lounges, statesrooms, suite bedrooms, storerooms, officers' quarters, crew's quarters, messrooms, bathrooms —in fact, on any protected deck.

Durability

Litosilo is laid to last. Years of service under varying degrees of wear and tear, and in all climates, warrant the highest claims for its remarkable durability. Traffiic, even heavy trucking, will not destroy its surface.

Litosilo is more durable than wood because it will not crack or splinter, and it is fire-proof, watertight and vermin-proof. On a large passenger ship, fire heated the steel deck and warped it out of shape. The Litosilo decking did not crack, burn or come loose, but followed every bend of the red-hot steel.

Litosilo is more durable than concrete because it will not crack, crumble or disintegrate.

An additional advantage over both wood and concrete deck sheathing, which makes for durability, is the fact that the manner of application of Litosilo prevents the steel deck plates from corroding. As an additional preventive the steel plates are first coated with Madesco Bituminous Solution.

Service

We will furnish and apply Litosilo of a specific thickness and color in accordance with your blueprints and specifications for a definite sum per square foot, subject to reasonable terms and conditions.

The coloring of Litosilo is usually red, as this is the most permanent color. However, it can be furnished in any color specified.

In some cases Litosilo is covered with an interlocking tiling as in large spaces on passenger ships, but if surfaced with Litosilo Hard Finish, as in staterooms, etc., this is unnecessary.

Our large stock of material is always ready for immediate shipment, and our skilled mechanics are always available to apply Litosilo with speed and thoroughness.

Litosilo has been shipped from Philadelphia and applied in Montreal four days after receipt of order, in Baltimore in one day, and in Boston in two days.

Time Saving

One mechanic with helpers can apply from 500 to 1000 feet of Litosilo per working day—four times as fast as wood can be put down. This is due to the fact that it requires no lengthy preliminaries nor tedious after touches.

Litosilo is laid in a continuous plastic mass on steel and wood decks with a trowel. Ten hours later in summer, and about forty-eight hours later in midwinter, joiners may screw the sills directly to the Litosilo decking. Litosilo is never laid less than 1½ inches thick on steel, nor less than 1 inch thick on wood. Experience proves that these are, respectively, the minimum practicable thicknesses.

Whether an entirely new deck is needed or only a portion, Litosilo will save time. Repairs or additions can be made rapidly. Sections of Litosilo can be cut out and new material put in without disturbing the other parts of the deck. The new part will form a perfect bond with the old.

Screwing Wood Sills to Litosilo Deck the same as to Wood Deck

Reliability of Material

The uniformly high quality of Litosilo Decking is a result of the standardization of materials determined after many years of study and experiment.

All basic materials are analyzed at the factory before being unloaded from the cars, insuring that they shall be up to the standards fixed.

Weight and Characteristics

The lightness of Litosilo is another advantage over wood and concrete deck sheathing. One square foot of Litosilo 1½ inches thick weighs only 7¾ to 8 pounds and has a tensile strength of 600 pounds per square inch, whereas a

Litosilo Decking

square foot of concrete of the same thickness weighs 20 pounds, and a square foot of wood deck sheathing 3" thick weighs 14 pounds.

CHARACTERISTICS OF WOOD AND LITOSILO	
WOOD	LITOSILO
Insanitary	Sanitary
Inflammable	Fireproof
Requires constant repair	Requires no repair
Holds vermin	Repels vermin
Corrodes steel deck plates	Preserves steel deck plates

Installation

Litosilo is being used by the Emergency Fleet Corporation and has been approved by the American Bureau of Shipping and Lloyd's. More than 200 ships now have Litosilo decking and nearly 300 more ships being built in 14 yards will be equipped with Litosilo.

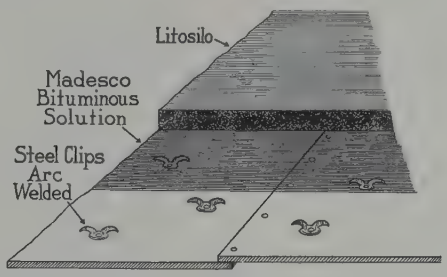
The following is a list of some of the ships that have Litosilo decking:

S. S. Siboney

Allentown	Panama
Abraham Lincoln	Colon
Light Burno	Maine
Texarkana	Fort Wayne
Sunbeam	Galahad
Chester Sun	Chas. H. Cramp
Great Northern	Santa Luisa
Northern Pacific	Santa Elisa
H. M. Flagler	Santa Leonora
Sunoil	Duquesne
Wm. Rockefeller	Homestead
Siboney	Federal
Orizaba	Tollard
Santa Ana	Worcester
Santa Lucia	Waubesa
America	El Almirante
Yaqua	El Capitan
Holden Evans	Gulf Queen
Brandywine	Pannant
Shenandoah	Joseph Cudahy
Harold Walker	Olivette
Santa Teresa	Cabegon
Bramell Point	Wonewoc

Method of Applying Litosilo on Steel Deck

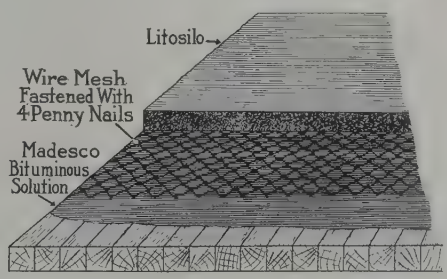
In applying Litosilo on steel decks the first operation is the arc welding of clips into the steel plates to insure a perfect bond between the Litosilo and the deck. The welding of the clips is done rapidly by our own patented process developed for this purpose. The steel plates of the deck are then painted with Madesco Bituminous Solution and the Litosilo is applied to the desired thickness and finished with a trowel. (See sketch). Where the area of the deck to be covered with Litosilo is exceptionally large, expansion joints are made every 20 feet and filled with asphalt.



Method of Applying Litosol on Steel Deck

Method of Applying on Wood Deck

The first operation in applying Litosilo on wood decks is painting the deck, if so specified. Wire mesh is then fastened to the deck by means of 4 penny nails bent over the wire. The Litosilo is then applied and finished off with a trowel as described for steel decks.



Method of Applying Litosilo on Wood Deck

Guarantee

We give the following guarantee because guarantees are customary, not for fear that you will find fault with Litosilo. No material could meet the exacting demands of marine service for fifteen years, as Litosilo has done, unless it was practically perfect.

We guarantee that Litosilo contains all of the qualities claimed for it in this catalog. We guarantee it to be fire-proof, watertight, and vermin-proof. It will neither crumble nor crack.

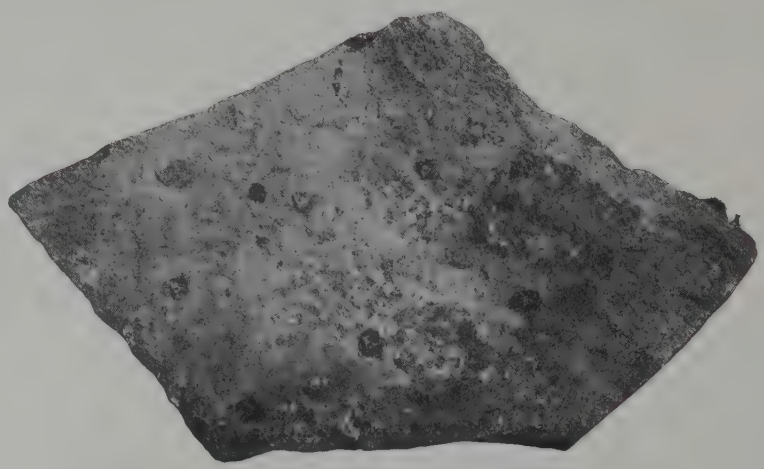
Nails and screws may be driven into it with perfect safety, and they will hold.

As the application of Litosilo is as important as its preparation, this guarantee is good only when it is applied by our own skillful mechanics.

Asbestolith Decking

Description of "Asbestolith"

"Asbestolith" is a remarkably light, warm and durable material, absolutely fireproof; impervious to heat, cold and dampness; elastic, clean and noiseless—hence thoroughly sanitary. It will not chip, pit, tear loose from its base, nor disintegrate under wear. As a material for ship's decks its superiority has been proved in the test of continuous use and demonstrated by successful applications and tested durability on the decks of United States warships. Among its first applications for deck covering was on the United States steamers "Cincinnati" and "Dolphin," wherein the excellence of this material was conclusively proved. "Asbestolith" has since been applied to the decks of more than eight hundred vessels and the company is daily making new contracts for work on vessels of the Navy and the mechant marine.



This Asbestolith Floor Was 11 Years on Deck With No Corrosion

Adaptability

"Asbestolith" is particularly adapted for use on board ships as a flooring for protected decks such as in officers' and crew's quarters, staterooms, dining rooms, storerooms, etc.

Ward Line S.S. Mexico

Colors and Weight

"Asbestolith" is made in various colors, such as red, buff, slate and black, and may be laid either with a solid color or with borders of another color, producing a pleasing effect.

The comparative light weight of "Asbestolith" (less than half the weight of marble, tiling, etc.) makes it desirable for use on vessels, where weight is a factor of importance. One-half inch "Asbestolith" flooring weighs approximately two pounds per square foot and one-inch flooring approximately four pounds.

Durability

"Asbestolith" neither rusts nor corrodes any material upon which it is laid, whether steel, iron or wood. It has been usual with other flooring compositions to treat the floor with some preventive solution to guard against rust or corrosion. But this has never been necessary with "Asbestolith," which in itself is of preservative nature. This has been thoroughly demonstrated and indubitably proved by numerous exhaustive tests, and especially by samples of "Asbestolith" flooring taken from vessels upon which it had been laid fully eleven years before. The decks underneath the "Asbestolith".

Ward Line S.S. Esperanza

flooring were found to be free from corrosion or rust, conclusive proof of the preservative qualities of "Asbestolith." The samples showed no disintegration and the life of the material was still intact.

Reliability of Ingredients

The experiments of the Asbestolith Manufacturing Company prove that for a deck covering a minimum of from 48 to 50 per cent of magnesium oxide in the floor is absolutely necessary, and the density of the liquid must be 22 degrees Baumé. "Asbestolith" is not the cheapest material, because it uses a full quantity of magnesium oxide and the proper percentage of 22 degrees Baumé magnesium

ASBESTOLITH MANUFACTURING CO.

R. C. BURNSIDE, PRESIDENT, 1 MADISON AVE., NEW YORK, N. Y.

Asbestolith Decking

chloride, while the other elements of the composition are carefully prepared and proportioned, with the result that "Asbestolith" has been applied to the decks of more than eight hundred ships with one hundred per cent of satisfaction to the owners.

Laying and Finishing

The method of laying and finishing "Asbestolith," either on the floors of buildings or the decks of ships, hermetically seals the entire surface, making it impossible for germs or dirt of any kind to obtain an entrance, and the smooth surface will not accumulate dust. It can be washed with hot or cold water or disinfectants without the slightest injury, is the easiest floor to keep clean and is the most sanitary flooring extant, as is proved by its wide adoption by hospitals everywhere. It is easily laid, while in a plastic condition, on any surface, hardening quickly and is ready for use in a few hours, and when finished it presents a fine-grained smooth surface, while it has a resiliency which makes it easy to walk on, noiselessly and comfortably, and it never becomes slippery. Its safety and its resistance to wear are important factors on board ship, and while its first cost is somewhat higher than that of the much inferior compositions offered as substitutes for it, "Asbestolith," because of its many advantages and wonderful durability, is by far the most economical material in the end.

Hawaiian-American Line S.S. Honolulan

Method of Shipment

To facilitate shipment and to insure the proper proportion of the various ingredients of "Asbestolith" the materials are mixed and shipped dry. The liquid which is prepared by a steam process to eliminate corroding properties is added to the dry materials on the job.

The processes of making the ingredients of "Asbestolith" which effectively eliminate all foreign materials that might cause disintegration, coupled with the great care used in weighing, proportioning and mixing the ingredients, insure the consistent reliability of "Asbestolith."

Fire Test

The absolute fireproof qualities of "Asbestolith" were demonstrated by a fire test made at the Testing Laboratory of Columbia University, New York, N. Y., by Professor Ira N. Woolson, M. E. The report of this test, shown below, shows that "Asbestolith" withstood a temperature of 1759° F.

Time min.	Temp. Bk. of Sample	Difference	Temp. of Fur. ° F.
0	75		797
1	75	0	806
3	82	7	929
5	96	21	1046
6			1116
10	140	65	1354
11			1386
15	166	91	1591*
16			1646
20	180	105	1749
22			1769
25	182	107	1749
30	202	127	1759

*Note: Began to warp between supports, no cracks.

Hawaiian-American Line S.S. Iowan

Present Installations

This page might be filled with a list of vessels upon which "Asbestolith" has been laid. Among them are fourteen of the New York and Cuba Mail Steamship Company, nineteen of the American Hawaiian Steamship Company, seventeen of the Standard Oil Company, nine of the Luckenbach Steamship Company, eight of the Clyde Steamship Company, six of the United Fruit Company, twelve of the Shawmut Steamship Company, and many others for the Barber Steamship Company, Southern Pacific Company, Italian Steamship Company, Hudson River Day Line, Hartford and New York Line, French, Russian, Booth, Munson, Red "D" and other lines, Emery Steamship Company, New York and Porto Rico Steamship Company, Eastern Steamship Company, Providence Coal Company, and scores of other steamships, yachts, tugs, etc. Among recent orders are many ships of the Emergency Fleet Corporation, as well as work for the Navy.

Among the shipbuilders for whom the company has applied "Asbestolith" to decks are the American Shipbuilding Company, Robbins, Staten Island, Fore River, Cramps, Empire, Harlan & Hollingsworth, Robert Jacob (City Island), Newport News, Union Dry Dock, Maryland Steel, Tietjen & Lang, Bethlehem Shipbuilding Company, New York Shipbuilding, Chester Shipbuilding, W. & A. Fletcher Company and J. W. Sullivan & Co. yards.

ASBESTOLITH MANUFACTURING CO.

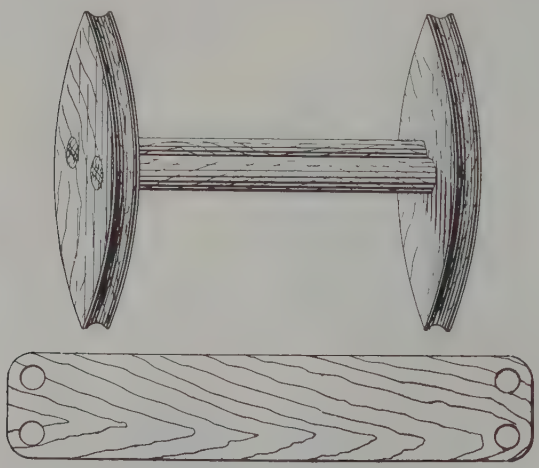
R. C. BURNSIDE, PRESIDENT, 1 MADISON AVE., NEW YORK, N. Y.

Jacobs Ladder Steps and Deck Gratings

Jacobs Ladder Steps

The Eichmann Company is prepared to furnish Steps of any type and size for Jacobs Ladders. The styles shown in the illustrations below, owing to their design and sturdy construction, have proved to be very serviceable and meet the demand for steps of comparatively small cost.

The assembly drawing below shows a typical arrangement of one type of Eichmann step.



Types of Eichmann Jacobs Ladder Steps

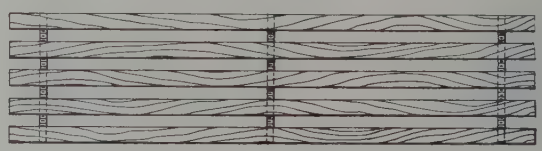
Deck Gratings

Eichmann Deck Gratings (reversible) consist of a series of parallel well-seasoned close-grained maple slats made up into sections. Each section is assembled with strong iron screw rods which cut their own threads through the slats. This method of construction keeps the mat from warping and the slats from shifting, and also prevents decay.

The sections are made 24", 30" and 36" square. The 24" and 30" sizes have three iron screw rods, and the 36" size has four rods. The slats are made in two sizes,—5/8" x 7/8" and 1 1/8" x 7/8".

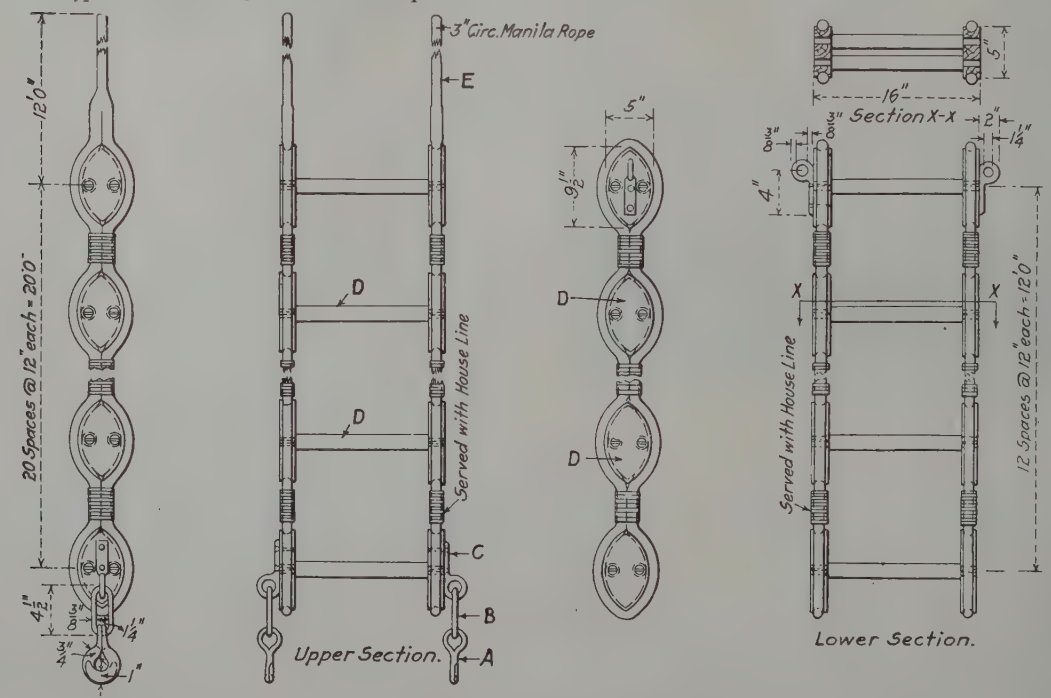
The sections are kept in stock, ready for immediate delivery. All orders should be accompanied by a diagram showing the exact space to be covered.

Eichmann Deck Gratings are especially adapted for use aboard ship in storerooms, showers, passageways, etc., and on bridges, hatches, etc.



Section of Eichmann Deck Grating

The Eichmann Company is also prepared to do all types of wood repair work on ships.



Typical Jacobs Ladder Assembly with Eichman Steps

BILL OF MATERIAL.

A—2 Sister Hooks
B—2 Lengthening Links
C— 4 Eyeplates
D—17 Eichmann Steps
E—3" Circ. Manila Rope

THE EICHMANN COMPANY

7 McKIBBEN ST., BROOKLYN, N. Y.

Spars—Booms—Lumber

Spars
Cargo Booms
Derrick Masts

The International Spar Company manufactures Spars of any diameter, and up to 140 feet or more in length; also Cargo Booms, Derrick Masks, etc. These products can be furnished either from Douglas Fir or Spruce.

Finished Spars

Spars and Booms can be furnished either octagon or finished. However, purchasers will effect a saving of 30% by ordering them finished according to detailed blueprints. The finished spars are carefully sanded and oiled, and loaded in a manner that prevents them from being damaged in transit.

Ship Lumber

The International Spar Company manufactures, in addition to spars and booms, Ship Timbers. Decking and all other types of lumber necessary for the construction of ships, furnished in Spruce or Fir.

Facilities

The International Spar Company possesses facilities which enable this concern to handle any orders, no matter how large, as it maintains the largest spar operation on the Pacific Coast.

The Main Office is located in Seattle, Washington. A Local Yard is maintained in New York City. W. H. Hahn, Grand Central Terminal, New York, N. Y., is the Eastern Sales Manager.

INTERNATIONAL SPAR COMPANY

SEATTLE

Watertight Doors

Standard Approved Units

Dee Standard Watertight Doors are manufactured and shipped as a unit complete with the necessary fittings including Hinges, Dogs, Clips, etc., ready to rivet to bulkhead plates.

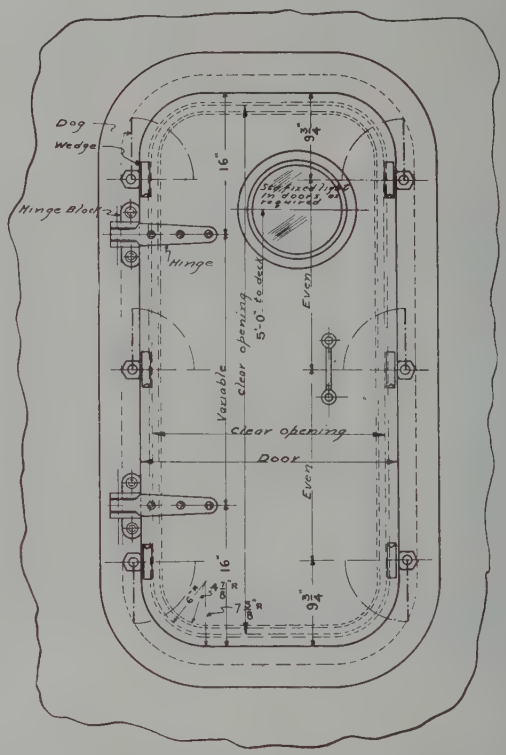
These doors have been approved by the American Bureau of Shipping and have also been approved and used by some of the leading Marine Engineers and Shipbuilders.

The weight of a complete door and frame with a clear opening of 2 feet by 5 feet is approximately 500 pounds.

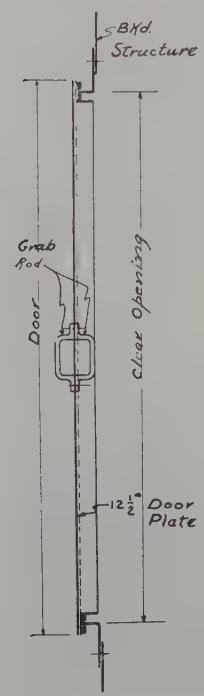
Features of Construction

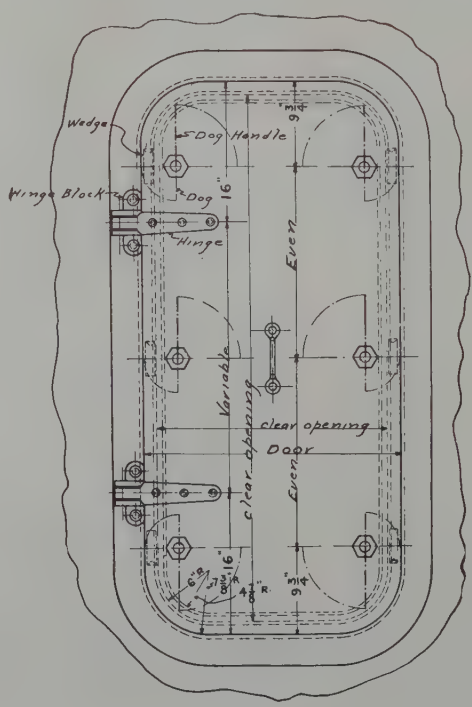
The Dee Hinged Watertight Door is of particularly strong, rigid construction, detailed in accordance with the best standard practice. It is closed by means of lever slips or dogs which, by engaging with the wedge pieces, pull the door tightly home against the bulkhead. The dogs may be mounted either on the door itself or on the bulkhead, as shown in the accompanying drawings.

A watertight joint is secured by a flat bar rubber gasket strip 1 7/8" wide and 1/4" thick fitted all around the door, and pressed by the action of the dogs against the projecting flange of the frame riveted around the doorway. When the dog is square to the edge of the door this rubber gasket is compressed 1/16", forming a securely watertight connection between the door and the bulkhead. The rubber strip is continuous all around the door and is fixed on both edges by double strips of iron secured by brass screws. By this means it is effectively prevented from sticking to the part of the frame against which it is pressed and tearing when the door is opened.



Type of Door with Dog mounted on Bulkhead Frame. (End view similar to type shown below.)





Type of Door with Dog Mounted on Door

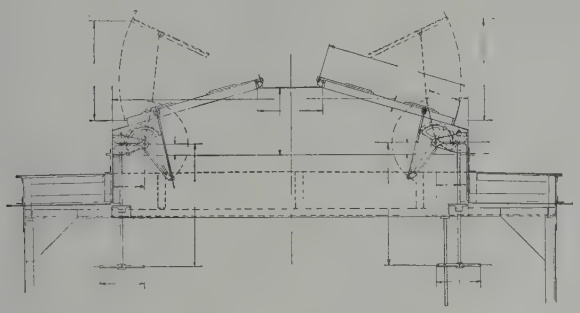
The door itself is amply stiffened, and the six dogs which serve to hold it tightly against the bulkhead are sturdy and sufficient in size and number to withstand any pressure which may be brought against them in service. The dogs are also made particularly massive in order to stand up under the rough usage to which they will very likely be subjected.

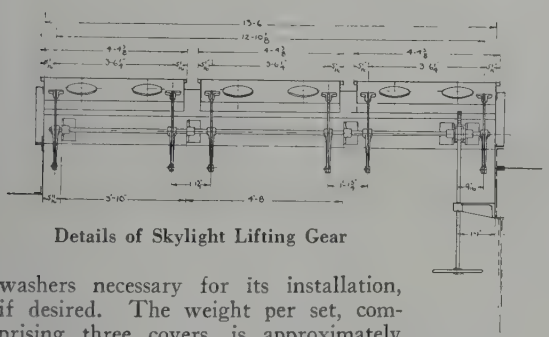
The hinges have oval pin holes so that the dogs may move the door laterally against the bulkhead and compress the rubber. They are securely riveted to door and bulkhead. The grab rods are conveniently located and of large stock firmly secured to the door. A standard fixed light may be placed in the door as shown on the drawing below, and may be located where desired.

Skylight Lifting Gear

Skylight Lifting Gear

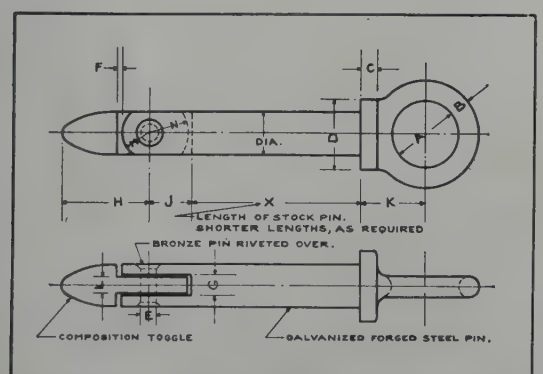
Dee Standard Skylight Lifting Gear is designed to meet the severe conditions to which it may be subjected. The shafts and rods are of cold rolled steel, and the hinge pads and levers are of malleable iron. Bracket bearings and guides of heavy cast iron are furnished with all bolts, nuts and washers necessary for its installation, if desired. The weight per set, comprising three covers, is approximately 450 pounds for a 13 foot length of horizontal shaft.





Details of Skylight Lifting Gear

TABLE OF DIMENSIONS—STANDARD TOGGLE PINS



DIA	A	B	C	D	E	F	G	H	J	K	L	M	N	X
½"	3/4	1/4	3/16	13/16	3/16	1/16	7/32	1	1/2	3/4	3/16	6/16	7/16	3
5/8"	3/4	1/4	3/16	1	3/16	1/16	9/32	1 1/2	5/8	3/4	1/4	3/8	9/16	3
¾"	3/4	1/4	3/16	1 3/16	3/16	1/16	9/32	1 1/2	11/16	3/4	1/4	7/16	5/8	3
7/8"	3/4	1/4	1/4	1 3/8	1/4	1/16	5/32	1 3/4	13/16	15/16	1/4	1/2	3/4	3

Toggle Pins

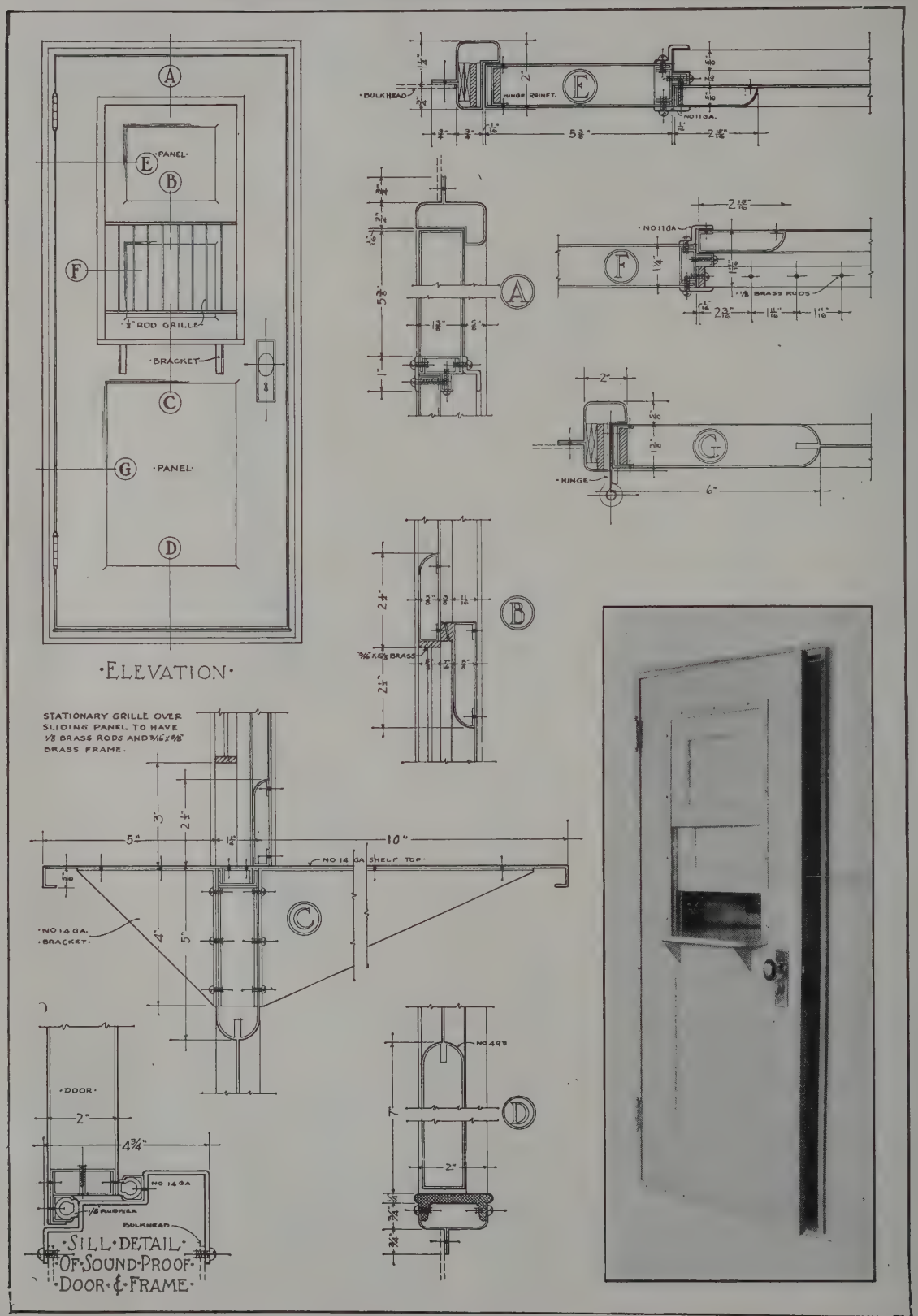
Dee Standard Drop Forged Toggle Pins as detailed in the preceding column can be supplied promptly in all sizes as listed. These pins are also carried in stock in size ¾" diameter by 3" long (x dimension) with galvanized drop forged steel toggle end.

Standard Galley Skylight Lifting Device

Galley Skylight Lifting Device

The Dee Standard Galley Skylight Device illustrated above is provided with threaded rods having a double pitch acme thread with 4 threads to the inch, turned from 1¼" solid cold rolled steel. The travelers or lifting blocks are made from hard bronze castings accurately cut to fit the rods, and all parts completely assembled make a device operating quickly and easily, and especially adapted to single skylight covers. This device can also be supplied with a 12" hand wheel in place of the crank handle. The weight complete is 50 pounds.

Dahlstrom Metallic Doors



DAHLSTROM METALLIC DOOR COMPANY

71 BLACKSTONE AVE., JAMESTOWN, N. Y.

Hatches, Bunks and Metal Work

Adaptability

We furnished all the Hollow-Metal doors, Watertight doors and Manholes for the interior of the 100 "Eagle" boats ordered by the Government from the Ford Motor Co., also rifle and pistol racks, tables, windscoops, rain-tight vent covers and magazine flood-tight gear boxes.

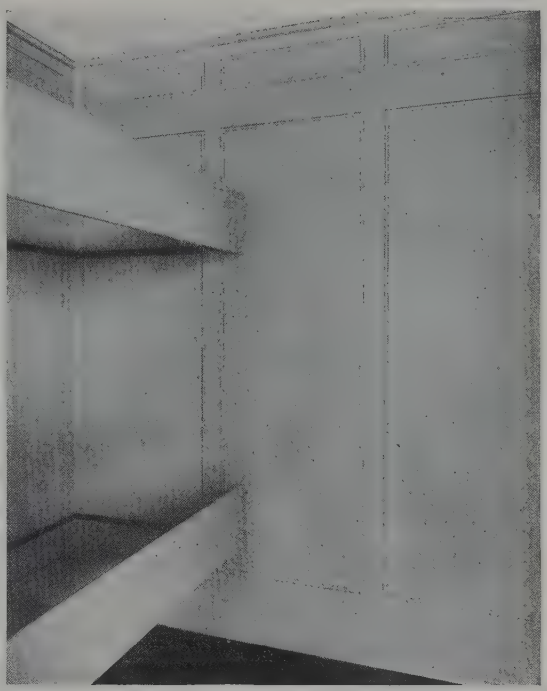
Our Engineers developed and adapted our Hollow Metal Construction to the need of the Naval Service. Our Doors as well as our specialties are to be found on the Nation's Battleship's, Cruisers, Destroyers, etc. Dahlstrom is a name that is well known to the Bethlehem Shipbuilding Corporation, the New York Ship Building Corporation, the Newport News Shipbuilding Corporation, Cramp & Sons Ship & Engine Building Company, and other well known ship builders.

We made the original installation in Battleships of Hollow-Metal doors and partition work, and have continued to do the great majority of this class of work since that time.

Products

The products of the Dahlstrom Metallic Door Company now comprise a line which is recognized as standard for this type of equipment. Following is an itemized list of these products:

- Joiner Doors
  - Watertight
  - Non-Watertight
  - Dutch to pantries
  - Screen
    - double
    - single
  - Sliding Panels
  - Sound-Proof, radio room



- Hatches — Frame and cover proper
- Man Hole Covers
  - Watertight
  - Oil tight
- State Room Work
  - Partition walls
  - Bunks
  - Rifle and Pistol Lockers
- Metal Specialties
  - Cocoa Matting End Strips
  - Mouldings, strips, tubes, special shapes

Manufacturing Facilities

We pioneered the Hollow Metal Doors, trim and cold drawn metal specialty field. Since our organization in 1904, we have constantly striven to better our products, and to meet the changing requirements of the trade. As a result, Dahlstrom Hollow Metal Doors are accepted as Standard in all modern steel fighting ships.

Our Engineering Department will submit designs for special equipment.

The machinery and equipment of our plant is of the most modern design, and much of it is especially designed and made at our factory.

Offices and Factories

The executive offices and factories of the Dahlstrom Metallic Door Company are located in Jamestown, New York. The address of the New York office is 130 East 15th Street, and the address of the Chicago office is 19 La Salle Street. In addition to these, branch offices are maintained in all the principal cities.

DAHLSTROM METALLIC DOOR COMPANY

71 BLACKSTONE AVE., JAMESTOWN, N. Y.

Steward Deadrise Metallic Lifeboat (Nesting Type)
Patented October 23rd, 1917

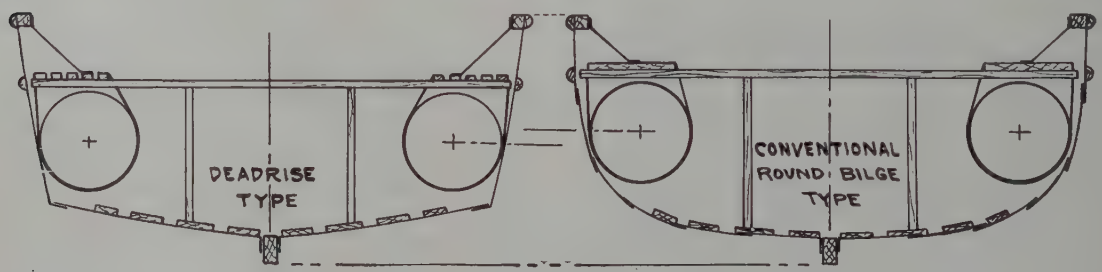
Steward Deadrise Metallic Lifeboat

The dimensions of the Steward Deadrise Metallic Lifeboat (Nesting Type) are as follows: Length 26′-0″, Beam 9′-0″, Depth 3′-3″. The cubic capacity is 540 cubic feet. The sides are non-collapsible.

U. S. Steamboat Inspection Service rating—Class 1-A (50 persons).

This boat has about 70% less rivets and seams than the conventional round bilge boat. Thus the probability of leakage is reduced by 70%. The plates are wrapped on and not hammered on as they are on round bilge boats. Twelve plates make up a boat of our dead-rise type as against 48 plates in a round bilge boat of the same size.

The cross-sections shown, compare our Deadrise type with the ordinary round bilge type of the same beam and depth. The air tanks and thwarts are considerably lower and the number of skin plates is less in the Deadrise Boat. The Deadrise Boat has a lower center of gravity and consequently greater stability than the round bilge type. The Deadrise Type also offers greater protection and comfort for the occupants, and is easier to beach than the round bilge type.



DIMENSIONS, CAPACITIES AND WEIGHTS OF LIFEBOATS.

Length	Breadth	Depth	Cubic Capacity	Persons at 10 cu. ft. min.	Weight of Boat and Outfit	Weight of Boat Fully Loaded
28	9′ 4″	4′ 1½″	680	60	4,100 lbs.	12,500 lbs.
28	8′ 4″	3′ 9″	560	50	3,500 lbs.	10,500 lbs.
26	7′ 9″	3′ 4½″	430	40	2,900 lbs.	8,500 lbs.
26	9′ 0″	3′ 3″	540	50	3,100 lbs.	10,100 lbs.
24	7′ 9″	3′ 4½″	390	37	2,600 lbs.	7,800 lbs.
22	6′ 9″	2′ 11″	270	25	2,000 lbs.	5,500 lbs.
20	6′ 0″	2′ 8½″	210	19	1,500 lbs.	4,200 lbs.

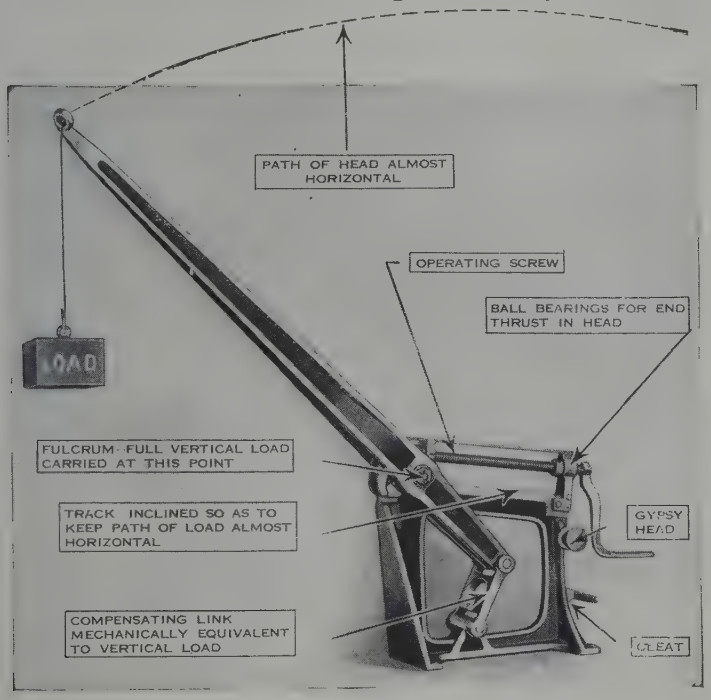
The 26′ boat is designed to nest one on top of the other. This boat may also be used stowed singly with advantage as it has a large carrying capacity.

STEWARD DAVIT & EQUIPMENT CORPORATION

17 BATTERY PLACE, NEW YORK CITY

Steward Mechanical Davits

The fulcrum of the Steward Davit is located intermediate of the boom ends. A correct balancing of the load is thus secured. This relieves the screw of tension and greater efficiency


PATH OF HEAD ALMOST HORIZONTAL
OPERATING SCREW
BALL BEARINGS FOR END THRUST IN HEAD
LOAD
FULCRUM FULL VERTICAL LOAD CARRIED AT THIS POINT
TRACK INCLINED SO AS TO KEEP PATH OF LOAD ALMOST HORIZONTAL
GYPSY HEAD
COMPENSATING LINK MECHANICALLY EQUIVALENT TO VERTICAL LOAD
CLEAT

Steward Mechanical Davit

is possible than in any davit which has its fulcrum at the end of the booms. The inclined track, on which the fulcrum moves, and the ball thrust bearings, insure ease of operation.

Davit—Size 4-S. Outreach from davit frame 5′ 6″. Working load per pair 8,585 lbs. Factory test load per pair 17,170 lbs., to which every pair is tested. Height from base to top of boom 12′ 3″. This davit is suitable for lifeboats up to and including 26′ 0″ x 7′ 9″ x 3′ 4″, weighing loaded 8,585 lbs.

Davit—Size 2-S. Outreach from davit frame 6′ 10″. Working load per pair 13,524 lbs. Factory test load per pair 26,850 lbs., to which every davit is tested. Height from base to top of boom 14′ 8″. This davit is suitable for lifeboats above 26′ up to and including 30′ 0″ x 9′ 0″ x 4′ 0″, weighing loaded 13,425 lbs.

The above davits will cover all usual conditions and are kept on hand for immediate delivery. We also have davits for nested boats, banked boats and boats stowed inboard of others. Also davits with special outreach, special height and special side overhang. We require a sketch of section through the ship's gunwale in order to specify davits for special conditions.

Our Factory at Hudson, New York, consists of new, up-to-date buildings equipped with the latest and most efficient machinery for the manufacture of our products, including machine shops, forge shops, hot galvanizing plant, etc., and a testing shop where every davit is tested to double its working load.

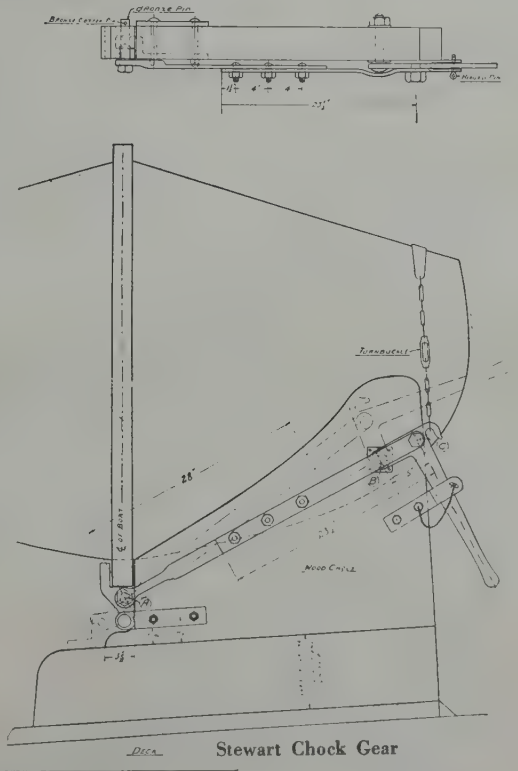
Steward Chock Gear

No outboard chocks are used in the Steward system of lifeboat stowage, as illustrated in the diagram below. The keel is carried on the hinge block. The raising of the lever lowers the hinge block about six inches, taking up slack and leaving the boat suspended on the falls ready for swinging outboard, and at the same time releases the gripes.

This chock gear can be used with advantage on all types of davits, and is absolutely necessary where the old type round bar revolving davit is used. Otherwise the boat has to be lifted from the chocks by the falls which requires a considerable number of men who are usually not available in an emergency. With Steward davits and chocks, a lifeboat can be handled and swung outboard by two to four men, depending upon the size of the boat.

With Steward Chocks and Davits the time required to release gripes and chocks and swing the boat to outboard position is from fifteen to thirty seconds; a trained crew can, of course, get the boat out quicker than an unskilled crew.

Steward Chock Gear may be applied to old chocks with comparatively few alterations. It is positive and simple and adds efficiency to all types of davits.



Stewart Chock Gear

STEWARD DAVIT & EQUIPMENT CORPORATION
17 BATTERY PLACE, NEW YORK CITY

Life Saving Devices and Equipment

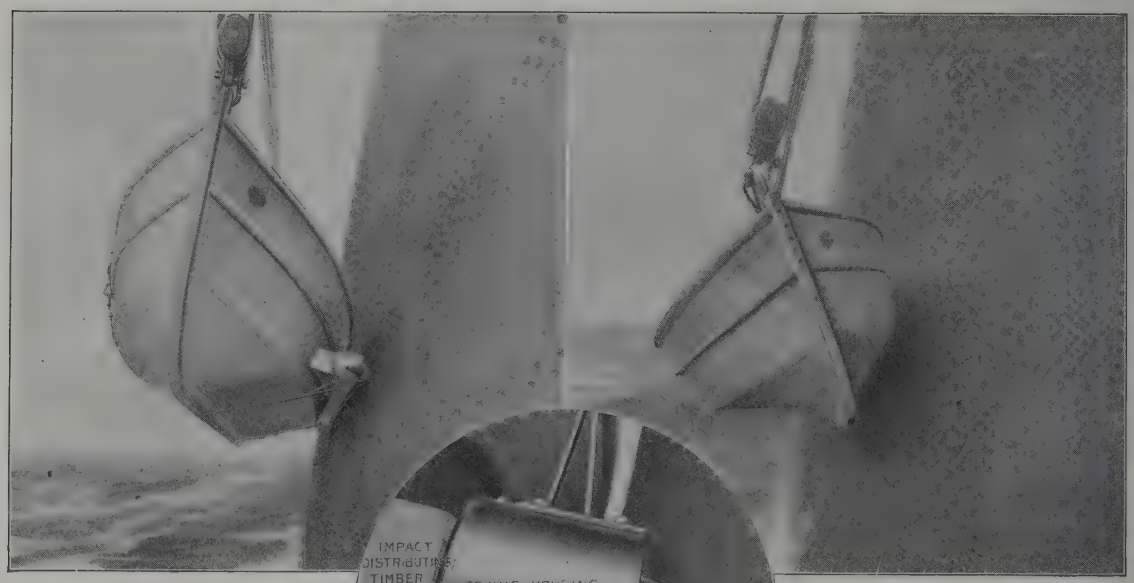
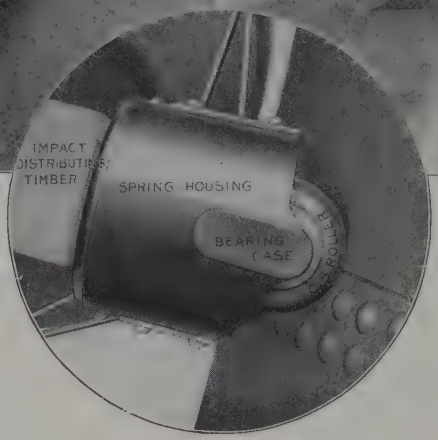


Illustration Showing a Lifeboat Being Launched Equipped With the Steward Lifeboat Roller Carriage



Steward Boat Roller Carriage

Illustration Showing a Lifeboat Being Launched Without the Steward Lifeboat Roller Carriage

Steward Lifeboat Roller

A Steward Lifeboat Roller Carriage enables the boat to roll down the side of ship even if the ship is listed, and also eliminates the possibility of capsizing. This device also protects the boat from damage caused by being thrown against the side of a rolling ship. When launched without this device, the lifeboat is frequently subjected to damage from scraping against the seams and rivets of the ship.

Steward Boat Releasing Gear

The Steward Boat Releasing Gear has been approved by the United States Steamboat Inspection Service.

This Gear is strong, simple and well designed. It is built to resist abuse and neglect, and it will not rust. The whole Gear has a positive control and can be unhooked by hand, if necessary, while the falls can be hooked on by one man.

Strength tests show 59,600 pounds ultimate for each hook, making a total of 119,200 pounds or 59 tons for both ends.

The use of the Steward Releasing Gear guarantees:

1. Simultaneous Release under full load.
2. Simultaneous Release partially waterborne.
3. Simultaneous Release under no load.
4. Unhooking by hand by one man.
5. No resistance to towing strain.
6. No cast metal taking the load.
7. No safety pins required.
8. Premature release impossible.

Gear Engaged

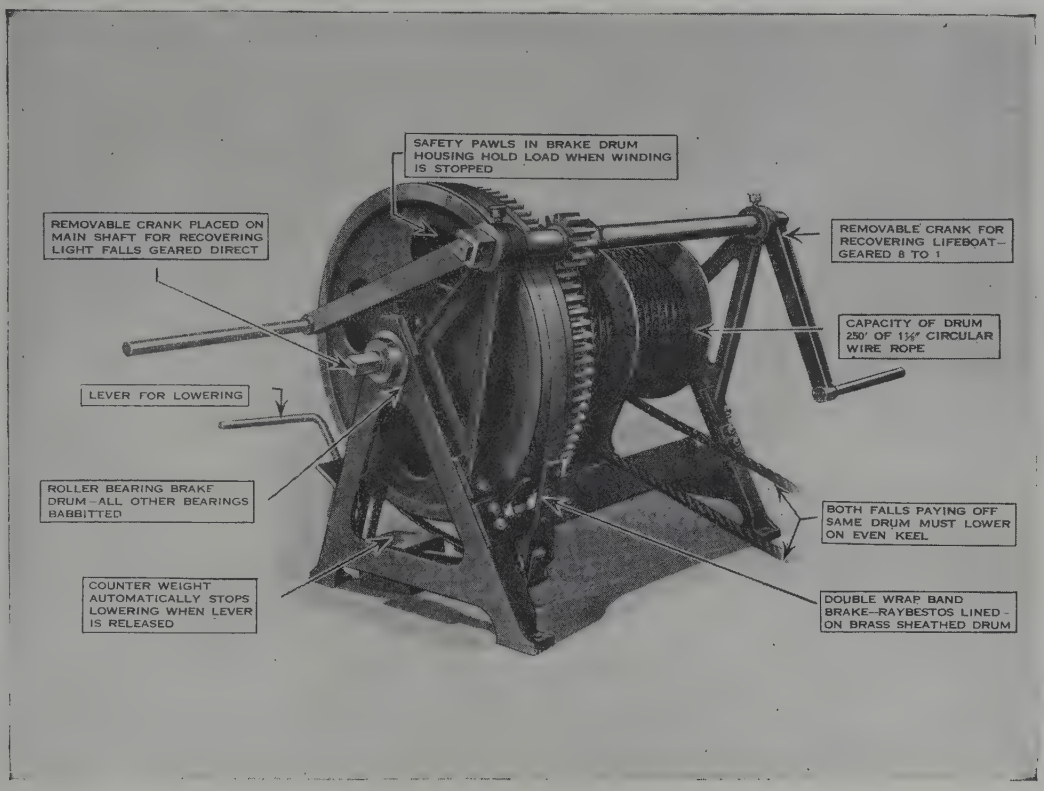
Gear Released

Steward Boat Releasing Gear

STEWARD DAVIT & EQUIPMENT CORPORATION

17 BATTERY PLACE, NEW YORK CITY

Life Saving Devices and Equipment


SAFETY PAWLS IN BRAKE DRUM HOUSING HOLD LOAD WHEN WINDING IS STOPPED
REMOVABLE CRANK PLACED ON MAIN SHAFT FOR RECOVERING LIGHT FALLS GEARED DIRECT
REMOVABLE CRANK FOR RECOVERING LIFEBOAT—GEARED 8 TO 1
CAPACITY OF DRUM 250' OF 1¼" CIRCULAR WIRE ROPE
LEVER FOR LOWERING
ROLLER BEARING BRAKE DRUM—ALL OTHER BEARINGS BABBITTED
BOTH FALLS PAYING OFF SAME DRUM MUST LOWER ON EVEN KEEL
COUNTER WEIGHT AUTOMATICALLY STOPS LOWERING WHEN LEVER IS RELEASED
DOUBLE WRAP BAND BRAKE—RAYBESTOS LINED ON BRASS SHEATHED DRUM

Steward Lifeboat Falls Controller

Steward Lifeboat Falls Controller

With the Steward Lifeboat Falls Controller, one man controls the lowering of a lifeboat with the greatest ease. The boat can be lowered on an even keel only. If the operator stops lowering, the counter-weight automatically applies the brake and stops the boat until the lever is again raised. The use of this device necessitates but one-third of the men required for the recovery of the boat by hand falls.

For the rapid recovery of light falls, the crank handles are connected direct to the running shaft. The construction throughout is rust and neglect proof. The base is 3′ 6″ x 2′ 9″ and the height is 3′ 5″.

As a labor and life-saving device, it is invaluable. Allows the use of wire rope avoiding the cost of frequent renewals of Manila rope.

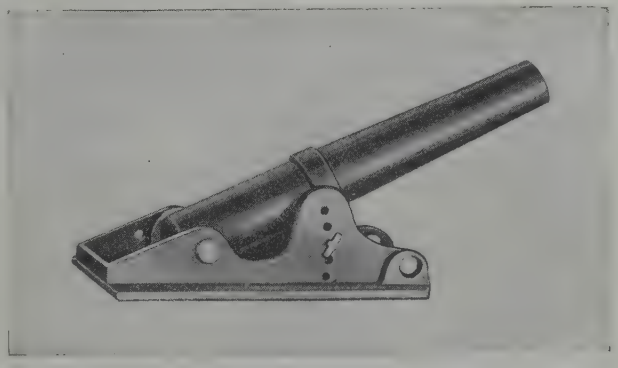
Steward Line Throwing Guns

Steward Line Throwing Guns and outfits are manufactured in our plant and are tested there in the presence of, and passed by, the United States Steamboat Inspection Service Inspector.

The recoil in the Steward Gun acts through the carriage at a point considerably lower than in ordinary guns. This eliminates the tendency to tip.

By actual demonstration our Gun, when fired without lashing and backed against the deck house or hatch coaming, remains on the deck. On the other hand the conventional type of gun, when fired without lashing will turn several somersaults and turn over.

Practically all the prominent shipping companies and ship-builders, including the United States Shipping Board Emergency Fleet Corporation and the United States Shipping Board Emergency Fleet Corporation Division of Operations, are using our Gun.



Steward Line Throwing Gun
Base 12″ x 26″ Barrel 32″ long Bore 2½″

Offices and Factory

The Main Office of the Steward Davit and Equipment Corporation is located at 17 Battery Place, New York, N. Y. The Factory is at Hudson, New York. The following Branch Offices are maintained: Colman Building, Seattle, Wash., and Sherwood Building, San Francisco, Cal.

Lundin Lifeboats—Welin Davits—Balsa Insulation

Welin Davits and Lundin Lifeboats on board U. S. S. Susquehanna

Welin Quadrant Davits

Over ten thousand sets of Welin Quadrant Davits are now in use in all parts of the world. Repeat orders from the leading ship owners and builders testify to the complete satisfaction they have given.

Specifications

The frame and davit arms are made of the best cast steel. The actuating screw is made of Tobin bronze. After assembling, all davits are carefully inspected and tested by a representative from American Bureau of Shipping or Lloyd's Register of Shipping by swinging a load, equal to double the maximum service load, on each arm from fully inboard to fully outboard position.

Computations

The weight of the boat, the equipment, and the persons allowed must be added together and the total be within the test load of a single davit. Welin Quadrant Davits when computed in this way will meet the approval of the U. S. Steamboat Inspection Service, the American Bureau of Shipping and British Lloyd's Register of Shipping.

The outreach of a davit is measured with the arm in the outboard position. With the vessel upright it is the distance between the center line of the boat and the outboard foot of the davit frame. Care should be taken that the outreach is great enough to allow of clearing the ship's side and all obstructions by not less than 6″ when the ship is in the upright position.

Size.	Outreach.	Test Load Per Single Davit, Pounds.	Approximate Weight per Set, Pounds.
G	5′ 7″	4,500	1,120
D	6′ 0″	8,500	2,050
D	7′ 0″	8,500	2,650
B	7′ 0″	13,000	5,200
H	7′ 0″	16,500	5,750
K	7′ 0″	27,000	15,000

The above are standard sizes. Special sizes built when required.

We also manufacture A. B. C. Life Rafts made of Balsa and approved by the U. S. Steamboat Inspection Service.

Lundin Decked Lifeboats

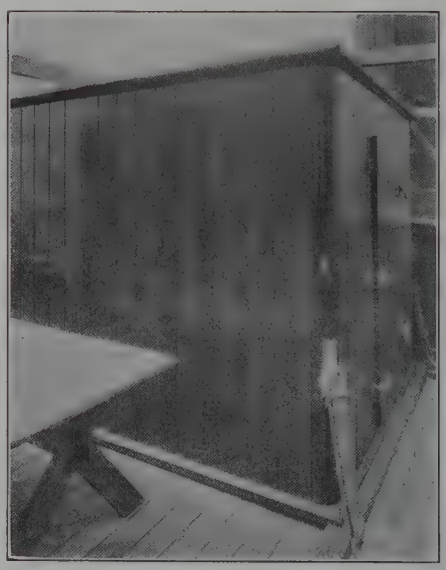
The Lundin Decked Lifeboat is superior to all other lifeboats because of its seaworthiness, strength, stability, buoyancy and protection for passengers. This statement has been proved repeatedly in most severe Government tests and in actual disasters at sea. The Board of Supervising Inspectors have given the highest possible classification to this type of lifeboat.

"The Lundin Decked Lifeboat shall be accepted as equivalent to Class 1-A lifeboats and shall be rated and accepted as lifeboats under davits and may be placed in nests of two under a single pair of davits."—Extract from General Rules and Regulations of the Board of Supervising Inspectors.

When two Lundin boats are nested they occupy approximately the same height as one ordinary boat. Furthermore, there is a greater capacity in persons for deck space utilized than with any other type of lifeboat.

DIMENSIONS AND CAPACITIES

Length Overall.	Beam Overall.	Depth With Sides Folded.	Capacity, In Cu. Ft.	Capacity, In Persons.	Approximate Weight of Boat Only.	Approximate Weight of Boat Fully Loaded.
Lundin Lifeboats: Decked Type.						
30′	10′ 0″	3′ 4″	765	76	5,500	16,500
28′	9′ 4″	3′ 1″	607	60	4,600	13,300
26′	8′ 8″	3′ 0″	507	50	4,000	11,300
24′	8′ 0″	2′ 9″	403	40	3,400	9,350
Lundin Lifeboats: Semi-decked Type.						
20′	7′ 0″	2′ 5″	252	25	2,500	6,300
20′	6′ 0″	2′ 4″	207	20	2,000	5,700
14′	6′ 0″	2′ 0″	120	12	1,150	2,900



Balsa Provision Box on Board S. S. "Narvik"

Balsa Insulation

Balsa is eminently suitable for ships' insulation, owing to exceptional insulation efficiency, structural strength, simplicity of installation, lasting qualities and saving in weight. The first installation with this material was made in 1910 and during ten years of continued satisfactory service, no repairs have been necessary. Balsa is being installed in the cold storage rooms of the first fourteen passenger liners of the U. S. Shipping Board.

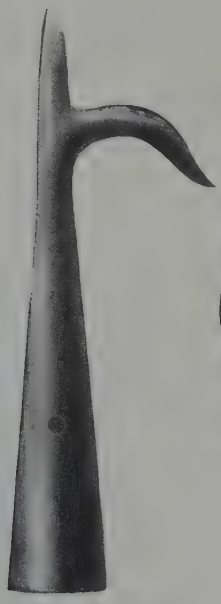
AMERICAN BALSA COMPANY, INC.

50 EAST 42nd ST., NEW YORK, N. Y.

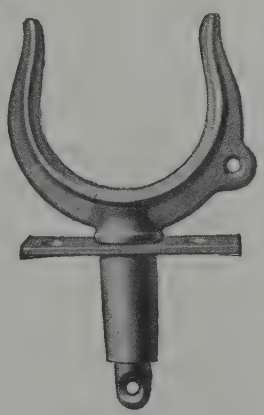
Marine Hardware and Castings

Marine Hardware

We manufacture completely in our own plant Galvanized Boat Hardware of all types, including Rowlocks, Boat Hooks, Cleats, Folding Anchors, etc. A large stock is kept on hand assuring prompt shipment of all orders. Write for catalog and prices.



Sharp Point Boat Hook



Socket Row Lock

Clinch Rings

We make Malleable Iron Clinch Rings with Straight or Countersunk Hole, either self colored or hot galvanized. All sizes are kept in stock. Prices will be furnished on request.

Malleable Iron Clinch Rings

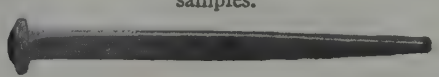
Straight Hole — Counter Sunk Hole

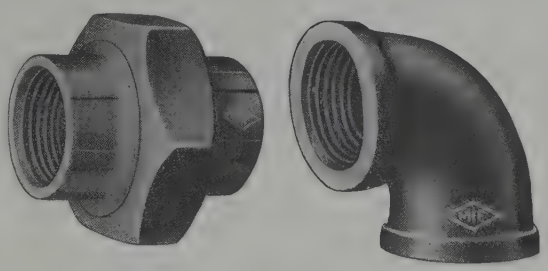
Hot Galvanizing

We make a specialty of Job Galvanizing of Ship's Fittings. Years of experience and the best of facilities enable us to offer prompt, satisfactory service.

Nails

We specialize in Hot Galvanized Cut and Wire Nails and carry in stock all kinds used by the boat builder. Send for special catalog, with price and samples.





Malleable Iron Pipe Fittings

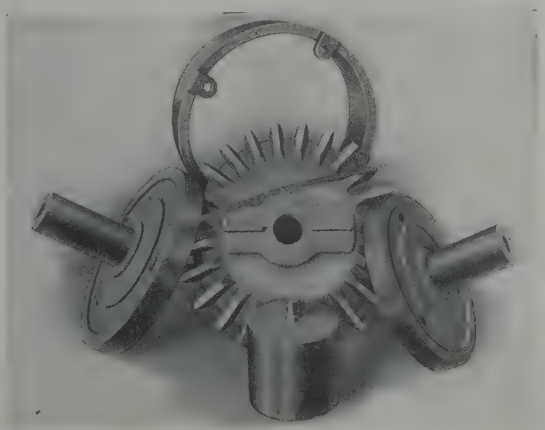
Pipe Fittings

Our principal item of manufacture is Malleable Iron Pipe Fittings for gas, steam, water and railings. Leading jobbers of plumbers' and steam-fitters' supplies carry our Malleable Iron Fitting line.

Castings

Castings

We have large foundries specializing in the manufacture of Malleable Iron, Semi-Steel, and Low Carbon Steel Castings to order from customers' patterns or drawings. Any necessary machining can also be done in our plant. We make and machine such castings as Anchors, Chocks, Cleats, Steering Quadrants, Propellers, Flange Pipe Fittings, etc. Send us your drawings for estimates, or patterns for sample castings, and prices.



Castings

MALLEABLE IRON FITTINGS CO.

BRANFORD, CONN.

"American" Rope and Oakum

Foreword

American Manufacturing Company is the largest manufacturer in the world of Manila Rope, Oil Well Cordage, Transmission Rope, Commercial Twines and "American" No. 1 Ships' Oakum.

The Company's principal mill is ideally located in Brooklyn, N. Y. City, along the waterfront, and in close proximity to all important rail and water carriers. This splendid location greatly facilitates the shipment of merchandise. The daily production of the Brooklyn mill alone amounts to about 400,000 pounds.

The Western Branch of this Company is the St. Louis Cordage Mills, St. Louis, Mo.; and other mills are located in Philadelphia, Pa., Charleston, S. C., and Victory Mills, N. Y.

Sales offices are maintained at: Boston, Mass., Chicago, Ill.; Pittsburgh, Pa.; New Orleans, La.; Galveston, Texas; St. Louis, Mo., and Philadelphia, Pa.

"American" Manila Rope

"American" Brand Manila Rope is made from high grade, carefully selected Manila Hemp Fibre of the best quality by men long skilled in the art of rope making.

The yarns are evenly and carefully spun on slow speed machinery and particular attention is given to the forming and laying process so that in the finished rope there is equal tension on each and every strand.

The result is that "American" Brand Manila Rope is superior in strength and durability and consequently has won an enviable reputation among the big and careful buyers of Manila rope. The parting of a rope may produce disastrous results and it is for that reason that we recommend a standard rope like "American" when quality—and quality in Manila rope is strength—is desired.

Manufacturing Facilities

The various mills of this Company are all equipped with machinery of the most modern design; the workers are carefully trained in the various branches of the business in which they specialize and the utmost precaution is taken to select only the best grades of fibre for use in the manufacture of "American" Cordage. The result is that "American" Products are well, and favorably, known the world over because of their superior quality.

Manila Hemp

Manila Fibre is grown solely in the Philippine Archipeligo, and is obtained from the Abaca or Lanut, a species of the wild Banana plant. The best textures are obtained from the usual growth of this plant, which is about 14 months. The fibre is first extracted entirely by hand. It is then separated and allowed to dry, after which it is assorted into different grades and packed for export.

Quality in rope depends on the grade of fibre used and on the care given to the process of manufacture. As there are 33 grades of Manila Fibre used, it is necessary to specify a standard brand of pure quality like "American." This name stands for unsurpassed service and dependability.

"AMERICAN" BRAND MANILA ROPE.

Approximate Weight and Tensile Strength
3 strand—Coils 200 Fms.—1200 Feet

Circ. ins.	Diameter Inches	Approximate Feet Per Pound Feet	1200 Foot Coil Approximate Weight Lbs.	Approximate Strain Borne by New Manila Rope—Lbs.
¾	¼	50′	26†	620
1	5/16	31′ 7″	36†	1000
1⅛	5/16	24′	50†	1600
1¼	7/16	18′ 6″	60†	2100
1½	½	12′ 7″	90	2400
1¾	9/16	9′ 7″	125	3300
2	5/8	7′ 6″	160	4000
2¼	¾	6′	200	4700
2½	13/16	5′ 1″	234	5600
2¾	⅞	4′ 6″	270	6500
3	1	3′ 8″	325	7500
3¼	1 1/16	3′ 2″	375	8900
3½	1 1/8	2′ 9″	432	10500
3¾	1¼	2′ 4″	505	12500
4	1 5/16	2′ 1″	576	14000
4¼	1 3/8	1′ 10″	650	15400
4½	1½	1′ 8″	720	17000
4¾	1 9/16	1′ 6″	810	18400
5	1 5/8	1′ 4″	900	20000
5½	1¾	1′ 1″	1080	25000
6	2	11″	1296	30000
6½	2⅛	9½″	1515	33000
7	2¼	8″	1765	37000
7½	2⅜	7″	2015	43000
8	2⅝	6¼″	2304	50000
8½	2⅞	5½″	2580	*56000
9	3	5″	2910	62000
9½	3⅛	4½″	3250	68000
10	3¼	4″	3600	75000
10½	——	3½″	3975	82000

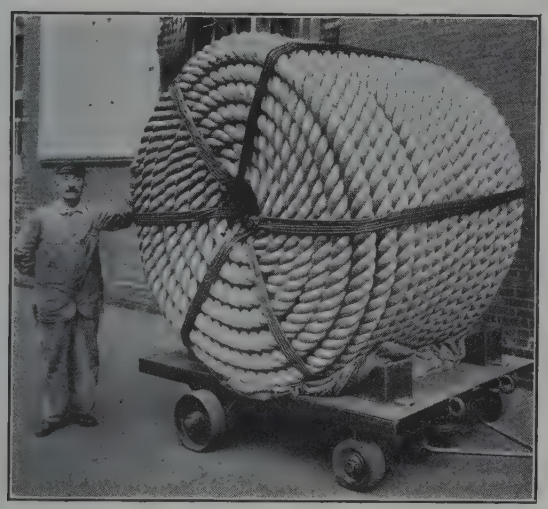
*Above 50,000 lbs. the strengths designated in table are calculated as actual tests have not been made. 4 strand weighs about ⅛ more than 3 strand. †Stock coils made to weight.

"American" Rope and Oakum

"American" Bolt Rope

"American" Bolt Rope is made of fine yarn spun from Manila Hemp of the highest quality, almost white in color. This rope is very soft and pliable and of high lustre. It is largely used in marine work and in sail making. A big quantity of "American" Bolt Rope is used on the tow boats in New York Harbor, as, working in and out of slips the rope must be extra strong and easy to handle. It is not possible to make any better Rope. Bolt Rope is usually specified, soft laid, although we can make it hard laid if required.

All sizes, 3 and 4 strand in coils and half coils.



"American" Towing Line
240 Fathom Coil of 11 Inches in Circumference

"American" Marine Rope

Buoy Lines: For anchoring buoys.

Cable-Fisherman's: Used for anchoring vessels off fishing banks. A soft hawser laid 9 strand, manila rope, Tarred or untarred. Generally supplied tarred to withstand action of sea water. Sizes most used are 7" and 9" circ.

Canal Lines: Used as Canal Tow Lines. Sizes principally used are, 5/8" and 3/4" diameter—3 and 4 strand. If 4 strand, without core.

Block and Fall Rope: For hoisting purposes. Used on derricks, pile drivers and drop hammers. Plain and graphite hard laid—4 strand with or without heart.

Launching Lines: 8" to 15" circumference—3 strand. "American" Manila Rope and "American" Bolt Rope.

Wrecking Lines: Strength and durability are the all important features of a wrecking line. "American" Wrecking Lines are made to give long and efficient service. They have a world wide reputation for quality. Made any length in any size up to 20" circumference.

Wheel Rope: A six-strand bolt rope used in steering gears. Made with graphited center if desired.

Sail Rope: Extra soft laid bolt rope used in sail making.

Steamship Lines: Hawsers and Warps—For warping vessels into piers and for mooring. Made from highest grade Manila Hemp. Made in all sizes, 3 or 4 strand.

Cargo Nets: For loading and unloading merchandise, used as a sling. Made only of "American" Brand Manila Rope.

Towing Hawsers: For sea towing and harbor use. Made from the highest grade Manila Hemp. All sizes 3 and 4 strand.

"Amco" Brand Coir Rope: Is made from the fibrous covering of the cocanut. Coir Rope is regularly made 3 strand but we can make 4 strand Coir Rope in sizes above 5/8" diameter if required.

Tarred Marine Cordage

Marlines: Made 2 yarn or 3 yarn. Put up in 5 or 10 lb. coils, 1, 5 and 10 lb. balls, packed in bales weighing 150, 250 and 500 lb. each.

Ratlines: Made in sizes 9 thread to 27 thread. Put up in 50 and 100 lb. coils.

Houselines: Made 2 or 3 yarn. Put up 5 or 10 lb. coils, 1, 5 and 10 lb. balls packed in bales weighing 150, 250 and 500 lbs. each.

Rounding and Hambroline: Made usually in 3/16 inch size. Put up in 50 lb. coils.

Seizing: Made 6 thread and 6 thread fine. Put up in 50 lb. coils.

Spun Yarn: Made 2 or 3 yarn. Put up in 5 or 10 lb. coils, 1, 5, and 10 lb. balls packed in bales weighing 150, 250 and 500 lbs. each.

All of these are manufactured in three qualities:

"Amco" Brand, our first grade, is used extensively in lieu of cordage made from Russian Hemp. It has given universal satisfaction. "Clipper" Brand, our second grade, is well and favorably known because of its high quality. India, our third grade, is specified wherever a good serviceable article is required at a moderate price.

"American" No. 1 Best Marine Oakum

"American" No. 1 Best Marine Oakum is manufactured from long clean hemp fibre, and is thoroughly and carefully impregnated with a high quality of pine tar. We guarantee this oakum to be made in accordance with National Bureau of Standards specifications. "American" No. 1 Best Marine Oakum has been supplied to the leading boat and ship building companies in large quantities for caulking decks, sides and bottoms of vessels and for other marine use. Packed either spun or unspun in standard 50 lb. Oakum bales.

"American" No. 1 Best Marine Oakum

Prices and further data concerning any of the items of our manufacture will be gladly furnished, upon request.

Manila Rope

Walk-Laid Rope

"Walk-Laid" is our method of making rope. It is the oldest method, and it is generally admitted to be the best means of producing a rope which is perfect so far as possible. "Walk-Laid Rope" can be made in any size and of any construction, either three, four or six strand, or nine strand (Hawser Laid).

Our "Walks" are the longest in the world, accommodating 1500 foot lengths of rope in any size.

The strands are hauled out each the same length, starting from the same point and traveling to the same point each trip. This makes it possible to make a "Walk-Laid Rope" of which each strand will be the same length. The tension or load put on the rope when in service will be taken equally by its strands.

This is the principle point of superiority of a "Walk-Laid Rope" over a "Machine Laid Rope."

Ratline

Wall Ratline is made of Tarred American Hemp and is furnished in the types and sizes listed in the table below.

Size	Weight per Fathom	Length of Coil	Weight of Coil	Breaking Strain
6 thread, ¾ inch	0.18	200	36	650
9 thread, 1 inch	.25	200	50	1,120
12 thread, 1 ⅛ inch	.35	200	70	1,500
15 thread, 1 ¼ inch	.45	200	90	1,800
18 thread, 1 ⅜ inch	.53	200	106	2,100
21 thread, 1 ½ inch	.60	200	120	2,400
24 thread, 1 ⅝ inch	.70	200	140	2,650

Marline, tarred—2 ply—put up in coils of 5 or 10 pounds.

Houseline, tarred—3 ply—put up in coils of 5 or 10 pounds.

Spunyarn—2 ply or 3 ply—put up in coils of 5 or 10 pounds.

Govenment Specifications Manila Rope

In use by the Navy Department—Bureau of Construction and Repair—Reference C. & R. No. Z21R4 (S)—Panama Canal and U. S. Engineers.

Directions governing requirements for Manila Rope in accordance with agreement made with the Committee of Cordage Manufacturers regarding commercial practice. Requirements:

1. Material—No other fiber than Manila or Abaca fiber shall be used and no grade of Manila lower than Government Grade I shall be used in any size of rope.

(a) For rope from ¾" to 1⅛" circumference, inclusive, not more than 25 per cent of Government Grade F shall be used, the balance to be higher grades.

(b) For rope from 1¼" to 1¾" circumference, inclusive, not more than 40 per cent of Government Grade F shall be used, the balance to be higher.

(c) For rope 2" circumference and larger, not more than 50 per cent of Government Grade I shall be used, the balance to be higher.

Approximate diameter in inches	Circumference in inches	Approximate gross weight of a 1,200-foot coil	Maximum net weight per foot rope	Minimum breaking strength in pounds
¼	¾	24	0.0196	700
5/16	1	35	.0286	1,200
⅜	1⅛	50	.0408	1,450
7/16	1¼	66	.0539	1,750
15/32	1⅜	78	.0637	2,100
½	1½	90	.0735	2,450
9/16	1¾	126	.1029	3,150
⅝	2	160	.1307	4,000
¾	2¼	198	.1617	4,900
13/16	2½	234	.1911	5,900
⅞	2¾	270	.2205	7,000
1	3	324	.2645	8,200
1 1/16	3¼	378	.3087	9,500
1 ⅛	3½	432	.3528	11,000
1 ¼	3¾	504	.4115	12,500
1 5/16	4	576	.4703	14,200
1 ⅜	4¼	648	.5290	16,000
1 ½	4½	720	.5879	17,500
1 9/16	4¾	810	.6615	19,500
1 ⅝	5	900	.7348	21,500
1 ¾	5½	1,080	.8818	25,500
2	6	1,296	1.059	30,000
2 1/16	6½	1,500	1.225	34,000
2 ¼	7	1,764	1.441	38,500
2 ½	7½	2,016	1,646	43,500
2 ⅝	8	2,304	1.881	49,000
2 ⅞	8½	2,580	2.107	55,000
3	9	2,916	2.381	61,000
3 ⅛	9½	3,240	2.645	67,000
3 ¼	10	3,600	2.940	73,000

Note—4-strand medium laid rope when ordered may run up to 7 per cent heavier than 3-strand rope of the same size, and must show 95 per cent of the strength required for 3-strand rope of the same size. Other requirements are the same as for 3-strand rope.

Relative Prices of "Wall" Manila Rope

The relative prices of "Wall" Manila Rope are given in the table below. The prices shown in the table represent the cost per pound of each size of rope above the cost of 2¼ inch circumference Manila rope.

RELATIVE COST OF "WALL" MANILA ROPE IN CENTS PER POUND

2¼" cir.—¾" diam.	Basis
2" " —⅝" "	½c. over "
1¾" " —9/16" "	1c. " "
1½" " —½" "	1c. " "
1¼" " —7/16" "	1c. " "
1⅛" " —⅜" "	1½c. " "
1" " —5/16" "	2c. " "
¾" " —¼" "	2c. " "
9/16" " —3/16" "	2½c. " "
Rope, 4 strand	1c. " "

Navy Department Specifications

1. General Specifications: General Specifications for Inspection of Material, issued by the Navy Department, in effect at date of opening of bids, shall form part of these specifications.

2. Material: Oakum shall be made from Italian, Russian or American hemp (Cannabis sativa), line or tow, or from any No. 1 grade Sunn, or No. 2 grade Benaries, or North Bengal Sunn, or from any combination of these fibres; and shall be thoroughly carded and finished, free from excessive lumps, dirt, or other extraneous matter.

3. Spinning: Oakum shall be spun by machine into slivers or threads in the form of balls or hanks not exceeding 5 pounds each; it shall be soft and uniform in texture, strong and sufficiently twisted to be suitable in all respects for calking seams of vessels. The slivers or threads shall contain not less than 43 feet to the pound and not more than 75 feet to the pound, unless otherwise required.

4. Impregnation: The fibers shall be thoroughly impregnated with pine tar to an amount not to exceed 30 per cent of the total weight of the fiber and tar.

5. Packing: Oakum shall be baled in regular packages containing about 50 pounds each. Bales shall be compressed no more than necessary and shall be securely bound with laths and strong tarred sisal yarns.

6. Deliveries: Deliveries shall be marked with the name of the material, the name of the contractor, the name of the manufacturer, and the contract or requisition number under which delivery is made.

7. Basis of Payment: Payment shall be made on a basis of gross weight, and the gross weight delivered shall be the weight required by requisition or contract.

8. Note to Bidders: (a) Hemp (Cannabis sativa) recovered from old rope shall be considered the same as new hemp of the same name and grade.

(b) Bidders shall submit with their bids a 5-pound sample of the material which they propose to furnish prior to the time for opening of bids. Bids not accompanied by sample will not be considered.

Guarantee

"Wall" No. 1 Marine Oakum—Spun or Unspun—is guaranteed to be in strict accordance with Navy Department Specifications 2101c, March 1, 1919, which is quoted in opposite column.

We are in position to make this guarantee due to the fact that only the highest grade of fiber procurable is used in its manufacture, by skilled labor in our new factory which is equipped with patented machinery designed especially for manufacturing oakum.

Only one grade of "Wall" oakum is manufactured and every bale is stamped with the "Wall" name and trademark.

Stock and Deliveries

A large stock of Wall Oakum is carried in each of the Branches at New York City, Philadelphia, Baltimore, Norfolk, New Orleans and Galveston, thus insuring prompt deliveries and reducing freight rates.

In the neighborhood of New York, Philadelphia and Baltimore, deliveries are made direct to the shipyards by our own motor trucks.

Satisfied Customers

The following is a list of some of the largest users of Wall Oakum:

Bethlehem Shipbuilding Corp.
Navy Department.
Panama Canal.
Hog Island Shipyard.
Newburgh Shipyards.
Merchants Shipbuilding Corp.

WALL ROPE WORKS, INC., 48 SOUTH ST., NEW YORK, N. Y.

PHILADELPHIA BALTIMORE NORFOLK NEW ORLEANS GALVESTON

American Wire Rope

Wire Rope for Every Purpose

The American Steel & Wire Company manufactures a wire rope adapted for every practical purpose of ship or shipyard use, with a full line of wire rope fittings. Sales offices and warehouses are maintained in practically all large cities throughout the United States, as listed below.

Iron Wire Rope

American wire rope is made in five grades or strengths.

Iron Rope has the physical characteristics of softness, ductility and a comparatively low tensile strength of approximately 85,000 pounds per square inch in the drawn wires entering into the construction of ropes. Iron rope is but seldom used, except in the smaller sizes, because of the stronger and tougher qualities of steel rope. Practically all types of iron wire rope can be supplied, however, where desired.

Crucible Cast Steel Rope

This grade of steel derives its name from the early method of making carbon steel in small crucibles, capable of being operated by hand. The same grade of steel for rope is now made by the open hearth furnace, giving a product of a more uniform chemical composition.

The area is only about one-half as much as iron for the same strength, but it is harder and better resists external wear. When drawn into wire and properly treated crucible cast (or open hearth) steel has a tensile strength of 150,000 to 200,000 pounds per square inch of sectional area.

This grade of rope is applicable for rigging, derricks, hoists, dredges, cable ways, guy wires, etc.

Extra Strong Crucible Cast Steel Rope

As the name indicates, this is a stronger grade of crucible open hearth steel, of somewhat tougher chemical composition and of tensile strength running from 180,000 to 220,000 pounds per square inch of sectional area. It is somewhat lighter for the same strength than crucible steel rope. In general, its uses are the same as those of crucible steel rope, except that it may be employed for heavier loading.

Plow Steel Rope

The name of plow steel, as applied to wire rope, means a high grade, open hearth steel of tensile strength in a wire of 200,000 to 260,000 pounds per square inch of sectional area. It combines lightness with great strength, but is somewhat stiffer than the crucible steel.

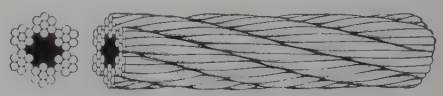
Plow steel is a most economical rope to use where the weight of rope has to be considered. It is used extensively for the running ropes of cargo handling gear, also for heavy hoisting, derricks, dredges and, in general, for heavy service.

Monitor Plow Steel Rope

This grade is made of a carefully selected open hearth steel wire for a tensile strength from 220,000 to 280,000 pounds per square inch of sectional area. This is the highest strength rope made. It is stiffer in the same diameter than the plow and crucible steel grades, but strength for strength, it is equally flexible. It is used for the most severe service, where great strength, lightness and abrasive resisting qualities are required.

Transmission, Haulage or Standing Rope

This rope is composed of 6 strands of 7 wires each, laid around a hemp core and can be supplied in all five qualities. Its coarse wires resist abrasion and corrosion to the greatest possible extent. In general, it can be used where abrasion is severe and the flexibility required is a minimum, on such installations as ore and coal dock haulage roads operating small grip cars, gravity hoists, etc.



Transmission Haulage or Standing Rope

CORRESPONDING CIRCUMFERENCE FOR GIVEN DIAMETERS WIRE ROPE

Dia.:	2¾	2½	2⅜	2⅛	2¼	2⅛	2	1⅞	1⅞	1¾	1⅝	1½	1⅜	1⅜	1¼	1⅛	1⅛	1	⅞	⅞	¾	⅝	⅝	½	⅜	⅜	¼
Circ.:	8⅝	7⅞	7½	7¼	7⅛	6¾	6½	6¼	6	5¾	5½	5¼	5	4¾	4½	4¼	4	3¾	3½	3¼	3	2¾	2½	2¼	2	1¾	1½	1¼	1⅛	1	¾

SALES OFFICES

CHICAGO	208 So. La Salle Street	CINCINNATI	Union Trust Building
NEW YORK	30 Church Street	BALTIMORE	32 So. Charles Street
CLEVELAND	Western Reserve Building	WILKES-BARRE, PA.	Miners Bank Building
WORCESTER	94 Grove Street	ST. LOUIS	3d National Bank Building
BOSTON	120 Franklin Street	ST. PAUL-MINNEAPOLIS	Pioneer Bldg., St. Paul
PHILADELPHIA	Widener Building	OKLAHOMA CITY	State National Bank Building
PITTSBURGH	Frick Building	BIRMINGHAM, ALA.	Brown-Marx Building
BUFFALO	337 Washington Street	DENVER	1st National Bank Building
DETROIT	Foot of First Street	SALT LAKE CITY	Walker Bank Building

UNITED STATES STEEL PRODUCTS COMPANY

Pacific Coast Dept.
San Francisco, Los Angeles, Seattle, Portland

Export Department
30 Church Street, New York

LOCATION OF WAREHOUSES

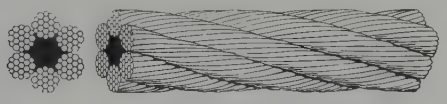
BALTIMORE	DES MOINES	LOUISVILLE	PITTSBURGH	SEATTLE
BUFFALO	DETROIT	MEMPHIS	PORTLAND	ST. LOUIS
CEDAR RAPIDS	FARGO	NEW HAVEN	RICHMOND, IND.	ST. PAUL
CHICAGO	KANSAS CITY	NEW ORLEANS	SALT LAKE CITY	TRENTON
CLEVELAND	LINCOLN	NEW YORK	SAN FRANCISCO	WORCESTER
DENVER	LOS ANGELES	PHILADELPHIA	SAVANNAH	

AMERICAN STEEL & WIRE COMPANY

Address nearest office. For list of offices see above.

Standard Hoisting Rope

This rope is composed of 6 strands of 19 wires each, laid around a hemp core. The smaller wires permit this rope to pass readily over sheaves and drums of moderate size. This rope is particularly adapted for hoisting work in general, aboard ship and in the shipyard.



Standard Hoisting Rope

Other Grades of Hoisting Rope

Where greater flexibility is required, the following types offer a hoisting rope to meet the conditions.

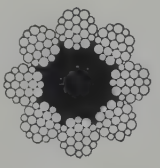
Extra Flexible Hoisting Rope—8 strands of 19 wires each, laid around hemp core. Adapted for use over small sheaves, on derricks, dredges, pile drivers, etc.

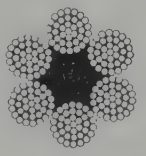
Special Flexible Hoisting Rope—6 strands of 37 wires each, laid around hemp core. Used where great flexibility is required, such as on electric cranes, boat crane falls, steering gear, relieving tackles, etc.

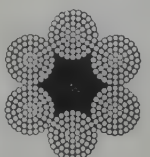
Extra Special Flexible Hoisting Rope—6 strands of 61 wires each, laid around hemp core. Most flexible of hoisting ropes. Particularly adapted for dredging.

DATA ON VARIOUS TYPES OF HOISTING ROPES

Diameter in Inches	Approximate Weight per Foot in Pounds	Monitor Plow Steel		Plow Steel Crucible Cast Steel		Extra Strong		Crucible Cast Steel		Iron	
		Approximate Strength in Tons of 2000 Pounds	Proper Working Load in Tons of 2000 Pounds	Approximate Strength in Tons of 2000 Pounds	Proper Working Load in Tons of 2000 Pounds	Approximate Strength in Tons of 2000 Pounds	Proper Working Load in Tons of 2000 Pounds	Approximate Strength in Tons of 2000 Pounds	Proper Working Load in Tons of 2000 Pounds	Approximate Strength in Tons of 2000 Pounds	Proper Working Load in Tons of 2000 Pounds
STANDARD HOISTING ROPE—6 STRANDS, 19 WIRES TO THE STRAND, 1 HEMP CORE											
2¾	11.95	315	63	275	55	243	48.6	211	42.2	111	22.2
2½	9.85	263	53	229	46	200	40	170	34	92	18.4
2¼	8	210	42	186	37	160	32	133	26.6	72	14.4
2	6.30	166	33	140	28	123	24.6	106	21.2	55	11
1⅞	5.55	150	30	127	25	112	22.4	96	19	50	10
1¾	4.85	133	27	112	22	99	19.8	85	17	44	8.8
1⅝	4.15	110	22	94	19	83	16.6	72	14.4	38	7.6
1½	3.55	98	20	82	16	73	14.6	64	12.8	33	6.6
1⅜	3	84	17	72	14	64	12.8	56	11.2	28	5.6
1¼	2.45	69	14	58	12	53	10.6	47	9.4	22.8	4.56
1⅛	2	56	11	47	9.4	43	8.6	38	7.6	18.6	3.72
1	1.5	45	9	38	7.6	34	6.80	30	6	14.5	2.90
⅞	1.20	35	7	29	5.8	26	5.20	23	4.6	11.8	2.36
¾	.89	26.3	5.3	23	4.6	20.2	4.04	17.5	3.5	8.5	1.70
⅝	.62	19	3.8	15.5	3.1	14	2.80	12.5	2.5	6	1.20
9/16	.50	14.5	2.9	12.3	2.4	11.2	2.24	10	2	4.7	.94
½	.39	12.1	2.4	10	2	9.2	1.84	8.4	1.68	3.9	.78
7/16	.30	9.4	1.9	8	1.6	7.25	1.45	6.5	1.30	2.9	.58
⅜	.22	6.75	1.35	5.75	1.15	5.30	1.06	4.8	.96	2.4	.48
5/16	.15	4.50	.9	3.8	.76	3.50	.70	3.1	.62	1.5	.30
¼	.10	3.15	.63	2.65	.53	2.43	.49	2.2	.44	1.1	.22
EXTRA FLEXIBLE HOISTING ROPE—8 STRANDS, 19 WIRES TO THE STRAND, 1 HEMP CORE											
1½	3.19	80	16	74	14.8	66	13	58	11.6		
1⅜	2.70	68	13	64	12.8	57	11	51	10.2		
1¼	2.20	56	11	52	10.4	47	9.4	42	8.4		
1⅛	1.80	46	9.2	43	8.6	38	7.6	34	6.8		
1	1.42	36	7.2	33	6.6	29.7	5.9	26	5.2		
⅞	1.08	28	5.6	26	5.2	23	4.6	20	4		
¾	.80	22	4.4	20	4.4	17.6	3.5	15.3	3.06		
⅝	.56	15	3	14	2.8	12.4	2.5	10.9	2.18		
9/16	.45	12	2.4	11.6	2.32	10.1	2	8.7	1.74		
½	.35	9.5	1.9	8.7	1.74	8	1.6	7.3	1.46		
7/16				6.90	1.38	6.30	1.26	5.7	1.14		
⅜				5.12	1.02	4.66	.93	4.2	.84		
5/16				3.35	.67	3.05	.61	2.75	.55		
¼				2.25	.45	2.02	.40	1.80	.36		
SPECIAL FLEXIBLE HOISTING ROPE—6 STRANDS, 37 WIRES TO THE STRAND, 1 HEMP CORE											
2¾	11.95	278	55	265	53	233	47	200	40		
2½	9.85	225	45	214	43	187	37	160	32		
2¼	8	184	37	175	35	150	30	125	25		
2	6.30	137	27	130	26	117	23	105	21		
1⅞	5.55	125	25	119	23.8	106	21.2	94	18.8		
1¾	4.85	113	23	108	22	95	19	84	17		
1⅝	4.15	95	19	90	18	79	16	71	14		
1½	3.55	84	17	80	16	71	14	63	12		
1⅜	3	71	14	68	14	61	12	55	11		
1¼	2.45	58	11	55	11	50	10	45	9		
1⅛	2	46	9.2	44	9	39	8	34	7		
1	1.58	37	7.4	35	7	32	6.4	29	6		
⅞	1.20	29	5.8	27	5	25	5	23	5		
¾	.89	23	4.6	21	4	19	3.8	17.5	3.5		
⅝	.62	16	3.2	14	3	12.6	2.5	11.2	2.2		
9/16	.50	12.5	2.5	11.5	2.3	10.5	2.1	9.5	1.9		
½	.39	9.75	1.9	9.25	1.85	8.25	1.65	7.25	1.45		
7/16	.30	7.50	1.5	7.2	1.4	6.35	1.27	5.5	1.1		
⅜	.22	5.30	1.06	5.1	1	4.65	.93	4.2	.84		
EXTRA SPECIAL FLEXIBLE HOISTING ROPE—6 STRANDS, 61 WIRES TO THE STRAND, 1 HEMP CORE											
3¼	16.60	370	74	350	70	315	63	280	56		
3	14.20	325	65	310	62	275	55	240	48		
2¾	11.95	278	56	265	53	233	47	200	40		
2½	9.85	225	45	214	43	187	37	160	32		
2¼	8.00	184	37	175	35	150	30	125	25		
2	6.30	137	27	130	26	117	23	105	21		







Galvanized Wire Rope

Thoroughly Protective Galvanizing

The American Steel and Wire Company employs a special galvanizing process which insures adhesion of the zinc to the metal. The galvanizing does not crack, chip or flake. It thoroughly protects the rope from corrosion.

Ship's Rigging or Guy Rope

Ship's Rigging is a galvanized iron rope, made of 6 strands, 7 wires to the strand, with 1 hemp core. The larger sizes are sometimes made of 6 strands, 12 wires to the strand, with 1 hemp core. It is adapted for use as ship's rigging, guys for smokestacks, derricks, etc.

Yacht Rigging or Guy Rope

Yacht Rigging is the name applied to galvanized crucible cast steel wire rope, made of 6 strands, 7 wires to the strand, or of 6 strands, 19 wires to the strand, with 1 hemp core. For standing rigging and guys the type with 7 wires to the strand is generally used. Also made in galvanized plow steel. The type with 19 wires to the strand is used for running rigging, topping lifts, boat slings, wheel ropes, mooring and warping lines, straight-hauls and backstays on yachts, etc.

Hawsers and Mooring Lines

These are made of 6 strands, 12 or 24 wires to the strand, with 7 hemp cores, in crucible cast steel, extra galvanized. The hemp core in each strand gives an added flexibility, and consequent ease of handling, particularly valuable in mooring lines. Deep Sea Towing Hawsers are built with 6 strands, 37 wires to the strand, of extra galvanized steel, 1 hemp core; particularly adapted for use with automatic towing machines.

Running Rope

This is constructed of 6 strands, 12 wires to the strand, with 7 hemp cores, in iron, crucible cast steel and plow steel, extra galvanized. Used for running rigging where the greatest flexibility is required and for ridge ropes, boat ladders and Jacob's ladders, boom pendants, etc.

GALVANIZED RUNNING ROPE—6 STRANDS—12 WIRES TO THE STRAND—7 HEMP CORES

Diameter in Inches	Approximate Weight per Foot in Pounds	Approximate Strength in Tons of 2000 Pounds		
		Iron	Cast Steel	Plow Steel
1 5/8	2.76	.....	.....	59.5
1 1/2	2.36	.....	.....	51.5
1 7/16	2.16	.....	.....	47.
1 3/8	2.	.....	.....	43.25
1 1/4	1.63	.....	.....	35.
1 1/16	1.47	.....	.....	31.
1 1/8	1.33	.....	.....	28.5
1 1/16	1.18	10.1	22.5	25.
1	1.05	8.7	19.5	21.03
7/8	.80	6.9	15.5	17.
13/16	.68	6.	13.5	15.
3/4	.59	5.1	11.5	12.5
5/8	.42	3.6	8.	8.8
9/16	.33	2.8	6.5	6.9
1/2	.26	2.2	5.	5.5
7/16	.20	1.7	3.9	4.4
3/8	.14	1.3	2.85	3.3
5/16	.10	.82	1.98	2.3

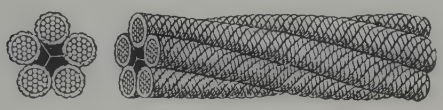
DATA ON GALVANIZED WIRE ROPE

Type of Rope	Diameter in Inches	Approximate Weight per Foot in Pounds	Approximate Strength in Tons of 2000 Pounds	Circumference of Manila Rope of Equal Strength
Iron Ship's Rigging or Guy Rope 6 Strands 7 or 12 Wires to Strand	1 3/4	4.85	42	11
	1 11/16	4.42	38	10 1/2
	1 5/8	4.15	35	10
	1 1/2	3.55	30	9 1/2
	1 7/16	3.24	28	9
	1 3/8	3	26	8 1/2
	1 1/4	2.45	23	8
	1 1/16	2.21	19	7 1/2
	1 1/8	2	18	6 1/2
	1 1/16	1.77	16.1	6
	1	1.58	14.1	5 3/4
	7/8	1.20	11.1	5 1/4
	13/16	1.03	9.4	5
	3/4	.89	7.8	4 1/4
	5/8	.62	5.7	4 1/2
	9/16	.50	4.46	3 3/4
	1/2	.39	3.39	3
	7/16	.30	2.35	2 1/2
	3/8	.22	1.95	2 1/4
	5/16	.15	1.42	2
	5/32	.125	1.20	1 3/4
	1/4	.09	.99	1 1/2
	3/16	.063	.79	1 1/4
	1/8	.04	.61	1 1/8
Crucible Cast Steel Yacht Rigging 6 Strands 7 or 19 Wires to Strand	1 1/4	2.45	42	13
	1 1/8	2.21	38	12
	1 1/8	2	34	11
	1 1/16	1.77	31	10
	1	1.58	28	9
	7/8	1.20	22	8 1/2
	13/16	1.03	19	8
	3/4	.89	16.8	7
	5/8	.62	11.7	6
	9/16	.50	9	5 1/4
	1/2	.39	7	4 3/4
	7/16	.34	6	4 1/2
	3/8	.30	5	4 1/4
	5/16	.22	4.2	3 3/4
	1/4	.15	3.2	3
Steel Hawsers 6 Strands—12 Wires to Strand 7 Hemp Cores	2 1/16	4.43	83	.....
	2	4.20	77	.....
	1 15/16	3.89	71	.....
	1 13/16	3.42	66	.....
	1 3/4	3.23	61	13.5
	1 11/16	2.94	57	13
	1 5/8	2.76	53	12.5
	1 1/2	2.36	45	12
	1 7/16	2.16	41	11.5
	1 3/8	2	38	11
	1 1/4	1.63	31	10
	1 1/8	1.47	28	9.25
	1 1/8	1.33	26	8.75
Steel Hawsers and Mooring Lines 6 Strands 24 Wires to Strand—7 Hemp Cores	2 1/16	5.81	113	.....
	2	5.51	106	.....
	1 15/16	5.09	98	.....
	1 13/16	4.48	88	.....
	1 3/4	4.24	82	.....
	1 11/16	3.86	76	.....
	1 5/8	3.63	74	.....
	1 1/2	3.10	63	13.5
	1 7/16	2.92	55	13.0
	1 3/8	2.62	50	12.0
	1 1/4	2.15	42	12.0
	1 1/8	1.93	38	11.0
	1 1/8	1.75	34	10.25
	1 1/16	1.54	27	9.25
	1	1.38	25	8.75
	7/8	1.05	20	.....
	13/16	.90	17	.....
	3/4	.78	14	.....
	5/8	.54	10.5	.....
	1/2	.34	6.6	.....
	3/8	.21	4	.....
				Strength in Tons
Deep Sea Steel Towing Hawsers 6 Strands 37 Wires to Strand 1 Hemp Core	2 3/8	8.82		188
	2 5/16	8.36		182
	2 1/4	8		171
	2 1/8	7.06		155
	2 1/16	6.65		140
	2	6.30		132
	1 15/16	5.84		125
	1 13/16	5.13		112
	1 3/4	4.85		104
	1 11/16	4.42		97
	1 5/8	4.15		87
	1 1/2	3.55		76
	1 7/16	3.24		72
	1 3/8	3		66
	1 1/4	2.45		54
	1 1/8	2.21		47
	1 1/8	2		42
	1 1/16	1.77		38
	1	1.58		31.5
	7/8	1.20		26
	13/16	1.03		22
	1/2	.89		20

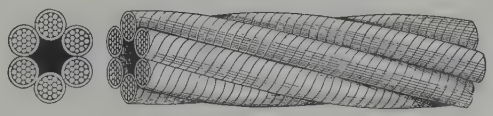
Marlin Clad, Steel Clad and Tiller Rope

DATA ON MARLIN CLAD WIRE ROPE—5 STRANDS, 19 WIRES TO STRAND, 1 HEMP CORE

Diameter in Inches before Serving	Approximate Diameter after Serving with Marlin	Approximate Circumference after Serving with Marlin	Crucible Cast Steel			Extra Strong Crucible Cast Steel			Plow Steel		
			Approximate Breaking Strain in Tons of 2000 Lbs.	Allowable Working Strain in Tons of 2000 Lbs.	Approximate Weight per Foot in Pounds	Approximate Breaking Strain in Tons of 2000 Lbs.	Allowable Working Strain in Tons of 2000 Lbs.	Approximate Weight per Foot in Pounds	Approximate Breaking Strain in Tons of 2000 Lbs.	Allowable Working Strain in Tons of 2000 Lbs.	Approximate Weight per Foot in Pounds
1⅛	1½	4¾	38	7.60	2.07	64	13.0	3.06	72	14.0	3.06
1⅜	1¾	5½	56	11.6	3.06	53	10.6	2.52	58	12.0	2.52
1¼	1⅝	5⅛	47	9.4	2.52	43	8.60	2.07	47	9.50	2.07
1	1⅜	4⅜	30	6.00	1.66	34	6.80	1.66	38	7.60	1.66
⅞	1¼	3⅞	23	4.60	1.29	26	5.20	1.29	29	5.80	1.29
¾	1⅛	3½	17.5	3.50	1.12	20.2	4.04	1.12	23	4.60	1.12
⅝	1	3⅛	12.5	2.50	.80	14.0	2.80	.80	15.5	3.10	.80
½	¾	2⅜	8.4	1.68	.49	9.2	1.84	.49	10.0	2.00	.49
⅜	⅝	2	4.8	0.96	.36	5.30	1.06	.36	5.75	1.15	.36
¼	½	1½	2.2	0.44	.21	2.43	0.49	.21	2.65	0 53	.21



Marlin Clad Wire Rope

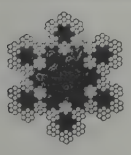


Steel Clad Wire Rope

Marlin Clad Wire Rope

This rope is constructed as follows: Each strand is served with tarred marlin; the strands are twisted around a hemp core. The usual number of wires in a strand is seven or nineteen and number of strands four, five or six. Marlin Clad Wire Rope is particularly adapted for ship's rigging, boat falls, cargo hoists, power transmission, etc. It is considerably stronger than manila rope of the same diameter. For instance, 1-inch diameter Marlin Clad Plow Steel Rope has a strength of 31,000 pounds, while the strength of 1-inch diameter manila rope is but 7,500 pounds. Marlin Clad Rope weighs approximately 30 per cent less than manila rope of the same strength.

Tiller Rope



This rope is made of 6 strands of 42 wires each, with 7 hemp cores. Since the wires are very fine, they should not be subject to much abrasion. Tiller Rope is used for steering lines on yachts and motor boats. It is particularly adapted for use where a maximum of flexibility is desired.

DATA ON TILLER ROPE

Diameter in Inches	Approximate Weight per Foot in Pounds	Diameter of Drum or Sheave in Inches Advised	Breaking Strength Approximate	
			Iron Pounds	Crucible Cast Steel Pounds
1	1.10	24	22,000	33,000
⅞	.84	21	15,500	26,000
¾	.62	18	11,000	18,000
⅝	.43	15	7,000	13,500
½	.35	13½	6,300	11,000
½	.28	12	5,800	9,000
7/16	.21	10½	4,000	6,500
⅜	.16	9	3,000	4,800
5/16	.11	7½	1,900	3,600
¼	.07	6	1,300	2,500
1/8	.042		750	1,350

Steel Clad Wire Rope

Steel Clad Wire Rope is made in three constructions: Hoisting Rope (6 strands, 19 wires to the strand, 1 hemp core)—Special Flexible Hoisting Rope (6 strands, 37 wires to the strand, 1 hemp core)—Extra Special Flexible Hoisting Rope (6 strands, 61 wires to the strand, 1 hemp core). Each of these types is made in four grades: Crucible Cast Steel—Extra Strong Crucible Cast Steel—Plow Steel—Monitor Plow Steel.

Under suitable conditions, Steel Clad Rope frequently gives additional service of from 50 to 100 per cent, easily offsetting any increased first cost. Its use is particularly recommended for dredging and similar difficult conditions of rope usage.

The flat strips of steel wire are wound spirally around each of the 6 strands composing the rope, give it additional wearing surface without sacrificing the flexibility. When the outer flat wheel winding is worn through in service, a complete hoisting rope remains, with unimpaired strength.

Data on Steel Clad Rope

The steel clad serving adds from ⅛ to ¼ inch in diameter to the bare wire. For instance if the diameter of bare rope is 2 inches, the finished diameter over serving is 2¼ inches.

The approximate strength and proper working load for any construction and grade of Steel Clad Rope is the same, for the bare rope diameter, as for the same diameter of similar grade of plain wire rope. Strength and proper load can therefore be obtained from the tables on page 829. For instance, a 2-inch bare rope diameter, in Steel Clad Plow Steel Hoisting Rope, has the same strength and proper load as 2-inch Plow Steel Hoisting Rope, 140 tons and 28 tons, respectively.

Approximate weights of Steel Clad Rope may be determined by adding one-third to the weight of plain rope of same type as given on page 829 using the bare rope diameter.

Wire Strand, Sash Cord, Spikes and Nails

Galvanized Steel Wire Strand

This is composed of 7 or 19 steel wires twisted into a single strand, galvanized or extra galvanized. Wire of this construction, in the smaller sizes and made of annealed steel, is especially adapted for use as seizing.

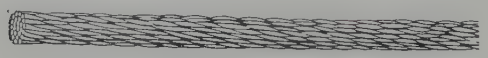
Made of hard steel, it has a wide variety of uses, such as for the guying of poles, smokestacks, in the transmission system of engine rooms telegraphs and similar apparatus, for navigational sounding machines, etc. Grades of higher strength than those listed below can be furnished. For sounding machines, the American Steel & Wire Company can also supply piano wire, where desired.

DATA ON GALVANIZED WIRE STRAND

Diameter Inches	Size of Wire Used Steel Wire Gauge	Approximate Weight per 1000 Feet in Pounds	Approximate Strength in Pounds
7 Wires Twisted Into a Single Strand			
¾	3	1,200	18,000
⅝	5	800	14,000
9/16	6	650	11,000
½	8	510	8,500
7/16	9	415	6,500
⅜	11	295	5,000
5/16	12	210	3,800
9/32	13	160	2,800
¼	14	125	2,300
7/32	15	95	1,800
3/16	16	75	1,400
5/32	17	55	900
1/8	18	40	700
7/64	19	32	500
3/32	20	25	450
5/64	21	20	400
1/16	22	13	300
19 Wires Twisted Into a Single Strand			
1	.200	2,100	32,000
⅞	.175	1,610	24,000
¾	.150	1,200	18,000
⅝	.125	800	14,000
9/16	.110	650	11,000
½	.100	510	8,500

Tinned Motor Boat Steering Cord

This type is designed to meet the demand for a light weight, steel cord of great flexibility. It is made in three types; 7 strands, 7 wires to the strand; 6 strands, 7 wires to the strand, cotton center; and 7 strands, 7 wires to the strand. It is particularly applicable to motor boat steering lines and, in general, for the same purposes as the galvanized wire strand described above, where greater flexibility and strength are desired.

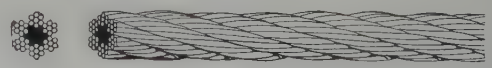


TINNED MOTOR BOAT STEERING CORD
7 Strands—19 Wires to the Strand

Diameter in Inches	Approximate Weight per 100 Feet in Pounds	Breaking Strength in Pounds
3/16	26.45	14,400
11/64	22.53	12,500
1/16	17.71	9,800
9/64	14.56	8,000
¼	12.00	7,000
7/64	9.50	5,600
5/32	6.47	4,200
9/64	4.44	2,800
1/8	2.88	2,000

Sash Cord

This cord is made up of 6 strands, 7 wires to the strand, with 1 cotton core. It is furnished "dead soft," unless ordered otherwise, and may be furnished galvanized. It is used principally for sash weights and whistles.



DATA ON SASH CORD

Diameter in Inches	Weight per Foot in Pounds		Approximate Breaking Stress in Pounds		
	Iron	Copper	Bright Iron	Annealed Iron	Bright Copper
¼	.101	.115	2200	1650	1320
3/16	.077	.087	1800	1411	1080
1/8	.056	.064	1400	1100	840
1/16	.025	.029	550	425	350
3/32	.014	.016	320	250	200
1/16	.006	.007	140	110	90

APPROXIMATE NUMBER OF BOAT SPIKES TO A KEG OF 200 POUNDS

Length, Inches	Inches Square					
	5/8	½	7/16	3/8	5/16	¼
3	....	....	....	1320	1660	3000
4	....	....	....	1140	1360	2375
5	....	....	....	940	1230	2050
6	....	450	600	800	1175	1825
7	....	375	590	650	990	....
8	260	335	510	600	880	....
9	240	300	400	525	....	....
10	220	275	360	475	....	....
11	205	260	320	....	....	....
12	190	240	230	....	....	....
14	175	....	....	....	....	....
16	160	....	....	....	....	....

Boat Spikes

The process of manufacture employed by the American Steel & Wire Company insures a Boat Spike with a clean cut, sharp, chisel point—a spike which drives easily and holds well after driven. The heads will not fly off and the product runs uniform as to lengths and gauges.

Nails for All Purposes

The American Steel & Wire Company manufactures nails in a wide range of sizes and styles suited to all requirements. Boat nails are manufactured in sizes from 4d to 20d, ranging from 1½ to 4 inches long and 3/16 to ⅜ gauge. Boat nails can also be supplied barbed.

Included among the products are roofing, fence and clinch nails, brads, staples, etc. Uniformity of length and gauge, for each kind and size, is rigidly maintained. The company's capacity and equipment for the manufacture of wire nails is unequalled.

Directions for Splicing Wire Rope

Tools Required

The tools required are a small marlin spike, nipping cutters, and either clamps or a small hemp rope sling with which to wrap around and untwist the rope. If a bench vise is accessible, it will be found very convenient for holding the rope.

Extra Length to be Allowed

In splicing rope, a certain length E-E′ is used up in making the splice. The additional length recommended for making a splice in different sizes of wire rope is as follows:

Diameter of Rope in Inches	Extra Length Allowed for the Splice Feet	Diameter of Rope in Inches	Extra Length Allowed for the Splice Feet
⅜	16	1	32
½	16	1⅛	36
⅝	20	1¼	40
¾	24	1½	44
⅞	28	...	..

Fig. 1

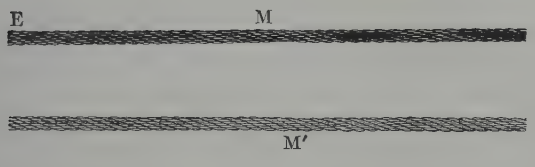


Fig. 2

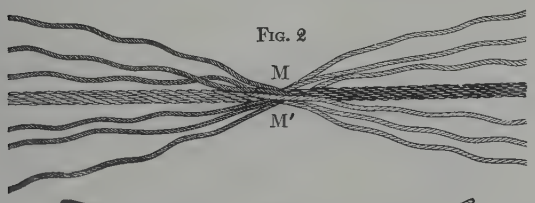


Fig. 3

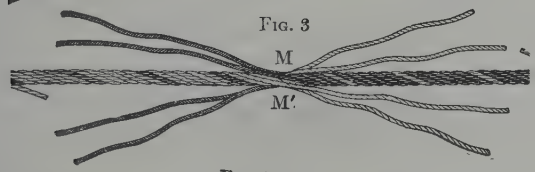


Fig. 4

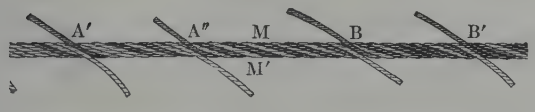
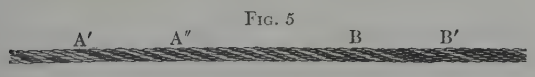


Fig. 5



Procedure in Splicing

Having measured carefully the length the rope should be after splicing and marked the points M and M′ (Fig. 1), unlay the strands from each end E and E′ to M and M′, and cut off the hemp center at M and M′, and then:

First. Interlock the six unlaid strands of each end alternately, cutting off the hemp centers at M and M′ and draw wire strands together, so that the points M and M′ meet, a s shown in Fig. 2.

Second. Unlay a strand from one end, and following the unlay closely, lay into the seam or groove it opens in the strand opposite it belonging to the other end of the rope, until there remains a length of strand equal in inches to the length of splice EE in feet, e. g., the straight end of the inlaid strand A on one-half-inch rope equal 16 inches for 16-foot splice. Then cut the other strand to about the same length from the point of meeting, as shown at A (Fig. 3).

Third. Unlay the adjacent strand in the opposite direction, and following the unlay closely, lay in its place the corresponding opposite strand, cutting the ends as described before at B (Fig. 3).

The four strands are now laid in place terminating at A and B, with the eight remaining at M and M′, as shown in Fig. 3.

It will be well after laying each pair of strands to tie them temporarily at the points A and B.

Pursue the same course with the remaining four pairs of opposite strands stopping each pair of strands so as to divide the space between A and B into five equal parts, as shown in Fig. 4, and cutting the ends as before.

All strands are now laid in their proper places with their respective ends passing each other, as shown in Fig. 4.

Securing the Ends

All methods of rope splicing are identical up to this point; their variety consists in the method of securing the ends. One good way is as follows:

Clamp the rope in a vise at a point to the left of A (Fig. 4), and by a hand clamp applied near A open up the rope by untwisting sufficiently to cut the hemp core at A, and, seizing it with the nippers, draw it out slowly. Then insert a marlin-spike under the two nearest strands to open up the rope and starting the loose strand into the space left vacant by the hemp center, rotate the marlin-spike so as to run the strand into the center. Cut the hemp core where the strand ends, and push the end of hemp back into its place. Remove the clamps and let the rope close together around it. Draw out the hemp core in the opposite direction and lay the other strand in the center of the rope in the same manner. Repeat the operation at the five remaining points, hammer the rope lightly at the points, where the ends pass each other at A, A′, B, B′, etc., with small wooden mallets, and the splice is complete, as shown in Fig. 5.

If a clamp and vise are not obtainable, two rope slings and short wooden levers may be used to untwist and open up the rope.

A rope spliced as above will be nearly as strong as the original rope, and smooth everywhere. After running a few days, the splice, if well made, cannot be pointed out except by the close examination of an expert.

Wire Rope Fittings

DATA ON OVAL THIMBLES—REGULAR SIZE

Size Thimble Width of Score in Inches	Circumference in Inches of Rope	Diameter of Pin that Inserted	Length Inside in Inches	Approximate Weight in Pounds	Size Thimble Width of Inches	Circumference of Rope in Inches	Diameter of Pin that Inserted	Length Inside in Inches	Approximate Weight in Pounds
2½	7⅜	3½	6	6.5	1	3	1 3/8	3⅜	.60
2¼	7⅛	3½	5½	5.9	⅞	2¾	1⅜	2½	.44
2	6¼	2⅜	5	3.9	¾	2¼	1⅛	2⅜	.37
1⅞	5¾	2⅛	4⅞	3.8	⅝	2	1¼	2⅛	.22
1¾	5½	2⅛	4¾	2.8	⅝	1⅞	1	2	.13
1⅝	5	2⅛	4½	2.	½	1½	1 1/16	1⅞	.13
1½	4¾	2 1/16	3⅞	1.80	7/16	1¼	1	1¾	.09
1⅜	4¼	2 1/16	3⅜	1.40	⅜	1⅛	⅞	1½	.06
1¼	4	2⅛	3¼	1.05	⅜	1	¾	1½	.05
1⅛	3½	1 1/16	3⅛	.90	¼	¾	⅝	1⅜	.03

DATA ON OVAL THIMBLES—EXTRA LARGE SIZE

2	6¼	3⅛	5½	5.8	⅞	2¾	2	3½	.55
1⅞	5¾	3¼	5¼	5.	¾	2¼	1¾	3½	.45
1¾	5½	3⅛	5	4.3	⅝	2	1⅜	2⅜	.31
1⅝	5	3	5	3.	½	1½	1½	2½	.15½
1½	4¾	3	4¾	2.16	7/16	1¼	1¼	2⅛	.14
1⅜	4¼	2 11/16	4½	1.55	⅜	1⅛	1	2	.12
1¼	4	2 1/16	4⅜	1.50	7/16	1	⅞	1⅜	.06
1⅛	3½	2½	4¼	1.25	¼	¾	¾	1	.03½
1	3	2 1/16	4⅛	.81					

DATA ON THIMBLES SPLICED INTO ROPE

Diameter of Rope in Inches	Circumference of Rope in Inches	Diameter of Rope in Inches	Circumference of Rope in Inches
2	6¼	⅞	2¾
1⅞	5¾	¾	2¼
1¾	5½	⅝	2
1⅝	5	½	1¾
1½	4¾	7/16	1½
1⅜	4¼	⅜	1¼
1¼	4	⅜	1⅛
1⅛	3½	⅜	1
1	3	¼	¾

Thimble Spliced into Rope

Galvanized Oval Thimble

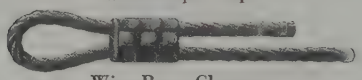
Galvanized Oval Thimbles

The American Steel and Wire Company manufactures a complete line of oval thimbles, heavily coated with zinc, as listed above. For hawsers, a special non-collapsible thimble is made.

Wire Rope Clips and Clamps

Clips are manufactured in standard sizes for wire ropes of from ¼ to 2½ inches diameter; cold galvanized furnished unless otherwise specified; hot galvanized and black can also be supplied. They are light, durable and convenient, but are not recommended for permanent fastening on hoisting rope. Not fewer than 2 clips should be used and preferably 4 to 6, particularly on larger sizes of rope.

Wire Rope Clips

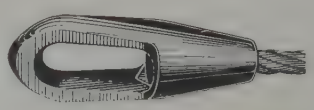


Wire Rope Clamps

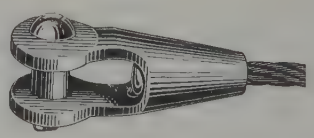
Clamps are made for wire rope from 1 5/16 to 2¼ inches diameter. From 2 to 6 clamps should be used. Alternate clamps and clips are better than all clamps, but for permanent work sockets are preferable.

Open and Closed Sockets

The American Steel and Wire Company manufactures open and closed sockets, for use with either steel or iron rope, in the standard sizes listed below. Sockets of special dimensions can also be supplied, when desired. The method of attaching makes them the strongest rope fastenings made, utilizing the full strength of the rope. Sockets are recommended for all permanent rope fastenings.



Closed Socket



Open Socket

DATA ON CLOSED SOCKETS					DATA ON OPEN SOCKETS			
Size Socket and Diameter of Rope in Inches	Circumference of Rope in Inches	Diameter of Pin that May be Inserted in	Length of Basket in Inches	Length Over All in Inches	Width Between Jaws in Inches	Diameter of Pin in Inches	Length of Basket in Inches	Length Over All in Inches
2¼	7⅛	...	...	....	3¾	4	9¼	22
2	6¼	...	...	....	3½	3¾	8¼	20
1¾	5½	...	...	....	2¾	3¼	7¼	16¾
1⅝	5	...	...	....	2⅞	2¼	6⅛	13⅝
1½	4¾	2¾	5½	12⅝	2⅞	2¼	5½	13
1⅜	4¼	2¾	5	11⅛	2⅛	1⅞	5	11½
1¼	4	2¾	5	11⅛	2⅛	1⅞	5	11½
1⅛	3½	2¼	4½	10½	1⅞	1⅝	4½	10
1	3	2¼	4½	10½	1⅞	1⅝	4½	10
⅞	2¾	2	4	9¼	1 1/16	1¼	4	8⅞
¾	2¼	1¾	3⅜	8	1 1/16	1⅛	3⅜	7⅜
⅝	2	1½	3	6⅝	1⅛	1	3	6¾
9/16	1¾	1 1/16	2¾	6	1 1/16	⅞	2¾	6
½	1½	1 1/16	2¾	6	1 1/16	⅞	2¾	6
7/16	1¼	1⅛	2½	5¼	⅞	⅝	2½	5½
⅜	1⅛	1⅛	2½	5¼	⅞	⅝	2½	5½
5/16	1	1 1/16	1⅝	3¾	1 1/16	½	1⅝	3½
¼	¾	1 1/16	1⅝	3¾	1 1/16	½	1⅝	3½

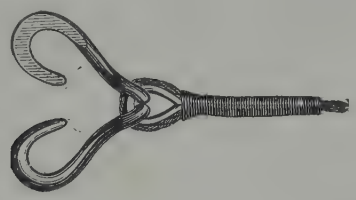
AMERICAN STEEL & WIRE COMPANY

Address nearest office. For list of offices see page 828.

Wire Rope Fittings

Sister Hooks and Thimble

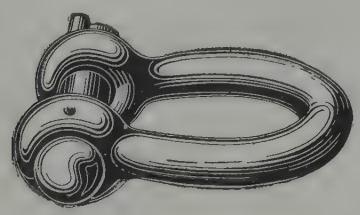
These are made for use with either steel or iron rope ¼ to 2½-inch diameters, and can be furnished loose or fastened. Sister Hooks are frequently employed where a rope has to be quickly attached and detached from a load and, at the same time, to hold the load fast as long as the rope is under strain.



Sister Hook with Thimble

Iron Guy Shackles

Standard Shackles can be supplied in the sizes listed below, either black or galvanized, as desired. To determine the proper size of shackle for any purpose, select the size having a strength equal to the rope with which it is to be used. Shackles are used extensively to connect ropes, the ends of which are equipped with thimbles, sockets, turnbuckles, etc.



Shackle

DATA ON SHACKLES

Size in Inches of Shackle (Diameter of Iron in Bow)	Government Test Maximum Strength in Pounds	Length Inside Inches	Width Between Eyes Inches	Diameter of Pin in Inches
3/16	10,890	1 3/8	5/8	1/2
1/4	15,200	1 3/4	11/16	9/16
5/16	18,390	1 7/8	11/4	5/8
3/8	24,800	1 7/8	7/8	11/16
7/16	33,400	2 1/4	1 1/16	3/4
1/2	43,400	3	1 3/16	7/8
9/16	55,200	3 1/2	1 3/8	1
5/8	74,900	4	1 3/4	1 1/8
3/4	90,200	4 1/2	1 7/8	1 1/4
7/8	92,040	5	2	1 3/8
1	94,100	5 1/2	2 1/8	1 1/2
1 1/8	103,800	6	2 1/4	1 5/8
1 1/4	155,542	6 1/2	2 1/2	1 3/4
1 3/8	172,400	7	2 3/4	1 7/8
1 1/2	235,620	8	3 1/4	2 1/8

Turnbuckles

Standard turnbuckles can be furnished with eye, shackle or hook ends, in any combination desired. From the strengths and working loads given in table below, the proper size is readily selected, by using the turnbuckle of the same strength as the rope. Where greater take-up is desired, two turnbuckles may be used.

Turnbuckle with Shackle

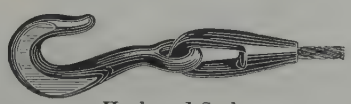
DATA ON TURN BUCKLES

Size Turnbuckle Outside Diameter Thread Inches	Approximate Breaking Strength in Pounds	Recommended Working Load in Pounds	Takeup Length Between Heads, Ins.	Length of Buckle Outside in Inches	Length Extended in Inches
1/4	1,350	270	4	4 3/4	12
5/16	2,250	450	4 1/4	5 1/4	13 1/2
3/8	3,350	670	4 1/2	5 3/4	14
7/16	4,650	930	5	6 1/4	16 1/2
1/2	6,250	1,250	6	7 1/2	18 1/4
9/16	8,100	1,620	7 1/4	9	23 1/8
5/8	10,000	2,000	8 1/2	10 1/2	24 1/4
3/4	15,000	3,000	9 1/4	11 3/4	27 1/2
7/8	21,000	4,200	10	12 3/4	30 1/2
1	27,500	5,500	11	14	33
1 1/8	34,500	6,900	12	15 1/2	39
1 1/4	44,500	8,900	13	16 3/4	40
1 3/8	52,500	10,500	14	18	50
1 1/2	64,500	12,900	15	19 1/2	51
1 5/8	75,500	15,100	16	21	51 1/2
1 3/4	87,000	17,400	18	23	55 1/2
1 7/8	102,500	20,500	18	23	66
2	115,000	23,000	24	31	74
2 1/8	132,500	26,500	24	31	....
2 1/4	151,000	30,200	24	32	....

Wire Rope Slings

The American Steel and Wire Company manufactures many types of wire rope slings. For practically every use the proper sling can be supplied. In ordering slings for special work, a sketch or blue print with full particulars should accompany the inquiry.

Swivel Hook with Thimble



Hook and Socket

Self-Locking Swivel Hook

Hooks

The American Steel and Wire Company manufactures Hooks of every type, solid, swivel, self-locking, etc. They can be furnished separate or fastened to sockets or thimbles, suitable for any size of wire rope.

The American Steel and Wire Company is equipped to advise the best installation for any work involving the use of wire rope and to supply the rope and fittings complete.

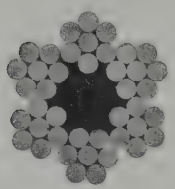
Roebling Wire Rope

Roebling Wire Rope

The John A. Roebling's Sons Company manufacture Bright and Galvanized Wire Rope in the following grades: Iron, Cast Steel, Extra Strong Cast Steel, Plough Steel and "Blue Center" (Reg. U. S. Pat. Off.) Steel. Catalogs containing complete information furnished by nearest branch office on request.

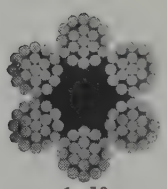
Standing Rigging Rope

Roebling 6 x 7 Galvanized Wire Rope and 6 x 19 Galvanized Wire Rope are particularly adapted for Standing Rigging.



6 x 7

Roebling 6 x 7 Galvanized Rigging Rope is recommended in diameters 1⅜" and smaller for shrouds and stays.

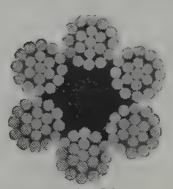


6 x 19

Roebling 6 x 19 Galvanized Rigging Rope is a more flexible rope than the 6 x 7 construction, and is recommended for Standing Rigging such as Smoke Stack Guys and Stays, Shrouds, Preventers, and also for Boom Pendants.

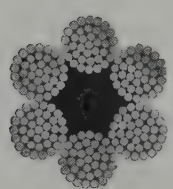
Running Rigging Rope

The construction of Roebling 6 x 19 Bright Wire Rope and 6 x 37 Bright and Galvanized Wire Rope is particularly adapted for Running Rigging.



6 x 19

Roebling 6 x 19 Bright Running Rope is recommended for Cargo Falls, Ash Hoists, Coal Hoists and for general running rope.

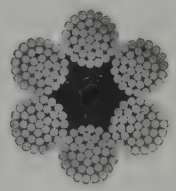


6 x 37

Roebling 6 x 37 Bright and Galvanized Running Rope is a more flexible rope than the 6 x 19 and is sometimes used for Cargo Falls, Ash Hoists and Coal Hoists when extra flexibility is necessary.

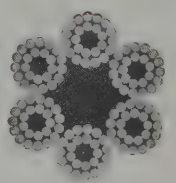
Hawsers and Mooring Lines

Roebling 6 x 37 and 6 x 24 Galvanized Wire Rope, due to their great strength and adequate flexibility, are particularly adapted for Hawsers and Mooring Lines.



6 x 37

Roebling 6 x 37 Galvanized Hawsers have great strength and the necessary flexibility for winding on the small drums of towing machines.

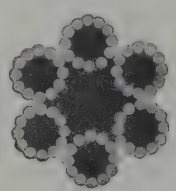


6 x 24

Roebling 6 x 24 Galvanized Mooring Lines and Hawsers have less metallic area than the 6 x 37 but are more flexible and elastic, and are recommended for Stream Lines or Anchor Lines, and for Tow Lines when automatic towing machines are not used.

Hemp Center Running Rope and Hawsers

The construction of the Roebling 6 x 12 Galvanized Wire Rope, with each strand consisting of 12 wires and a Hemp Core, makes this rope nearly as pliable, much stronger and safer, and more reliable than a manila hawser of equal size.

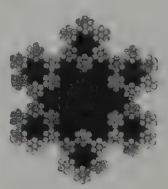


6 x 12

This type of rope is recommended as a Towing Hawser or as a Warp where maximum elasticity is essential.

Tiller Rope

Roebling Bright and Galvanized Tiller Rope is composed of 252 wires, and is made up of a hemp core around which are twisted 6 ropes, each of which consists of 6 strands, enclosing a hemp center.



Tiller Rope

This type of rope, which is extremely flexible, will pass around very small pulleys and sheaves, and consequently is particularly adapted for Tiller Rope.

New York, 117-119-121 Liberty St.
Boston, 95 Pearl St.
Philadelphia, 223 Arch St.
Chicago, 165 W. Lake St.
Cleveland, 701 St. Clair Ave., N.E.
Pittsburgh, Sandusky & Robinson Sts., N.S.

San Francisco, Cal., 624-646 Folsom St.
Los Angeles, 216 S. Alameda St.
Seattle, Wash., 900 First Ave., South
Atlanta, 69 Walton St.
Portland, Ore., 487 Lovejoy St.

JOHN A. ROEBLING'S SONS COMPANY, TRENTON, N. J.

Roebling Wire Rope Fittings

CLOSED SOCKETS
FOR USE WITH CAST STEEL AND PLOUGH STEEL WIRE ROPES

DIA. OF ROPE	CIR. OF ROPE	FOR CAST STEEL ROPES A	B	C	J	M	R	S	W	WGT. EACH	FOR PLOUGH STEEL ROPES A	B	C	J	M	R	S	W	WGT. EACH
1/4"	3/4"	2"	1 3/8"	1/2"	9/16"	1 7/16"	1/2"	5/16"	5/8"	.50 #	2"	1 3/4"	1/2"	9/16"	1 7/16"	1/2"	5/16"	5/8"	.50 #
3/8"	1"	2"	1 3/8"	5/8"	11/16"	1 7/8"	5/8"	3/8"	15/16"	.80 #	2"	1 3/4"	5/8"	11/16"	1 7/8"	5/8"	3/8"	15/16"	.80 #
1/2"	1 1/2"	2 1/2"	1 7/8"	3/4"	15/16"	2 1/2"	3/4"	7/16"	1 1/8"	1.60 #	2 1/2"	1 7/8"	3/4"	15/16"	2 1/2"	3/4"	7/16"	1 1/8"	1.60 #
5/8"	2"	3"	2 1/2"	1"	1 1/4"	3"	1"	9/16"	1 3/8"	3"	3"	2 1/2"	1"	1 1/4"	3"	1"	9/16"	1 3/8"	3"
3/4"	2 1/4"	3 1/2"	3"	1 1/16"	1 1/4"	3 1/2"	1 1/4"	5/8"	1 5/8"	4.50 #	3"	2 1/4"	1 1/4"	1 1/16"	3 1/2"	1 1/4"	5/8"	1 5/8"	4.50 #
7/8"	2 3/4"	4"	3 1/2"	1 1/16"	1 3/8"	4"	1 3/8"	11/16"	2"	7"	3 1/2"	2 3/4"	1 3/8"	1 1/16"	4"	1 3/8"	11/16"	2"	7"
1"	3"	4 1/2"	4"	1 1/4"	1 5/8"	4 1/2"	1 3/4"	13/16"	2 1/4"	11"	4"	3 1/4"	1 5/8"	1 1/4"	4 1/2"	1 3/4"	13/16"	2 1/4"	11"
1 1/8"	3 1/2"	5"	4 1/2"	1 3/8"	1 7/8"	5"	2"	15/16"	2 1/2"	16"	5"	4"	1 7/8"	1 3/8"	5"	2"	15/16"	2 1/2"	16"
1 1/4"	4"	5 1/2"	5"	1 1/2"	2 1/8"	5 1/2"	2 1/4"	1 1/16"	2 3/4"	22"	5 1/2"	4 3/4"	2 1/8"	1 1/2"	5 1/2"	2 1/4"	1 1/16"	2 3/4"	22"
1 3/8"	4 1/4"	6"	5 1/2"	1 5/8"	2 1/4"	6"	2 1/4"	1 1/8"	3"	28"	6"	5 1/4"	2 1/4"	1 5/8"	6"	2 1/4"	1 1/8"	3"	28"
1 1/2"	5"	6"	6"	1 3/4"	2 3/8"	6"	2 1/2"	1 1/4"	3 1/4"	36"	6 1/2"	6"	2 3/8"	1 3/4"	6 1/2"	2 1/2"	1 1/4"	3 1/4"	36"
1 3/4"	5 1/2"	6 1/2"	6 1/2"	2"	2 5/8"	6 1/2"	2 3/4"	1 3/8"	3 3/4"	58"	7 1/2"	7"	2 5/8"	2"	6 1/2"	2 3/4"	1 3/8"	3 3/4"	58"
2"	6 1/4"	7 1/2"	7"	2 1/4"	3"	7 1/2"	3 1/4"	1 5/8"	4 1/4"	85"	8 1/2"	9"	3"	2 1/4"	7 1/2"	3 1/4"	1 5/8"	4 1/4"	85"

SIZES 1/4" TO 1 3/4" INCLUSIVE ARE DROP FORGINGS
LARGER SIZES STEEL CASTINGS
DETAILS OF LARGER SIZE SOCKETS FURNISHED ON APPLICATION

OPEN SOCKETS
FOR USE WITH CAST STEEL AND PLOUGH STEEL WIRE ROPES

DIA. OF ROPE	CIR. OF ROPE	FOR CAST STEEL ROPES A	B	C	J	K	L	M	N	O	WGT. EACH	FOR PLOUGH STEEL ROPES A	B	C	J	K	L	M	N	O	WGT. EACH
1/4"	3/4"	2"	1 3/8"	1/2"	9/16"	1 1/16"	5/16"	1 5/16"	1 5/16"	1 1/16"	.87 #	2"	1 3/8"	1/2"	9/16"	1 1/16"	5/16"	1 5/16"	1 5/16"	1 1/16"	.87 #
3/8"	1"	2"	1 3/8"	5/8"	11/16"	1 3/8"	7/16"	1 7/16"	1 7/16"	1 3/16"	1.20 #	2"	1 3/4"	5/8"	11/16"	1 3/8"	7/16"	1 7/16"	1 7/16"	1 3/16"	1.12 #
1/2"	1 1/2"	2 1/2"	2"	1 1/16"	1 5/16"	1"	1/2"	1 7/8"	1 7/8"	1 5/16"	2.25 #	2 1/2"	2"	1 1/16"	1 5/16"	1"	1/2"	1 7/8"	1 7/8"	1 5/16"	2.25 #
5/8"	2"	3"	2 1/2"	1 1/4"	1 5/8"	1 1/4"	5/8"	2 1/4"	2 1/4"	1 9/16"	3.75 #	3"	2 1/2"	1 1/4"	1 5/8"	1 1/4"	5/8"	2 1/4"	2 1/4"	1 9/16"	3.75 #
3/4"	2 1/4"	3 1/2"	3"	1 7/16"	1 7/8"	1 1/2"	3/4"	2 5/8"	2 5/8"	1 13/16"	6"	3 1/2"	3"	1 7/16"	1 7/8"	1 1/2"	3/4"	2 5/8"	2 5/8"	1 13/16"	6"
7/8"	2 3/4"	4"	3 1/2"	1 3/4"	2 1/8"	1 3/4"	7/8"	3 1/16"	3 1/16"	2 1/16"	10"	4"	3 1/2"	1 3/4"	2 1/8"	1 3/4"	7/8"	3 1/16"	3 1/16"	2 1/16"	10"
1"	3"	4 1/2"	4"	2 1/16"	2 1/2"	2"	1"	3 1/2"	3 1/2"	2 5/16"	15.5 #	4"	4"	2 1/16"	2 1/2"	2"	1"	3 1/2"	3 1/2"	2 5/16"	15.5 #
1 1/8"	3 1/2"	5"	4 1/2"	2 5/16"	2 7/8"	2 1/4"	1 1/8"	4"	4"	2 9/16"	22"	5"	4 1/2"	2 5/16"	2 7/8"	2 1/4"	1 1/8"	4"	4"	2 9/16"	22"
1 1/4"	4"	5 1/2"	5"	2 9/16"	3 1/8"	2 1/2"	1 1/4"	4 1/2"	4 1/2"	2 13/16"	32"	5 1/2"	5"	2 9/16"	3 1/8"	2 1/2"	1 1/4"	4 1/2"	4 1/2"	2 13/16"	32"
1 3/8"	4 1/4"	6"	5 1/2"	2 13/16"	3 3/8"	2 3/4"	1 3/8"	4 7/8"	4 7/8"	3 1/16"	46"	6"	5 1/2"	2 13/16"	3 3/8"	2 3/4"	1 3/8"	4 7/8"	4 7/8"	3 1/16"	46"
1 1/2"	4 3/4"	6"	6"	3 1/16"	3 5/8"	3"	1 1/2"	5 1/4"	5 1/4"	3 5/16"	55"	6"	6"	3 1/16"	3 5/8"	3"	1 1/2"	5 1/4"	5 1/4"	3 5/16"	55"
1 5/8"	5"	6"	6"	3 1/16"	3 7/8"	3"	1 5/8"	5 5/8"	5 5/8"	3 9/16"	85"	6"	6"	3 1/16"	3 7/8"	3"	1 5/8"	5 5/8"	5 5/8"	3 9/16"	85"
1 3/4"	5 1/2"	6 1/2"	6 1/2"	3 7/16"	4 1/8"	3 1/2"	1 3/4"	6"	6"	3 13/16"	85"	7"	6 1/2"	3 7/16"	4 1/8"	3 1/2"	1 3/4"	6"	6"	3 13/16"	85"
2"	6 1/4"	7 1/2"	7"	3 13/16"	4 3/4"	4"	2"	6 3/4"	6 3/4"	4 5/16"	125"	8 1/2"	9"	4"	4 3/4"	4"	2"	6 3/4"	6 3/4"	4 5/16"	125"

SIZES 1/4 TO 1 3/4 INCLUSIVE ARE DROP FORGINGS
LARGER SIZES STEEL CASTINGS
DETAILS OF LARGER SIZE SOCKETS FURNISHED ON APPLICATION

GALVANIZED HEAVY STEEL WIRE ROPE THIMBLES
WITH DEEP SCORES

DIA. OF ROPE	CIR. OF ROPE	FOR CAST STEEL ROPES A	B	C	D	F	L	C	H	WGT. EACH	FOR PLOUGH STEEL ROPES A	B	C	D	F	L	C	H	WGT. EACH
1/2"	1 1/2"	1 1/4"	2 1/16"	1 1/16"	2 3/16"	3 1/16"	5/16"	5/16"	5/32"	.30 #	1 1/2"	2 1/4"	1 1/16"	2 3/16"	3 1/16"	5/16"	5/16"	5/32"	.30 #
5/8"	2"	1 5/8"	2 1/16"	1 3/8"	2 7/8"	4"	7/16"	7/16"	7/32"	.60 #	2"	2 1/16"	1 3/8"	2 7/8"	4"	7/16"	7/16"	7/32"	.60 #
3/4"	2 1/4"	1 7/8"	2 7/16"	1 5/8"	3 3/8"	4 3/4"	1/2"	1/2"	1/4"	1.00 #	2 1/4"	2 7/16"	1 5/8"	3 3/8"	4 3/4"	1/2"	1/2"	1/4"	1.00 #
7/8"	2 3/4"	2 1/4"	2 15/16"	1 7/8"	3 15/16"	5 1/2"	9/16"	9/16"	9/32"	1.25 #	2 3/4"	2 15/16"	1 7/8"	3 15/16"	5 1/2"	9/16"	9/16"	9/32"	1.25 #
1"	3"	2 5/8"	3 7/16"	2 1/8"	4 7/16"	6 1/4"	5/8"	5/8"	5/16"	1.60 #	3"	3 7/16"	2 1/8"	4 7/16"	6 1/4"	5/8"	5/8"	5/16"	1.60 #
1 1/8"	3 1/2"	3"	3 15/16"	2 3/8"	5"	7"	11/16"	11/16"	11/32"	2.25 #	3 1/2"	3 15/16"	2 3/8"	5"	7"	11/16"	11/16"	11/32"	2.25 #
1 1/4"	4"	3 3/8"	4 7/16"	2 5/8"	5 9/16"	7 3/4"	3/4"	3/4"	3/8"	2.75 #	4"	4 7/16"	2 5/8"	5 9/16"	7 3/4"	3/4"	3/4"	3/8"	2.75 #
1 3/8"	4 1/4"	3 3/4"	4 15/16"	2 7/8"	6 3/16"	8 1/2"	13/16"	13/16"	13/32"	3.50 #	4 1/4"	4 15/16"	2 7/8"	6 3/16"	8 1/2"	13/16"	13/16"	13/32"	3.50 #
1 1/2"	4 3/4"	4 1/8"	5 7/16"	3 1/8"	6 13/16"	9 1/4"	7/8"	7/8"	7/16"	4.75 #	4 3/4"	5 7/16"	3 1/8"	6 13/16"	9 1/4"	7/8"	7/8"	7/16"	4.75 #
1 5/8"	5"	4 1/2"	5 15/16"	3 3/8"	7 3/8"	10"	15/16"	15/16"	15/32"	6.00 #	5"	5 15/16"	3 3/8"	7 3/8"	10"	15/16"	15/16"	15/32"	6.00 #
1 3/4"	5 1/2"	4 7/8"	6 7/16"	3 5/8"	8"	10 3/4"	1"	1"	1/2"	7.50 #	5 1/2"	6 7/16"	3 5/8"	8"	10 3/4"	1"	1"	1/2"	7.50 #
1 7/8"	5 3/4"	5 1/4"	6 15/16"	3 7/8"	8 5/8"	11 5/8"	1 1/16"	1 1/16"	17/32"	8.25 #	5 3/4"	6 15/16"	3 7/8"	8 5/8"	11 5/8"	1 1/16"	1 1/16"	17/32"	8.25 #
2"	6"	5 1/2"	7 7/16"	4 1/8"	9 1/4"	12 1/2"	1 1/8"	1 1/8"	9/16"	11.75 #	6"	7 7/16"	4 1/8"	9 1/4"	12 1/2"	1 1/8"	1 1/8"	9/16"	11.75 #

SIZES 1/4 TO 1 3/4 ARE DROP FORGINGS
LARGER SIZES STEEL CASTINGS

STANDARD SOLID THIMBLES
FOR WIRE ROPE

NOTE: PIN HOLE "H" CAN BE CORED TO SUIT REQUIREMENTS

GALVANIZED CAST IRON

DIA. OF ROPE	CIR. OF ROPE	FOR CAST STEEL AND PLOUGH STEEL ROPES H	T	C	D	L	R	WGT. EACH
1/4"	1 1/2"	3/4"	7/8"	5/16"	2 1/8"	3 1/16"	1/2"	.60 #
5/8"	2"	1"	1 1/4"	7/16"	3 3/8"	5 1/16"	1 1/16"	2.25 #
3/4"	2 1/4"	1 1/16"	1 1/4"	7/16"	3 3/8"	5 1/16"	1 1/16"	2.25 #
7/8"	2 3/4"	1 5/16"	1 1/2"	5/8"	4 1/2"	6 9/16"	1"	4.50 #
1"	3"	1 5/16"	1 1/2"	5/8"	4 1/2"	6 9/16"	1"	4.50 #
1 1/8"	3 1/2"	1 11/16"	1 7/8"	13/16"	5 3/8"	7 7/8"	1 3/16"	8 #
1 1/4"	4"	1 11/16"	1 7/8"	13/16"	5 3/8"	7 7/8"	1 3/16"	8 #
1 3/8"	4 1/4"	2 1/8"	2 1/8"	15/16"	6 3/8"	9 1/8"	1 3/8"	15 #
1 1/2"	4 3/4"	2 1/8"	2 1/8"	15/16"	6 3/8"	9 1/8"	1 3/8"	15 #
1 5/8"	5"	2 1/8"	2 1/8"	15/16"	6 3/8"	9 1/8"	1 3/8"	15 #
1 3/4"	5 1/2"	2 1/2"	2 1/2"	1 1/8"	7 1/2"	10 3/4"	1 5/8"	22 #
1 7/8"	5 3/4"	2 1/2"	2 1/2"	1 1/8"	7 1/2"	10 3/4"	1 5/8"	22 #
2"	6"	2 1/2"	2 1/2"	1 1/8"	7 1/2"	10 3/4"	1 5/8"	22 #

STANDARD HAWSER THIMBLES
FOR STREAMLINES TOWLINES ETC.
EXTRA HEAVY STEEL CASTINGS
GALVANIZED

DIA. OF ROPE	CIR. OF ROPE	A	B	F	D	L	C	H	WGT. EACH
5/8"	2"	3"	4 1/2"	1 7/8"	4 1/2"	7 1/2"	7/16"	1/2"	3.50 #
3/4"	2 1/4"	3"	5 1/4"	2 1/16"	5 1/16"	8 7/16"	1/2"	9/16"	5.00 #
7/8"	2 3/4"	3 3/4"	5 3/4"	2 1/16"	5 1/16"	9 1/4"	5/8"	3/4"	6.50 #
1"	3"	3 3/4"	5 3/4"	2 1/16"	6 1/4"	9 1/4"	5/8"	3/4"	6.50 #
1 1/8"	3 1/2"	4 1/4"	6 1/4"	2 7/8"	7 1/8"	10 1/2"	7/8"	1"	13 #
1 1/4"	4"	4 1/4"	6 1/4"	2 7/8"	7 1/8"	10 1/2"	7/8"	1"	13 #
1 3/8"	4 1/4"	4 3/4"	7 1/8"	2 7/8"	8 3/8"	12 1/8"	1"	1 1/8"	17 #
1 1/2"	4 3/4"	5"	8"	3 1/8"	8 3/4"	14"	1"	1 1/8"	19 #
1 5/8"	5"	5"	8"	3 1/8"	9 1/4"	14"	1"	1 1/8"	28 #
1 3/4"	5 1/2"	5"	8"	3 1/8"	9 1/4"	14"	1"	1 1/8"	28 #
1 7/8"	5 3/4"	5 1/2"	9"	3 1/2"	10 1/8"	16"	1 1/16"	1 1/2"	43 #
2"	6"	6"	9"	3 1/2"	10 1/8"	16"	1 1/16"	1 1/2"	43 #

SIZES 1/4 TO 1 3/4 ARE DROP FORGINGS
LARGER SIZES STEEL CASTINGS
DETAILS OF LARGER SIZE SOCKETS FURNISHED ON APPLICATION

Other Products

Roebling Wire Rope Slings are made in many standard sizes, and are recommended for handling heavy materials in ship construction.

Among the great variety of Roebling wire rope fittings and accessories are the following: Wire Rope Sockets (Open and Closed), Thimbles, Hooks, Clips, Clamps, Hawser Reels, splicing Vises and Outfits, and Alligator Wrenches.

Roebling Electrical Wires and cables of all types and sizes can be furnished for ship wiring and outfitting.

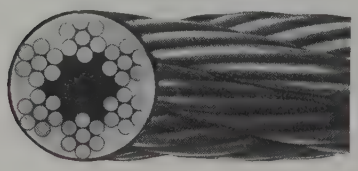
Welding Wire can also be furnished for both Gas and Electric Welding.

Complete Catalogs furnished by nearest branch office on request.

Wire and Fibre Rope

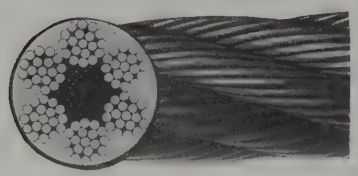
Waterbury Wire Rope

The Waterbury Company manufactures Wire Rope for all purposes in the following materials: Iron, Crucible Cast Steel, Plow Steel and Green Strand Giant Plow Steel.



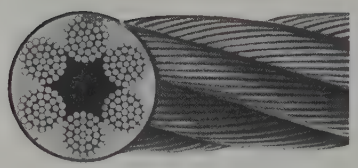
Haulage, Transmission and Standing Rope

Construction: 6 x 7. A relatively stiff rope capable of resisting external wear or abrasion. Large sheaves are necessary.



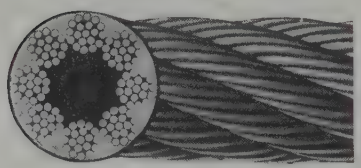
Hoisting Rope

Construction: 6 x 19. The wires are smaller than 6 x 7 and 6 x 12. This rope is less able to resist abrasion, but can be more readily bent.



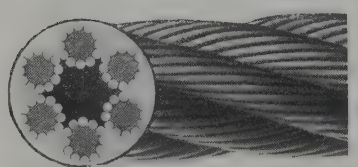
Special Flexible Hoisting Rope

Construction: 6 x 37. The wires are still smaller than in 6x19. This rope may be used over fairly small sheaves but is not adapted for much external wear.



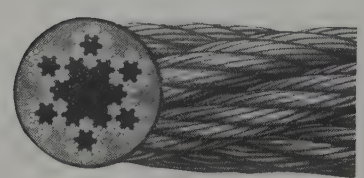
Extra Flexible Hoisting Rope

Construction: 8 x 19. More flexible than 6 x 19 and can be used over smaller sheaves. In flexibility, it is the same as 6 x 37, but not so strong.



Running Rigging and Mooring Lines

Construction: 6 x 12. Is generally made galvanized. It has a hemp core in each strand. Not as strong but more flexible than 6 x 19.

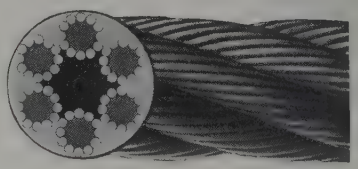


Tiller Rope

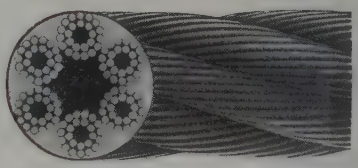
Construction: 6 x 7. It is the most flexible rope made. Can be bent around very small sheaves. Is constructed of very fine wires. For light loads.

Hawsers and Mooring Lines

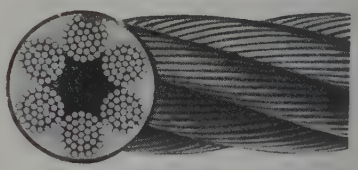
Construction: 6 strands—12 wires to the strand—7 hemp cores.



Construction: 6 strands—24 wires to the strand—7 hemp cores.

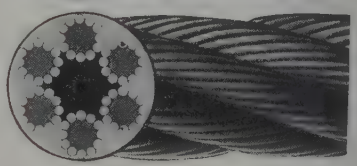


Construction: 6 strands—37 wires to the strand—1 hemp core.



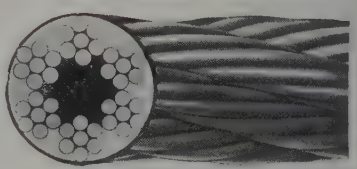
Running Rope

Construction: 6 strands—12 wires to the strand—7 hemp cores.



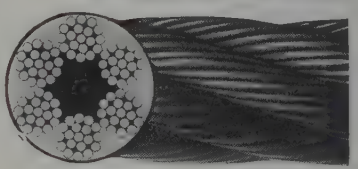
Yacht Rigging or Guy Rope

Construction: 6 strands—7 wires to the strand—1 hemp core.



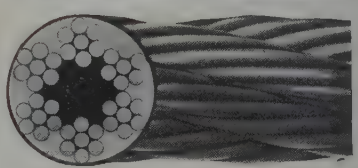
Flexible Yacht Rope

Construction: 6 strands—19 wires to the strand—1 hemp core.



Ship's Rigging or Guy Rope

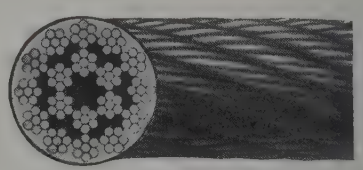
Construction: 7 or 12 wires strand—1 hemp core.



Non-Spinning Hoisting Rope

Construction: 18 strands, 7 wires to the strand with hemp center. Used principally as a hoisting rope. Is non-rotating, i. e., non-spinning, and made to overcome the spinning of loading buckets, beams, etc. Has greater flexibility and wearing surface, and more sectional area to stand a larger amount of wear and tear than wire rope of 6 strands, 19 wires.

Outer strands and inner rope strands are twisted in opposite directions.

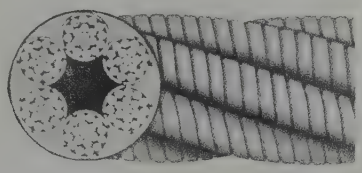


Non-Spinning Hoisting Rope

Wire and Fibre Rope

Waterbury Armored Wire Rope (Gore Patent)

Waterbury Armored Wire Rope (Gore Patent) embodies the first radical and important improvement in wire rope construction in many years. Each strand of the rope is wound with flat steel wire having convex edges which forms a protective armor.



Waterbury 4-Strand Manila Rope

The convex edges permit the flexing of the rope without any creeping of the armor wires, while the flat wire serving takes the abrasion on crown of strands from the tensile strength wires, also at the point the strands adjoin and wires converge and chafe during flexing movement.

The life of this rope is thus materially lengthened (this increase ranging from 50 to 150 per cent according to conditions) and the initial factor of safety is maintained longer in Waterbury Armored Wire Rope (Gore Patent) than in any other construction.

Waterbury Fibreclad

Waterbury Fibreclad is a wire rope each strand of which is served with the best grade of tarred Russian Hemp Marline. This fibre covering prevents the chafing and wear of the wire strands during flexing movements, and after being in service a short time the fibre packs into the interstices of the strands resulting in a rope having a smooth cylindrical surface.

The tarred Marline covering also protects the wire strands of the rope from moisture or water, eliminating the possibility of rust and also preventing foreign matter from working into the wire strands.

Waterbury Fibreclad (Marline Covered Wire Rope)

Unlike Manila Rope, Fibreclad is unaffected by changes in atmospheric conditions; it will not stretch in dry weather nor contract in wet weather and will not swell or jam nor ice up in freezing weather.

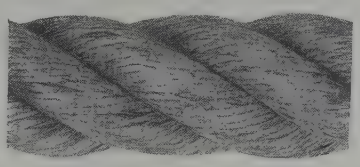
Fibreclad is about one-third the diameter of Manila Rope of the same strength, permitting the use of smaller blocks and reducing expense. Its weight is 50 per cent less than that of Manila of the same strength.

Fibreclad will coil down as readily as Manila Rope. As the wires are fibre covered it is more easily handled than wire rope of standard construction and is less cumbersome than Manila.

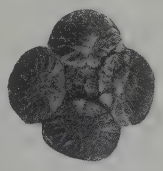
It will not rust or rot out in service as the fibre covering is impregnated with lubricant and preserves the wires. As it wears longer the ultimate cost is lower than that of either plain wire or Manila rope.

Waterbury Standard Manila Rope

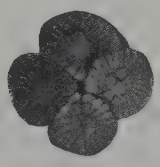
Waterbury Standard Manila Rope is in either 3 or 4 strand, the latter with or without heart. This grade of rope is most suitable for general work and most commonly called for. Waterbury Brand is made of selected and tough Manila fibre, and is the standard by which other grades of rope are judged.



Waterbury 4-Strand Manila Rope



(With heart)



(Without heart)

Waterbury Hoisting or Fall Rope is generally 4 strand, with heart, made of harder lay than ordinary 4-strand rope, to make the rope firm and hold its shape under stress or pressure. Sizes run 2 1/4 inch to 6 inch circumference.

Steamboat Lines for docking vessels are generally medium soft laid, since this makes them easier to handle and withstand sudden strains.

Wheel Rope for steering gear is made 4-strand with heart. The lay is not quite so hard as Hoisting Rope, being made flexible for use over wheel drums.

The best of Manila fibre enters into the manufacture of Yacht rope. The hemp being selected for the purpose, color and texture being considered, as well as strength and durability. This class of rope is used for yacht rigging, is of medium soft lay for easy handling, and made 3 or 4 strands, as desired.

Towing Lines, or Canal Lines, are generally Bolt Rope Stock, although in some cases users specify a pure good grade of Manila rope known as standard first quality (Waterbury Brand). Towing Lines are medium soft lay, i. e., with slightly less twist than generally put in standard ropes.

Branch Offices

In buying Waterbury Products you are assured of as high a quality as it is possible to make, also prompt and courteous attention. Complete stocks are carried at the following Branch Offices:—

Chicago, Ill., 1315-21 West Congress St.
San Francisco, Cal., 151 Main St.
New Orleans, La., 1018 Maison Blanche Bldg.

Crescent Hemp-Clad and Plain Wire Rope

Uses

Crescent Wire Ropes have been designed to meet a wide variety of shipboard and shipyard conditions, and all sizes and degrees of flexibility are obtainable. Standard Ropes are kept in stock for service in Hoisting, Hauling, Guy Ropes, Derricks, Cableways, Steam Shovels, Inclined Railways, Dredging, Pile Driving, Drilling, and Conveying. Wire rope accessories are also furnished.

Construction of Crescent Hemp-Clad Wire Rope

Crescent Hemp-Clad Wire Rope consists of a hemp center surrounded by five or six strands of steel wire, each spirally bound with strands of the highest grade of yacht marline. The marline covering prevents friction between the strands when the rope is in use, affords a protection against moisture, and keeps from the wire any abrasive and destructive foreign matter. It also offers protection to workmen's hands against broken wires.

Crescent Hemp-Clad Wire Rope

APPROXIMATE COMPARISON OF STRENGTH

Manila Rope			Crescent Hemp-Clad Wire Rope Diameter			
Circumference	Diam.	Approximate breaking strain	Iron	Crucible steel	Extra strong crucible steel	Plow steel
1¾	9/16	2,250	¼	.....	.....	.....
2	5/8	3,000	.....	.....	.....	.....
2¼	3/4	4,000	5/16	¼	.....	.....
2½	13/16	5,000	.....	.....	1/4	.....
2¾	7/8	5,800	.....	5/16	.....	¼
3	1	7,000	.....	.....	5/16	.....
3¼	1 1/16	8,000	½	.....	.....	5/16
3½	1 1/8	9,200	.....	3/8	.....	.....
3¾	1 1/4	11,000	.....	.....	3/8	.....
4	1 5/16	12,000	5/16	.....	.....	3/8
4¼	1 3/8	13,500	.....	7/16	.....	.....
4½	1½	15,500	.....	.....	7/16	.....
4¾	1 9/16	17,000	3/4	½	.....	7/16
5	1 5/8	19,000	.....	9/16	½	.....
5½	1¾	23,500	7/8	.....	9/16	½
6	2	27,000	.....	5/8	.....	.....
6½	2 1/8	31,500	1	.....	5/8	5/8
7	2¼	37,000	1 1/8	¾	.....	.....
7½	2½	42,000	.....	.....	¾	.....
8	2 5/8	48,000	1¼	7/8	.....	¾
8½	2 7/8	54,000	.....	.....	7/8	.....
9	3	61,000	1 3/8	1	.....	7/8
9½	3 1/8	67,000	1½	.....	1	.....
10	3 3/8	75,000	.....	1 1/8	.....	1

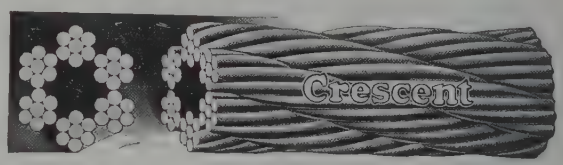
Advantages of Crescent Hemp-Clad Wire Rope

For marine purposes Crescent Hemp-Clad Wire Rope is without an equal. It is flexible, can be coiled and handled as easily as manila rope, does not swell when wet as the latter does, is not affected by ice in winter, and can be fastened around cleats or bits with the ease of manila rope. Its diameter is about 1/3 that of manila rope of equal strength, permitting the use of smaller blocks, and its weight 50% lighter. It will not rust, the lubricant in the fibre being in constant contact with the wire.

Crescent Wire Rope

Crescent Wire Ropes are made with hemp or steel core in Swedish Iron, Crucible Cast Steel, Mild Plow Steel, Plow Steel and Improved Plow Steel.

Crescent 7-Wire Single Strand
For Guys, Etc.



Crescent 6 x 7 Rope
For Haulage, Guy Ropes, Track Ropes, on Cableways, etc.

Crescent 6 x 19 Hoisting Rope
For Hoisting, Dredging and Main Cableways

Crescent 6 x 37 Special Extra Flexible Hoisting Rope
For Very Small Sheaves and Drums

Crescent 8 x 19 Flexible Hoisting Rope
For Use on Small Sheaves and Drums

Service

In order to insure absolutely satisfactory performance from Crescent Wire Ropes, the manufacturers offer users the benefit of a wide experience, and will recommend the most suitable rope for any given service. Branch Offices located at:

New York, 124 White Street
Cleveland, Rockefeller Building
New Orleans, Menge Hardware and Supply Co.
San Francisco, Rolph, Mills and Co.
Seattle, Rolph, Mills and Co.
Portland, Ore., Rolph, Mills and Co.

GEO. C. MOON CO., INC., GARWOOD, N. J.

Leschen Wire Rope

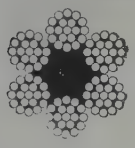


Fig. 1
Hoisting Rope
(6x19)

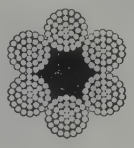


Fig. 2
Hoisting Rope
(6x37)

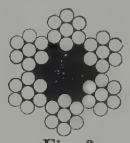


Fig. 3
Guy and Rigging Rope
(6x7)

Fig. 4
Running Rope and Mooring Line (6x12)

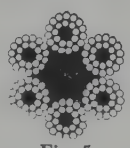


Fig. 5
Mooring Line and Hawser
(6x24)

Leschen Wire Rope

Leschen Wire Ropes are made in all standard grades, such as Plow Steel, Cast Steel and Iron, and in addition we are the designers and sole manufacturers of "Hercules" (Red-Strand) Wire Rope, which is a wire rope that is exceptionally efficient for heavy duty of all kinds because of the great resistance it offers to wear and stresses. It is especially recommended for use on cranes, derricks, cargo hoists, etc.

All materials used in the manufacture of Leschen Wire Rope are high grade in every respect, and in order to insure that our high standing is uniformly maintained, all material is subjected to exacting tests.

The Home Office and Factory of A. Leschen & Sons Rope Co. are at St. Louis, Mo. Branch stores are located at New York, Chicago, Denver and San Francisco.

"HERCULES" (RED STRAND) HOISTING ROPE. 6 STRANDS OF 19 WIRES EACH—1 HEMP CORE (FIG. 1)

Diam. in Inches	List Price per Foot	Approx. Strength in Tons of 2000 Lbs.	Proper Working Load in Tons of 2000 Lbs.	Approx. Weight per Foot	Diam. in Ft. of Drum or Sheave Advised
3/8	.14½	6.75	1.35	.22	1½
7/16	.15½	9.4	1.9	.30	1¾
1/2	.17	12.1	2.4	.39	2
9/16	.19	14.5	2.9	.50	2¼
5/8	.22½	19	3.8	.62	2½
3/4	.31	26.3	5.3	.89	3
7/8	.39	35	7	1.20	3½
1	.50	45	9	1.58	4
1 1/8	.62	56	11	2	4½
1 1/4	.75	69	14	2.45	5
1 3/8	.90	84	17	3	5½
1 1/2	1.10	98	20	3.55	6

"HERCULES" (RED STRAND) HOISTING ROPE. 6 STRANDS OF 37 WIRES EACH—1 HEMP CORE (FIG. 2)

3/8	$0.17½	5.30	1.06	.22	1
7/16	.18½	7.50	1.5	.30	1.15
1/2	.20	9.75	1.9	.39	1.33
9/16	.23	12.50	2.5	.50	1.50
5/8	.27	16	3.2	.62	1.75
3/4	.38	23	4.6	.89	1.83
7/8	.46	29	5.8	1.20	2.16
1	.59	37	7.4	1.58	2.50
1 1/8	.75	46	9.2	2	2.83
1 1/4	.86	58	11	2.45	3.20
1 3/8	1.05	71	14	3	3.50
1 1/2	1.25	84	17	3.55	3.75

PLOW STEEL HOISTING ROPE. 6 STRANDS OF 19 WIRES EACH—1 HEMP CORE (FIG. 1)

3/8	.12½	5.75	1.15	.22	1.50
7/16	.13	8	1.6	.30	1.75
1/2	.14	10	2	.39	2
9/16	.16	12.3	2.4	.50	2.25
5/8	.19	15.5	3.1	.62	2.5
3/4	.26	23	4.6	.89	3
7/8	.34	29	5.8	1.20	3.5
1	.43	38	7.6	1.58	4
1 1/8	.54	47	9.4	2	4.5

CAST STEEL HOISTING ROPE. 6 STRANDS OF 19 WIRES EACH—1 HEMP CORE (FIG. 1)

3/8	.09½	4.8	.96	.22	1.50
7/16	.10	6.5	1.30	.30	1.75
1/2	.11	8.4	1.68	.39	2
9/16	.12	10	2	.50	2.25
5/8	.14	12.5	2.5	.62	2.5
3/4	.19	17.5	3.5	.89	3
7/8	.24	23	4.6	1.20	3.5
1	.31	30	6	1.58	4
1 1/8	.38	38	7.6	2	4.5

GALVANIZED IRON GUY AND RIGGING ROPE. 6 STRANDS OF 7 WIRES EACH—1 HEMP CORE (FIG. 3)

Diam. in Inches	Circum. in Inches	List Price Per Foot	Approx. Strength in Tons of 2000 Lbs.	Approx. Weight per Foot
3/8	1 1/8	.04½	1.95	.22
7/16	1 1/4	.05	2.35	.30
1/2	1 1/2	.06	3.39	.39
9/16	1 3/4	.07	4.46	.50
5/8	2	.08	5.7	.62
3/4	2 1/4	.09	7.8	.89
13/16	2 1/2	.11	9.4	1.03
7/8	2 3/4	.13	11.1	1.20
1	3	.15	14.1	1.58
1 1/16	3 1/4	.17½	16.1	1.77
1 1/8	3 1/2	.19½	18	2
1 3/16	3 3/4	.22½	19	2.21
1 1/4	4	.25	23	2.45

GALVANIZED CAST STEEL RIGGING AND GUY ROPE. 6 STRANDS OF 7 WIRES EACH—1 HEMP CORE (FIG. 3)

3/8	1 1/8	.06	4.2	.22
7/16	1 1/4	.07	5	.30
1/2	1 1/2	.08¾	7	.39
9/16	1 3/4	.11	9	.50
5/8	2	.13	11.7	.62
3/4	2 1/4	.18½	16.8	.89
13/16	2 1/2	.22	19.	1.03
7/8	2 3/4	.24¾	22	1.20
1	3	.31¾	28	1.58
1 1/16	3 1/4	.35	31	1.77
1 1/8	3 1/2	.39½	34	2
1 3/16	3 3/4	.44	38	2.21
1 1/4	4	.47	42	2.45

GALVANIZED CAST STEEL RIGGING AND GUY ROPE. 6 STRANDS OF 19 WIRES EACH—1 HEMP CORE (FIG. 1)

3/8	1 1/8	.10¼	4.2	.22
7/16	1 1/4	.11	5	.30
1/2	1 1/2	.12	7	.39
9/16	1 3/4	.13	9	.50
5/8	2	.15¼	11.7	.62
3/4	2 1/4	.20¾	16.8	.89
13/16	2 1/2	.23½	19	1.03
7/8	2 3/4	.26¼	22	1.20
1	3	.34	28	1.58
1 1/16	3 1/4	.38	31	1.77
1 1/8	3 1/2	.41¾	34	2
1 3/16	3 3/4	.46	38	2.21
1 1/4	4	.50	42	2.45

GALVANIZED CAST STEEL RUNNING ROPE. 6 STRANDS OF 12 WIRES EACH—7 HEMP CENTERS (FIG. 4)

9/16	1	$0.07	1.98	.10
5/8	1 1/8	.07¾	2.85	.14
3/4	1 1/4	.08½	3.9	.20
1/2	1 1/2	.09	5	.26
9/16	1 3/4	.11	6.5	.33
5/8	2	.14	8	.42
3/4	2 1/4	.16½	11.5	.59
13/16	2 1/2	.20	13.5	.68
7/8	2 3/4	.23	15.5	.80
1	3	.27	19.5	1.05
1 1/16	3 1/4	.30	22.5	1.18

GALVANIZED STEEL MOORING LINES AND HAWSERS. 6 STRANDS OF 24 WIRES EACH—7 HEMP CORES (FIG. 5)

3/4	2 1/4	$0.22	14	.78
13/16	2 1/2	.25	17	.90
7/8	2 3/4	.29	20	1.05
1	3	.35	25	1.38
1 1/16	3 1/4	.40	27	1.54
1 1/8	3 1/2	.45	34	1.75
1 3/16	3 3/4	.51	38	1.93
1 1/4	4	.57	42	2.15
1 5/16	4 1/4	.62	50	2.62
1 3/8	4 1/2	.67	55	2.92
1 1/2	4 3/4	.73	63	3.10
1 5/8	5	.80	74	3.63
1 11/16	5 1/4	.86	76	3.86
1 3/4	5 1/2	.93	82	4.24
1 13/16	5 3/4	1.00	88	4.48
1 15/16	6	1.06	98	5.09
2	6 1/4	1.14	106	5.51

Madesco Tackle Blocks

Madesco Tackle Blocks

Madesco Tackle Blocks are made in a large variety of types for different purposes, as briefly described on this and the following page. The sturdiness of these blocks is assured by the fact that each part is constructed on engineering principles with a generous margin of safety, and that the straps, axle and fittings must all pass the most rigid inspection. The sheaves are thoroughly galvanized—the rope score smooth and free from those defects which shorten the life of the rope.

The Madesco tackle blocks are manufactured in our own modern plant, devoted exclusively to this work. Quick deliveries are assured because of large stock maintained and efficient supervision of shipment.

Madesco Tackle Blocks may also be obtained from the Coston Supply Co., 23 Water Street, New York City—Distributors, New York District; Wright and Lacy, 244 California St., San Francisco—Pacific Coast representative; Standard Supply and Hardware Co., New Orleans, La.; C. W. Greene Co., Tampa, Fla.; and from the Cameron and Barkley Co., Jacksonville, Fla., and Miami, Fla.

Triple Wide Mortise Wood Block with Regular Shackle

Wide and Regular Mortise Blocks

Madesco Wood Blocks are made with wide or regular mortise for general marine work and for use with manila rope. Either type can be furnished with one, two or three sheaves, as desired. The shells are of carefully selected hardwood, free from flaws of any kind, and are cross-riveted in the wide mortise type for additional strength and safety. The straps are of steel, and either self-lubricating patent rollers or common iron bushings can be furnished with both types.

The wide mortise tackle block illustrated above is of particularly heavy construction and is admirably adapted for use wherever a rugged block is needed. The regular mortise block is sometimes referred to as the "Inside Strap" Tackle Block and is suitable for lighter duty.

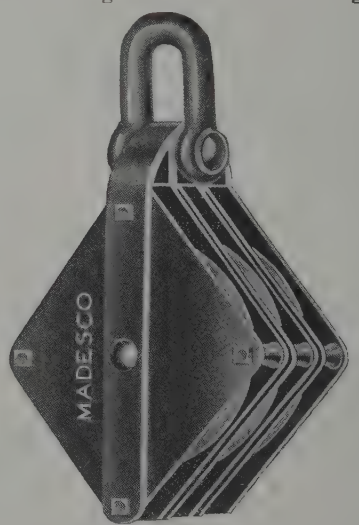
"Quaker" Cargo Hoister with Shackle

"Quaker" Cargo Hoister

The "Quaker" Cargo Hoister shown above is suitable for heavy hoisting duty on shipboard or for large contracting work where either manila or wire rope is used. It is furnished with a single sheave only, with heavy malleable iron shell, drop forged steel straps, and self-lubricating flanged bushing.

Diamond Shell Tackle Block

The Madesco Diamond Shell Tackle Block shown below, is non-toppling, and is particularly adapted for use where the position of the block remains constant relative to the leads. This type of block, which is suitable for use with wire rope, has sheet steel shell and steel straps, and can be furnished with one, two or three sheaves and with either self-lubricating or common iron bushings.



Heavy Pattern Triple Diamond Shell Block with Regular Shackle

Madesco Tackle Blocks

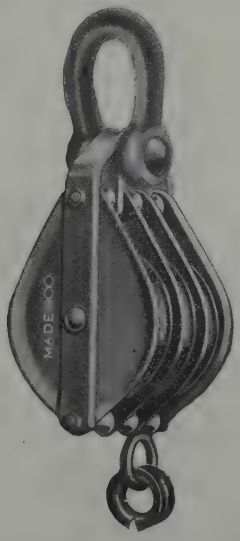
Double Oval Shell Block with Stiff Swivel Hook

Oval Shell Tackle Block

The Madesco Oval Shell Tackle Block, as illustrated above, is of heavy construction and suitable for heavy hoisting duty on board ship where the position of the block changes, since the leads meet no interference coming off the block. It can be used with wire rope and is furnished with one, two or three sheaves and with either self-lubricating or common iron bushings.

Pressed Steel Shell Tackle Block

This type of block, shown below, is for use with manila rope, and is preferred in some cases to wood blocks. It is furnished with one, two or three sheaves and is similar in construction to the Oval Shell Block mentioned above.



Heavy Pressed Steel Shell Triple Block with Regular Shackle

Snatch and Gin Blocks

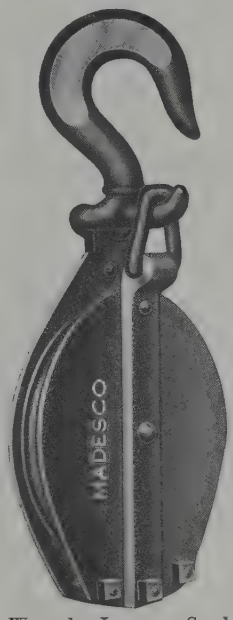
Snatch Blocks are furnished in all types, except of course, the Cargo Hoister, and made with heavy wood shell for manila rope and wrought iron or steel shell for wire rope as shown below.

Gin blocks, with single sheave and for manila rope, are made for light hoisting where a light, inexpensive block is desired.

Tackle Block Fittings

The following fittings may be supplied with Madesco Tackle Blocks, or on separate order: Regular Shackle, Upset Shackle, Reverse Upset Shackle, Swivel Jaw, Swivel Eye, Stiff Eye, Loose Front Hook, Loose Side Hook, Loose Swivel Hook, Stiff Swivel Hook, Stiff Front Hook, Side Sister Hook, and Loose Ring. Special Fittings furnished on order.

Heavy Wood Snatch Block



Wrought Iron or Steel Snatch Block for Wire Rope

How to Order

When ordering any of the various types of Madesco tackle blocks, be sure to cover the following:—Length of shell, diameter of sheave, number of sheaves, diameter or circumference of rope, kind of rope, kind of bushing, kind of fitting, galvanized or japanned straps and fittings, with or without beckets.

Rigging Details

Madesco Rigging Details consist of small castings and forgings similar to those shown in the drawing of the 5-ton Cargo Handling Gear in the Planning Section, and of all such castings and forgings for cargo handling gears of greater or lesser capacity.

McMillan Tackle Blocks

For Cargo Hoisting

McMillan Iron and Steel Tackle Blocks are designed for heavy lifting and can be used with wire, manila rope or chain. They are particularly adapted for cargo hoisting and are furnished in a wide variety of styles for all purposes.

The metal Cargo Hoisting Blocks, shown below, are made extra strong for rapid and heavy hoisting and are furnished with bronze self-lubricated

With Stiff Swivel Hook

With Swivel Eye and Shackle

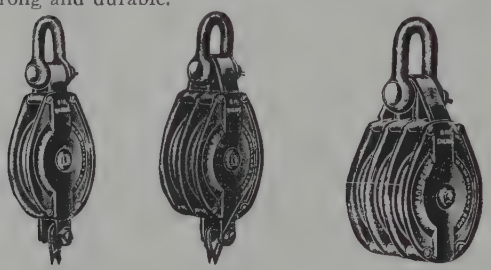
Metal Cargo Hoisting Blocks

bushed galvanized iron sheaves for either manila rope, wire rope, served wire or chain.

These blocks can also be furnished with swivel eyes and shackles or other standard fittings.

Heavy Wire Rope Snatch Block

Heavy Wire Rope Snatch Blocks, as illustrated above, are made for heavy work and will be found strong and durable.



Single Double Triple

Heavy Wire Rope Blocks with Shackle

Heavy Wire Rope Blocks can be furnished, either with shackles, as shown above, or with hooks, and overhauling weights.

Extra Heavy Wire Rope Blocks, as shown in the following column, can also be furnished single, double or triple, with lashing shackles or regular shackles, and diamond or pear pattern.

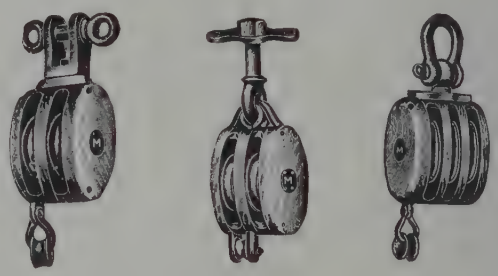
Diamond Pattern

Pear Pattern

Extra Heavy Wire Rope Blocks with Lashing Shackles

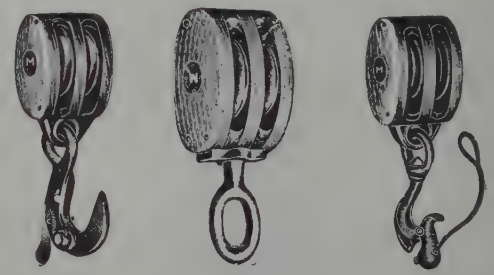
For Life Boats and Anchor Davits

McMillan Boat Davit Blocks, as shown below, are made in wood or iron and are furnished with or without beckets, and with one, two, three or four sheaves. These blocks are sturdy and well built, and arranged so as to prevent wear on sides of rope.



Davit Blocks

The Releasing Hook Block, shown below, is fitted with releasing hook which has been approved by the Board of Supervising Inspectors of Steam Vessels.

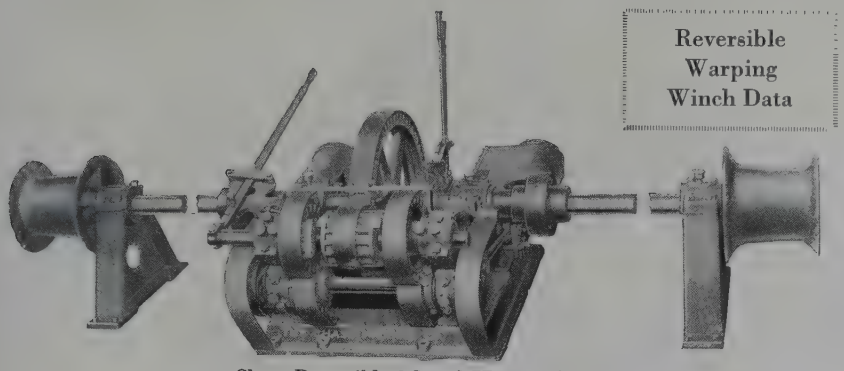


Davit Blocks

Other Products

W. H. McMillan's Sons also manufacture a large number of other types of tackle blocks and similar equipment for marine purposes, including Dead Eyes, Hearts, Topmast Trucks, Ship's Ladder Steps, Mast Hoops, Hanks, Lignumvitae wood (in the log, sawed or turned to shape), Cargo Block Sheaves, and Bushings, all types of Shackles, Cargo and Hatch Hooks, Ball Overhauling Weights, Iron Rollers, Heavy Wide Mortice Blocks, Jib Sheet Blocks, etc.

Ship Winches and Mooring Machines



Chase Reversible 2-Speed Warping Winch

Reversible Warping Winch Data

Two speeds.

Double cylinder 8″ x 8″ engine.

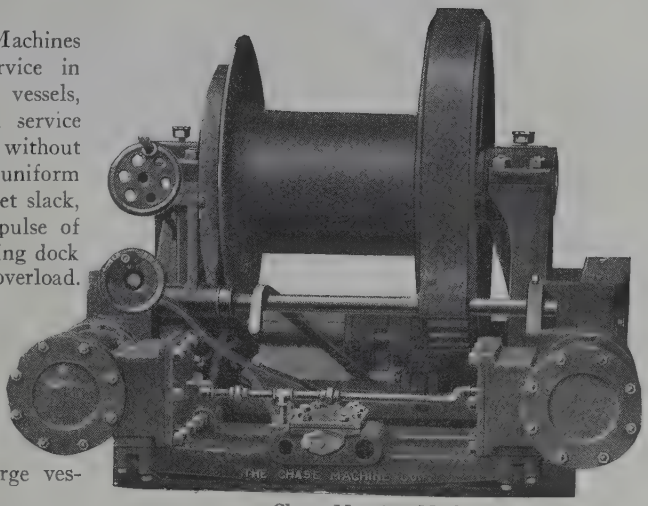
Fore and aft over all, 66″.

Shaft length as required.

Net weight (about) 6,500 pounds.

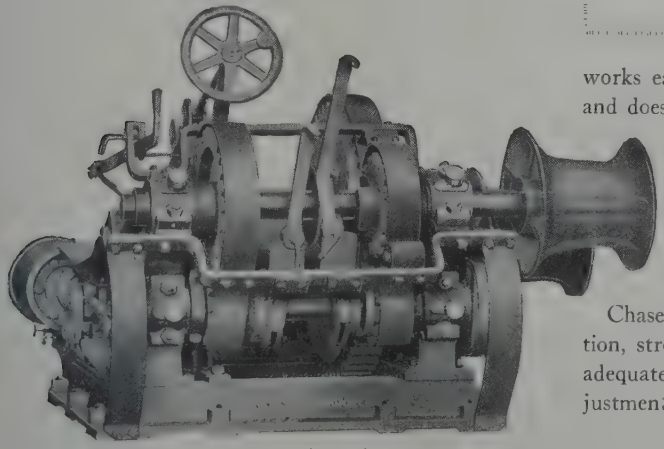
Mooring Machine

Chase Mooring Machines perform important service in docking and warping vessels, but the most essential service is in automatically and without attention maintaining uniform tension in the lines, so that they can neither get slack, permitting the vessel to range under the impulse of the unloading clams, breaking lines and damaging dock cargo handling apparatus, nor break under an overload. Tension in the lines is subject to rapid alteration of trim and draft as cargo is poured in or discharged, action of tides, and waves from passing vessels. Two machines are set forward of the hatch space and two aft, giving two breast lines and two shift lines, and additional machines for a breast line at bow and stern are recommended on large vessels. For data see table below.



Chase Mooring Machine

Size of Engine	Overall Dimensions			Net Weight Lbs.	Size of Cable	Number Required	Length of Ship
	Length	Width	Height				
6″ x 6″	48″	48″	38″	2500	¾″	4	250′
8″ x 8″	56″	56″	45″	4100	1″	4	350′
8″ x 10″	63″	63″	52″	5300	1⅛″	4 to 6	600′



Chase Reversible Cargo Hoist

Reversible Cargo Hoist

The Reversible Cargo Winch illustrated has two speeds, and is equipped with the improved Chase reverse valve, a simple, effective, and thoroughly satisfactory arrangement, which works easily and certainly, does not get out of order, and does not leak steam.

Double cylinder 8″ x 8″ engine.

Drum 12″ diameter, 15″ long, 26″ flanges.

Overall dimensions, 68½″ along shaft, by 66″ by 50″ high.

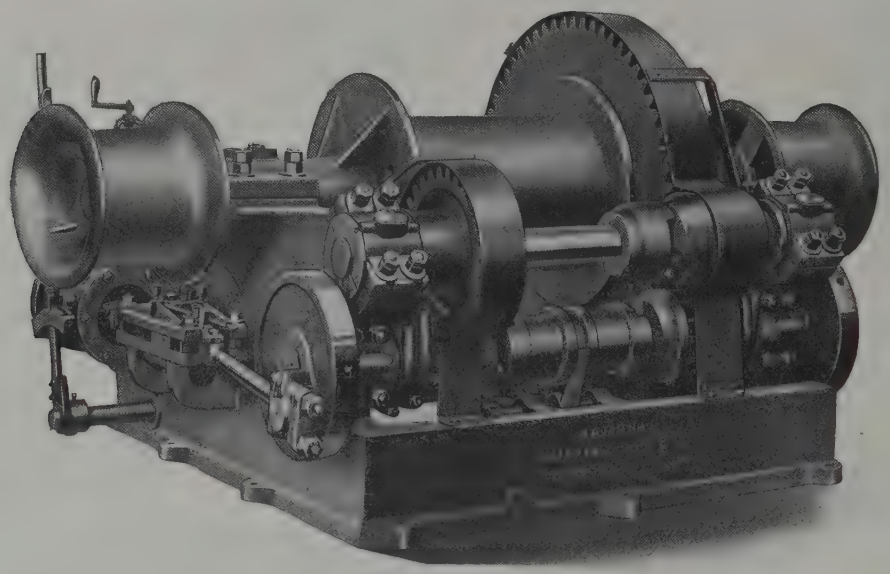
Net weight 5,500 pounds.

Chase winches are simple in design, handy in operation, strongly built, with ample wearing surfaces, and adequate provision for lubrication, take up, and adjustment.

THE CHASE MACHINE CO.

2313 ELM ST., N. W., CLEVELAND, OHIO

National Two-Speed Winch



The National Standard Cargo Winch

Two Speed Cargo Winch

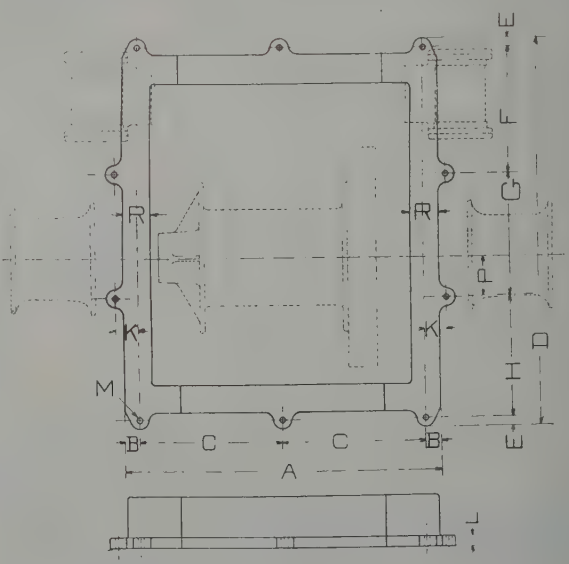
The "National" Steam Cargo Winch, illustrated above, is designed to handle light loads at a fast speed and heavy loads at slow speed and is, therefore, better adapted for general cargo service than any other type of winch. The link operating lever and throttle valve are conveniently arranged for the operator and all gearing is completely guarded to insure safety.

Construction

"National" Winches are particularly rugged throughout to meet severe service at the hands of inexperienced operators. The drum barrel is of large diameter and warping ends are fitted at each end of the drum shaft. They are fitted with "Stevenson" reversing link motion with large surfaces to stand the heavy wear and tear to which these parts are subjected. All bearings are fitted with renewable bronze liners. The piston rods are tobin bronze. The engine shaft is made square in the way of sliding clutch eliminating feather key. Gearing is especially strong designed, cast from metal patterns. The first reduction has machine-cut teeth to insure quiet running. The crank pin is of extra large diameter and both crank pin and crosshead pin are fitted with adjustable brasses. The steam stop valve is fitted with renewable screw and nut. These winches are built on a duplicate part system and tested with steam before shipment.

Engineering Data

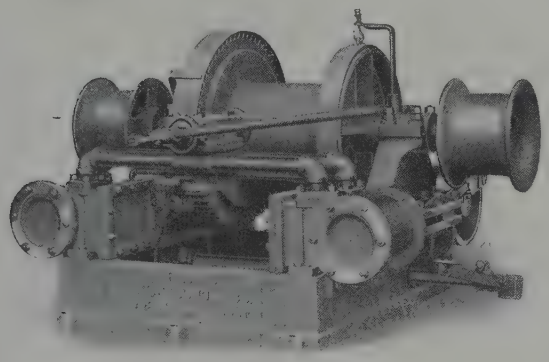
The "National" Standard Two-Speed Cargo Winch is made in two sizes. Technical data, for both these sizes, including capacities, weights, overall dimensions and bed-plate dimensions are given in the table below.



TWO SPEED CARGO WINCH

Order No.	H.P.	Cylinders		Drum		Hoist. Cap.		Shipping Wgt. Lbs.	Overall			Bedplate Dimensions—Inches												
		Dia. Ins.	Str'k Ins.	Dia. Ins.	L'gth Ins.	Sig'le Gear Lbs.	D'ble Gear Lbs.		Height Ins.	Width Ins.	Length Ins.	A	B	C	D	E	F	G	H	K	L	M	P	R
440	22	7¼	10	14	18	3,500	7,000	6,100	44	88	69 5/16	48 5/8	2½	21 13/16	5'9 9/16	1½	22 3/16	22 3/16	22 3/16	3 5/8	2	1¼	2 11/16	4 5/8
441	30	8¼	10	18	26	5,000	10,000	8,000	50¾	102½	73	59½	2¾	27	6'1	1½	23 3/8	23 1¼	23 3/8	3¾	2	1¼	7 3/16	5¼

National Cargo Winches

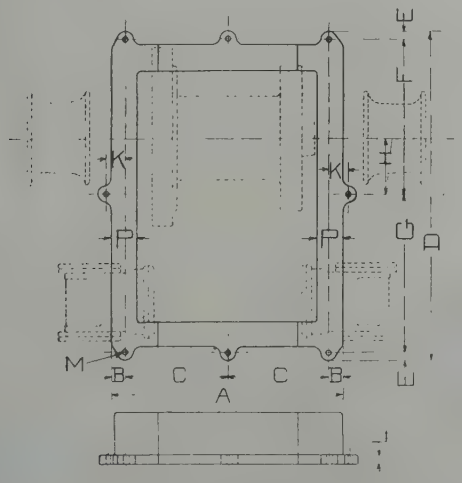


Reverse Throttle Valve Winch

Reverse Throttle Winch

The "National" Single Drum Reverse Throttle Valve Winch, illustrated above, is a particularly compact type of winch which has amply proved its excellence of design and construction and has been supplied in large quantities to the Emergency Fleet Corporation.

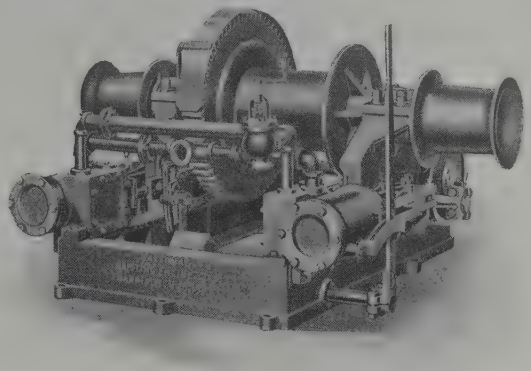
This type of winch is controlled by improved balanced reverse throttle valve, controlled by one lever and arranged to permit operation from either side. It is of exceedingly strong and simple construction, built to withstand severe service and requires minimum attention from the operator. Crank pins are extra large and shaft bearings are fitted with anti-friction metal to permit long running at a high speed without heating. Warping ends are mounted on both ends of the drum shaft for hauling, hoisting, mooring, etc. Bed plate and frame are heavy and strongly reinforced where required for rigidity and strength. Engine information and dimensions are given in plan and the table below.



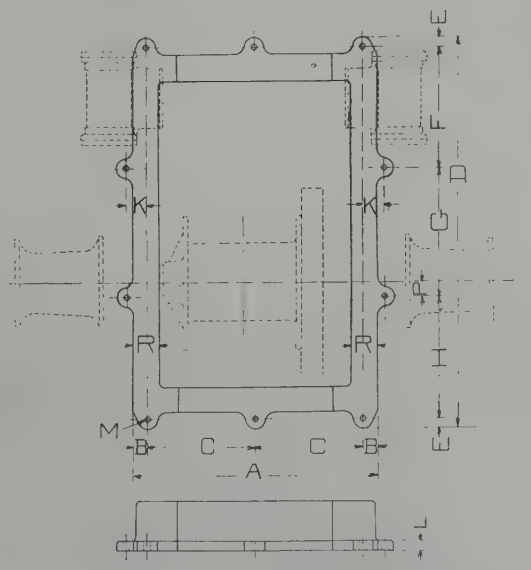
Single Geared Winch

The Single Geared Reverse Link Motion Winch illustrated below is designed for fast cargo hoisting where the loads are uniform weight. The drum barrel is of large diameter and the winch is fitted with the same high grade features and of the same construction as our standard Two-Speed Cargo Winch described on the opposite page.

We specialize in winches only and "National" Winches have well earned the reputation of being "the best built winch in America." "National" Winches are being used by the leading Shipbuilders and Steamship Concerns.



Single Geared Link Reverse Winch



Order No.	H.P.	Cylinders				Drum		Hoist Cap. Lbs.	Wgt. Lbs.	Overall			Bedplate Dimensions—Inches												
		Dia. Ins.	Str'k Ins	Inlet Ins.	Outlet Ins.	Dia. Ins.	L'th Ins.			Height Ins.	L'gth Ins.	Width Ins.	A	B	C	D	E	F	G	H	K	L	M	P	R
SINGLE GEARED REVERSE THROTTLE VALVE WINCH																									
444	12	6¼	8	1½	2	12	13	2,000	3,550	37½	55¼	62⅝	34	2½	14½	46	2⅝	32⅝	9	20⅜	0	1¼	1⅝	4⅛	
445	25	8¼	8	2	2½	16	20	5,000	5,400	45	66½	81⅝	45	2¾	19¾	63	1½	30	30	10⅝	3¾	2	1¼	5	
SINGLE GEARED LINK REVERSE WINCH																									
701	22	7¼	10	2	2	14	18	5,000	5,000	44	69⅝	84	43⅝	2½	19⅝	69⅝	1½	22⅛	22⅛	22⅛	3⅛	2	1¼	2⅞	4⅞
702	30	8¼	10	2	2½	14	20	8,000	6,500	49½	73	101⅞	58½	2¾	26½	73	1½	23⅝	23⅛	23⅝	3¾	2	1¼	5⅛	5

NATIONAL HOISTING ENGINE CO.

HARRISON, NEW JERSEY, U. S. A.

Lidgerwood Cargo Winches

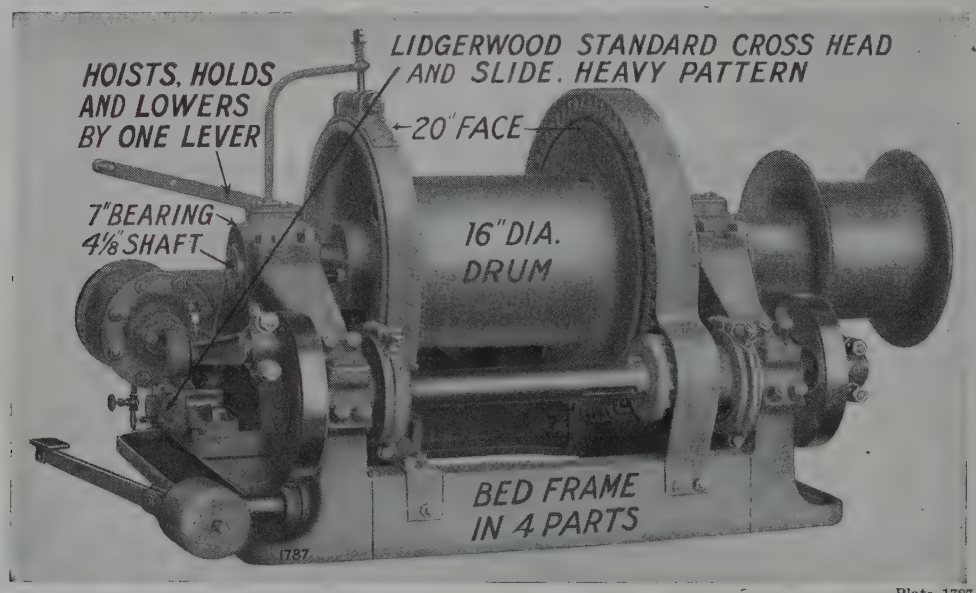


Plate 1787

The Lidgerwood Standardized Cargo Winch (Catalog No. 1917)

Advantages of Lidgerwood Standard Winches

The Lidgerwood Standard Cargo Winches are adapted for both large and small ships, for the rapid handling of both light and heavy loads. The following advantages have been secured in their design:

Ease and simplicity of operation. Safe and perfect control of load. Speed in handling normal loads. Minimum deck space for capacity required. Strength and ruggedness of construction to withstand the severe usage given by stevedores. Refinement in design, giving minimum weight without impairing strength.

Operation and Construction

These winches are controlled by a single lever operating a steam reverse valve. The lever is raised to hoist, and depressed to lower the load, entirely controlling the load by steam. The usual method is to instal in pairs, as shown in Plate 1899; one man can then easily handle two winches.

On the drum flange is a foot-operated band brake, with non-burn lining. This brake is not used for general cargo handling, but is furnished for emergency use.

The winches are of side frame construction, with cast iron frames, firmly secured by crosspieces at front and rear, with joints accurately planed and dowelled in place. All bearings are of generous proportions, lined with our special high grade babbitt metal containing 74% tin.

These winches have a single drum keyed to shaft, driven from crankshaft through straight spur gearing, protected by guard bands. Winches usually have one fixed winchhead, but two are furnished when required.

Cylinders are of piston valve type, securely bolted to side frames, and connected by a cast iron pipe bridge, which acts as a housing for the vertical reverse valve. Reverse valve embodies many improvements. Port openings are graduated to insure perfect load control; piston rings are inserted in the valve, reducing steam leak to a minimum; free steam and exhaust passages are obtained.

These winches may be operated successfully on steam pressures up to 200 pounds per square inch.

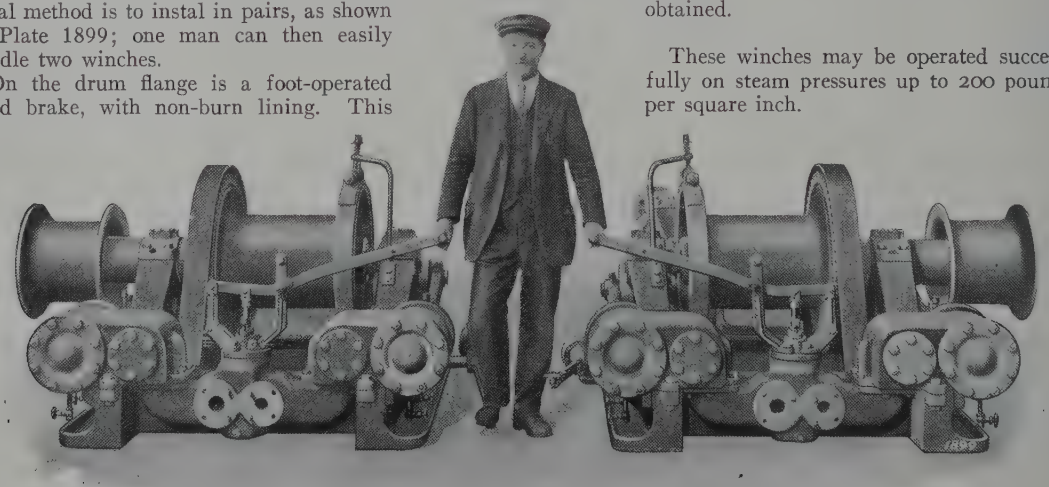


Plate 1899

Lidgerwood Cargo Winches

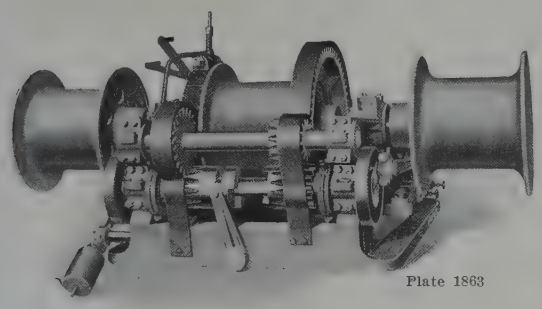


Plate 1863

Types of Standard Cargo Winches

Catalog No. 1917, shown in plate No. 1787, is made with double 8¼" x 8" cylinders, and is ample for general cargo handling.

Catalog No. 1917-C, shown in plate No. 1863, has the same cylinder and drum capacity as the No. 1917 but has compound gearing, and arranged for two speeds, hoisting heavy loads at slow speed and light loads at high speeds.

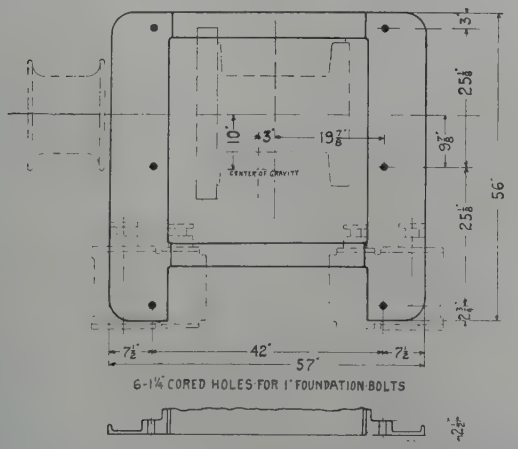
Catalog No. 1918 is the same general design as the No. 1917, but has double 9¼" x 12" cylinders, and is used for heavy duty, or for moderate duty where only low steam pressure is available.

Catalog No. 1918-C is the same size and type as the catalog No. 1918, but has compound gearing and two speeds.

The catalog No. 1917-W and the No. 1918-W are the No. 1917 and No. 1918 respectively with the drum omitted and winchheads placed on extended shaft, being designed for warping. In many cases, we have built these winches with the drum, making the winches also available for general cargo handling.

TABLE OF SIZES OF STANDARD WINCHES

Catalog Number	Cylinder Size Bore	Stroke	Drum Dimensions Diameter	Face	Bedplate Dimensions Length	Width
1917	8¼"	8"	16"	20"	57"	56"
1917-C	8¼"	8"	18"	17"	57"	56"
1917-W	8¼"	8"	—	—	57"	56"
1918	9¼"	12"	18"	18"	70"	58"
1918-C	9¼"	12"	18"	18"	70"	58"
1918-W	9¼"	12"	—	—	70"	58"



Plan View Drawing of No. 1917 Winch Showing Dimensions

All winches are built on duplicate part system, all parts being interchangeable on the same type winches.

The No. 1917 and 1917-C can be interchanged, each having same bedplate bolt holes for foundations, and pipe flanges. The same is true of the No. 1918 and 1918-C.

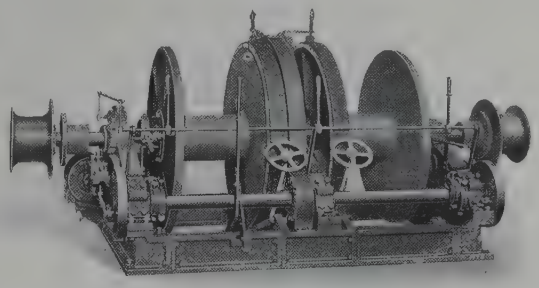


Plate 1778

Trawling Winch

Double Drum Trawling Winches

Plate No. 1778 shows one of our double drum trawling winches. The deep flanges allow the drums to hold and stow the large amount of rope used in trawling work.

Automatic Towing Engines

We build Automatic Tension Engines for towing. These engines are jerk-proof, as the strain tends to increase on the hawser the steam pressure automatically decreases in the cylinders, keeping the pull on the towing hawser practically constant. This permits of the use of lighter hawsers, reducing drag in water, increasing speed of tow.

We build a complete line of electric deck and dock winches, covering every type of marine service. We have produced a line of fixed drum electric hoists, of the same compact rugged construction as our standardized steam winches. These winches are of both direct current and alternating current types. When direct current is used the winch is generally provided with dynamic braking for lowering; with alternating current motors the load is lowered by reversing the controller. Winches are furnished with one or two winch heads as required.

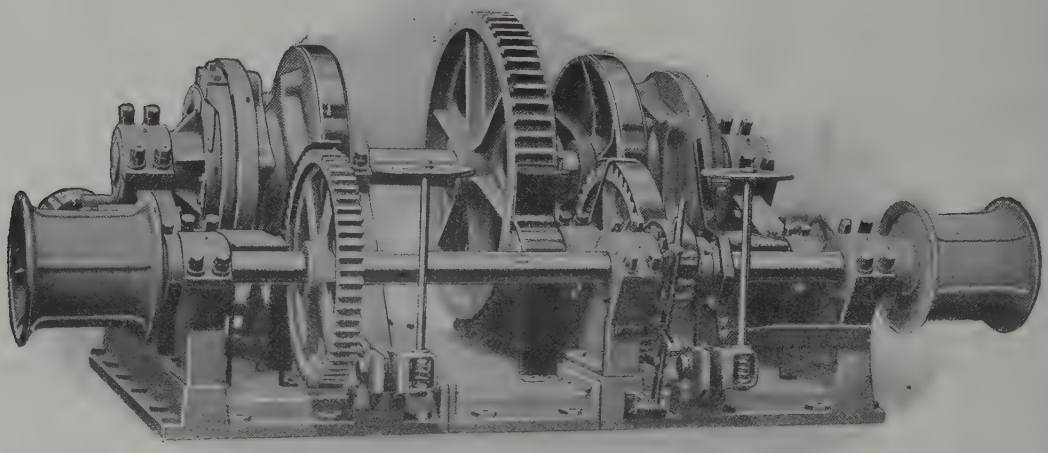
We have a complete line of oil driven winches for use on sailing vessels, and on lighters, for handling cargo and sail; and for use on oil driven ships where the electric generating set is not of sufficient power to drive the cargo winches.

We also build steering gear of the drum, screw and quadrant types.

Branch Offices

Branch offices are maintained in the following cities: Philadelphia, Pa.; Pittsburgh, Pa.; Chicago, Ill., and Seattle, Wash. We are fully equipped, through long experience, to advise as to the best installation for any conditions and to supply the equipment required.

Windlasses and Winches



Windlasses

The Mundy Spur Geared Windlasses are built for either steam drive for chains from 1 1/4″ to 2 3/4″, or for electric drive for chains from 3/4″ to 2 1/2″. The steam windlasses can be furnished with extra wide bedplate, as shown above, to meet special requirements. The brake bands are powerful, and operated by hand levers on electric machines, and brake wheels on the steam machines. A special locking device is fitted to the wildcat.

Winches

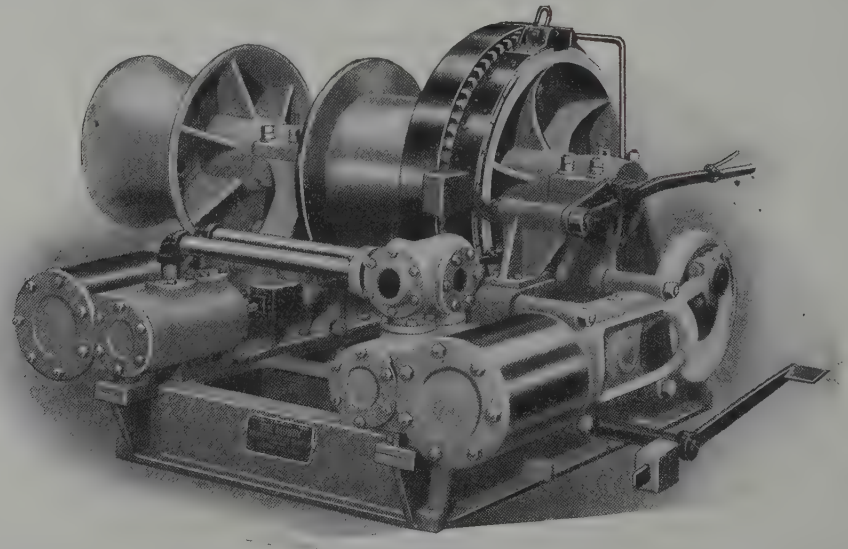
Mundy Winches are built in a large number of types and sizes for steam or electric drive. The Reversible Deck Winch illustrated below may be furnished with drum bolted to the main gear, or with friction drum, and with or without winch head. Other types of winches furnished are the Double Drum Winch, Helical Geared Single Drum Winch, Compound Geared Winch, Naval Electric Winch and Portable Electric Winch.

WINDLASS DIMENSIONS

Size of Chn.	Size of Cyl.	Overall			Center of Gravity			Bedplate		Found Bolts		Net Wgt. Lbs.
					Ver. Ht.	Distance from St'b'd End Bed Plate	Distance from After End Bed Plate					
		Height	Width	L'gth				Width	L'gth	No	Siz	
1¾″	8½x10″	5′ 3″	10′ 4″	8′ 4″	15″	4′ 0″	4′ 5″	7′ 10″	7′ 5″	12	1″	18500
2″	9 x10″	5′ 3″	11′ 0½″	8′ 4″	15″	4′ 1″	4′ 0″	8′ 1″	6′ 6″	24	1″	21500
2¼″	10x10″	5′ 9″	12′ 1″	8′ 11″	16″	4′ 3″	4′ 4″	8′ 4″	7′ 9½″	24	1″	28000

WINCH DIMENSIONS

Size of Cyl.	Drum		Overall			Center of Gravity			Bed Plate		Found Bolts		Net Wgt Lbs
						Ver Ht.	Dist. from Bed Plate edge						
	Dia	Wth	Ht.	Width	L'gth		Front	Right Hand	Width	L'gth	No.	Siz	
8½x10	18″	18″	4′ 3″	5′ 10″	5′ 11″	15″	36″	16½″	3′ 11″	5′ 7″	8	1″	7000
9 x10	20″	18″	4′ 4″	5′ 10″	5′ 11″	16″	36″	16½″	3′ 11″	5′ 7″	8	1″	7500
10x13	20″	18″	4′ 6″	6′ 2 ″	5′ 11″	16″	38″	17″	4′ 2 ″	5′ 7″	12	1″	9000

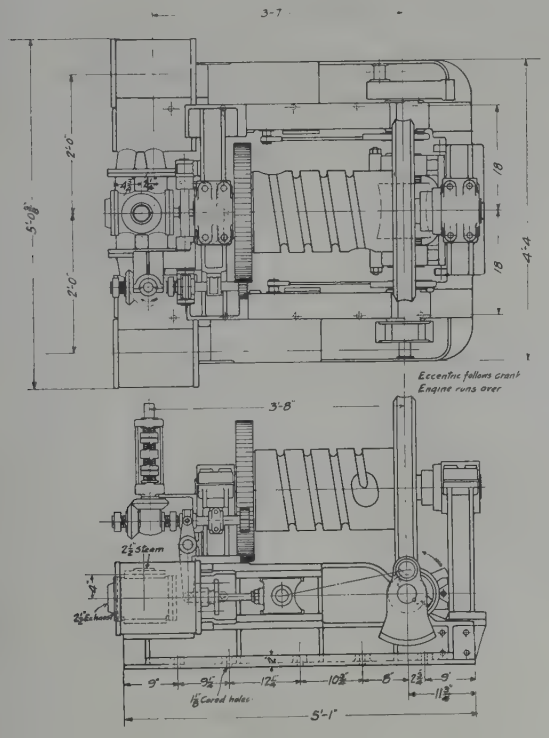


J. S. MUNDY HOISTING ENGINE CO., NEWARK, N. J.

Steering Engines, Capstans, Ash Hoists

Steering Engines

Mundy Steering Engines are built in various sizes and arrangement to suit requirements. The machine shown below is of the drum type and is a particularly compact form which may be arranged with drum above or in line with the engine, and to fit chain or wire rope connection to the



Mundy Steering Engine

tiller. This machine has Hindley type worm and gear drive, with positive adjustment to take up all lost motion. A polished brass steering column is furnished with the engine.

Screw Gear Steering Engine may also be furnished fitted for control by hydraulic telemotor and with steering gear of right and left screw type.

Hand Steerers

Mundy Hand Steerers are built in various sizes for emergency use and for sailing vessels. These steerers have a heavy shaft with right and left screw thread on which travel two heavy bronze nuts which are connected by forged links to a massive cast steel rudder crossarm. The after end of the shaft is supported in a universal self-aligning bearing with coil springs to take up the shock of heavy seas. The steerer may be furnished with iron steering wheel with wood handle, or with one or two iron or wood wheels as desired.

Ash Hoist

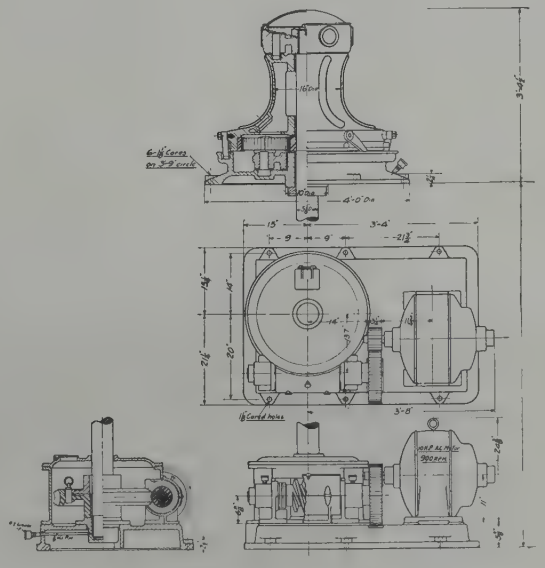
The Mundy Ash Hoist is fitted with a follow up gear so arranged that the engine hoists its load to a height in proportion to the number of turns of the handwheel, coming to rest when the wheel is stopped. An adjustable automatic stop is fitted on the operating shaft so that the maximum height of hoist may be closely regulated. This renders the machine proof against careless handling, as the bucket is positively stopped at either limit of the desired travel.

This hoist is built with 4½" x 6" cylinders, and is usually bolted in a vertical position to a bulkhead. It may be furnished with the Navy type control, with handwheel as shown, or with control by lever.

This engine is built on the sturdy lines of Mundy regular hoists and winches, and has given complete satisfaction in use on U. S. Naval vessels and on merchant ships.

Capstans

Mundy Electric Capstans as shown below are arranged for operation either by motor or by hand. These machines are strongly built, with large vertical shaft to avoid deflection, massive bedplate to hold lower gearing and motor, and also resistance and controller if desired, and substantial and properly proportioned castings. The cut worm and gear which drive the vertical shaft are totally enclosed to exclude dirt and dust, the worm running in



Mundy Capstan

an oil bath, and handholes with hinged covers are provided for inspection of the worm and gearing.

A special naval type of capstan is also built in various sizes with lever and clutch on lower bedplate for changing the speed. This type is in successful operation on several of the newer U. S. battleships.

Double Friction Drum Winch

The Lambert Double Friction Drum Cargo Winch is especially adapted for steamers with limited deck space. They are designed and built for severe work and the material and workmanship is the best. A few of their superior features are, bronzed brushed drums, large diameter shafts, wide bearings, cast iron machine moulded gears, forged steel cut pinions, turned and polished winch heads.

The hoisting can be done on each drum simultaneously or independently, as the drums are independent of each other and all levers are arranged for two-man control. We also build this winch with each drum having an independent gear. If desired we can furnish this winch without winch heads.

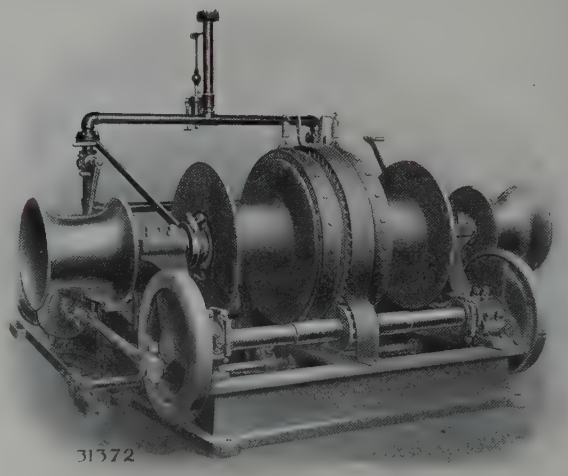

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TABLE OF SIZES

Size No. of Engine	Dimensions of Cylinders		Dimensions of Drums		Hoisting Capacity Both Drums Working Together Pounds	Hoisting Capacity One Drum Working at a Time Pounds
	Dia.	Stroke	Dia.	Length		
380	6½″	8″	12″	10″	1500	3000
381	7″	10″	14″	14″	2500	5000
382	7½″	10″	14″	14″	3000	6000
383	8½″	10″	14″	14″	3500	7000

Size No. of Engine	Dimensions of Bed Plate		Over-all Dimensions			Approx. Net Weight	Center of Gravity Above Bed Plate Ins.
	Width Ins.	Length Ins.	Width Ins.	Length Ins.	Height Ins.		
380	52	56	91	62	43	4600	16
381	60	68	102	74	44	5500	17
382	64	71	106	80	51	7000	19
383	64	71	106	80	51	7500	19

Single Drum Winch

When the deck space is available the Single Drum Cargo Winch is preferable. We illustrate below a pair of single fixed drum winches built right and left hand to work together over one hatch. They are equipped with reversing link motion ensuring maximum flexibility and permitting perfect control of load when lowering by steam. This winch is also built with steam reverse valve and with brakes arranged for one-man control.

All Lambert Hoists are built on the duplicate part system from accurate jigs and templets insuring accurate fit of repair parts.

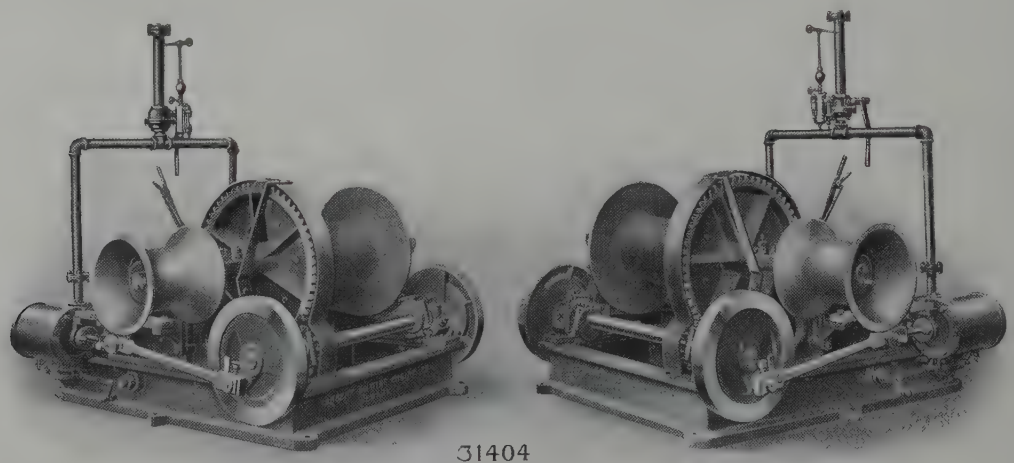
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TABLE OF SIZES OF SINGLE DRUM WINCH

Size No. of Engine	Dimensions of Cylinders		Dimensions of Drums		Weight Hoisted Single Line Usual Speed	Dimensions of Bed Plate		Over-all Dimensions			Approx. Net Weight Lbs.	Center of Gravity above Bed Plate Ins.
	Diameter Ins.	Stroke Ins.	Diameter Ins.	Length of Flanges Ins.		Width Ins.	Length Ins.	Width Ins.	Length Ins.	Height Ins.		
96	5½	8	12	19	2500	41	56	67	62	43	2600	16
97	6½	8	12	19	3500	41	56	67	62	43	2750	16
99	7	10	14	20	5000	43	68	74	74	44	3800	17
100	7½	10	14	25	7000	50	71	81	78	51	4700	18
101	8½	10	14	25	8000	50	71	81	78	51	4900	19
101½	9	10	14	29	9000	54	72	86	80	51	5400	19

Spur Gear Windlass

The Lambert Spur Gear Windlass illustrated below is driven by a pair of horizontal engines and is controlled by a steam reverse valve. The Spur gear Windlass has the advantage of higher efficiency over other types, permitting the use of smaller engines resulting in less fuel consumption. Spur Gears also require less attention and have better wearing qualities than worm gears. The Lambert Windlass is of heavy construction throughout and compact, reducing the required deck space to a minimum. All gears are open hearth steel with machine cut teeth, pinions forged steel with cut teeth.

(Continued on next page.)

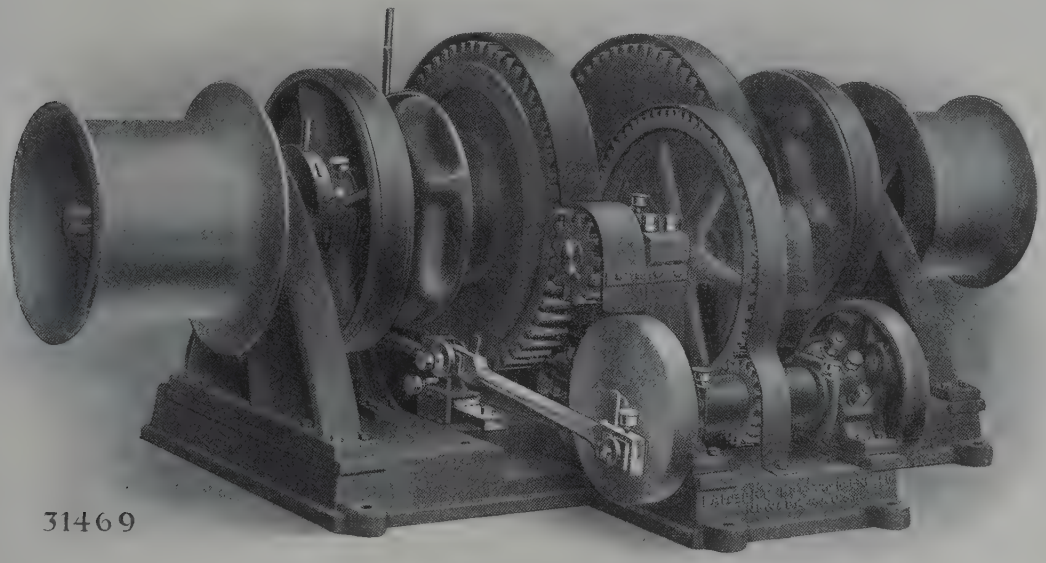
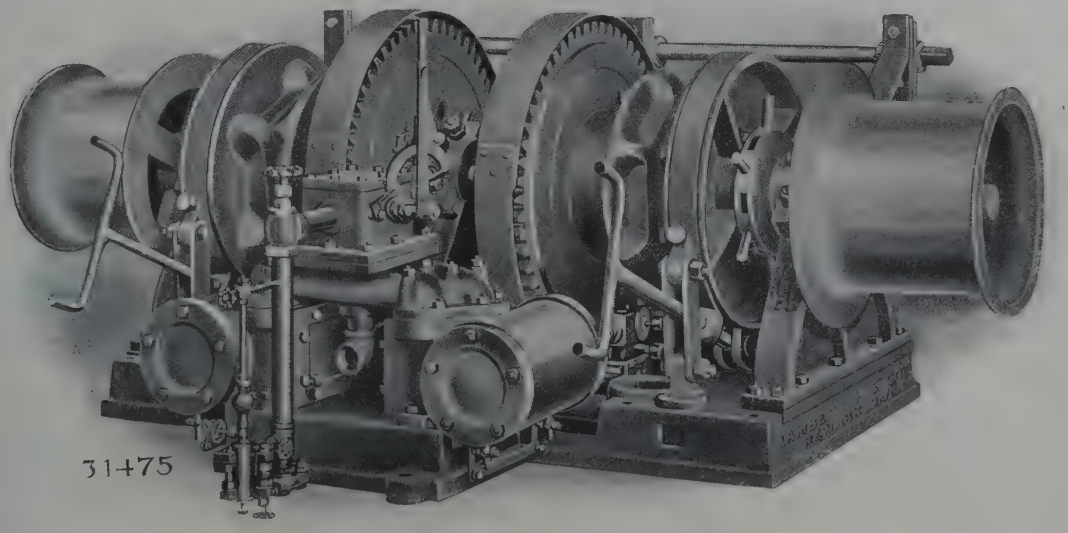


TABLE OF SIZES, ETC., OF STEAM WINDLASSES

Size No. of Engine	Size of Chain Ins.	Dimensions of Cylinder		Dimensions of Bed Plate		Over-all Dimensions			Distance Between Centers of Chains	Approx. Net Weight Pounds	Height Center of Gravity Ins.
		Diameter Ins.	Stroke Ins.	Width Ins.	Length Ins.	Width Ins.	Length Ins.	Height Ins.			
870	1¼–1⅜	6½	8	75	71	108	75	43	43	10,000	17
871	1⅜–1⅝	7½	8	78	84	118	90	54	43	16,000	19
872	1¾–1⅞	8½	10	90	92	134	102	64	48	21,000	21
873	2 –2⅛	9½	10	103	98	146	108	69	54	24,000	23
874	2¼–2⅜	10	12	114	108	160	118	74	60	33,000	25
875	2½–2¾	12	12	126	114	172	126	81	68	52,000	29



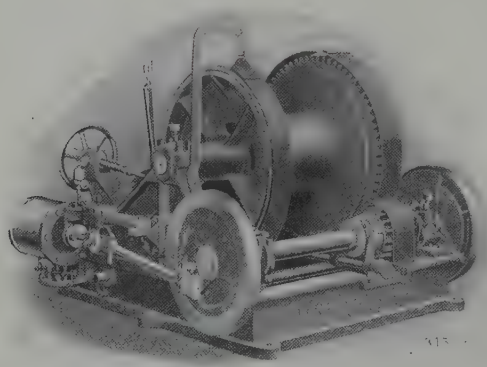
Winches and Capstans

The wild cats are engaged or disengaged by bronze lined friction clutches actuated by a hand wheel. They can be engaged with the engine in any position thus eliminating all objectional keys and lugs. The wild cats are equipped with powerful band brakes having non-burn lining and are hand operated. If desired the brakes can be operated by hand wheels from the forecastle deck. Large warping heads are arranged on the wild cat shafts. They can be mounted on the intermediate shaft permitting more speed but with reduced pulling capacity. When required the Windlass can be arranged for auxiliary hand power operation as shown below.

We build Windlasses in a number of sizes and if you will send us your specification we will submit prices covering your requirements.

Towing Winch

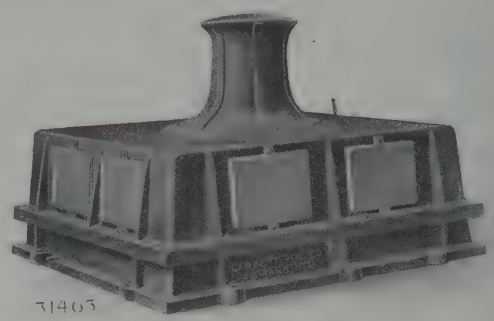
The Lambert Towing Winch illustrated below is especially designed for use in warping and towing vessels and barges through canals. This Winch embodies the same high grade of workmanship that characterizes our other types of engines. It is extremely rugged and compact and the drum stands and cylinders are securely bolted to a self-contained bed plate. The drum has long hubs and is bolted to the gear wheel thus eliminating shaft torsion and reducing bending stresses to a minimum. The drum is provided with a non-burn brake lining actuated by a handwheel and screw permitting fine adjustment. The steel pinion on the crank shaft is bronzed bushed and can be disengaged from the engine by the steel jaw clutch. All levers are conveniently arranged between the cylinders enabling the operator to always be in complete control of the vessel being towed.



If desired the drum shaft can be extended on either or both sides and winch heads mounted thereon. We build this winch in several sizes and capacities and if requested will gladly send Bulletin descriptive of these machines.

Steam Capstans

The Lambert Vertical Steam Capstan is widely adaptable and extremely durable and may be kept in continuous operation—pulling. It is operated by a double cylinder engine fully enclosed and protected. Large doors permit access to all working parts for inspection and lubrication. The Winch head is driven by accurate cut worm and worm wheel which run in oil insuring cool running and minimum wear. The end thrust of the worm is carried to the bed frame by means of special thrust bearings, thus relieving the crank discs of end pressure. The



Capstan illustrated is of the single speed type and is furnished with reversing or non-reversing engines. Built in two sizes with cylinders 8 x 8 having 9,000 lbs. single line pull and 7 x 8 cylinders having 7,000 lbs. pull. Further information furnished upon request.

Electric Capstans

We also build Electric Capstans of either the single or double speed type. Like the steam Capstan they are widely adaptable, being used in shipyards for warping ships along docks, in warehouses and drydocks for pulling cars, etc.

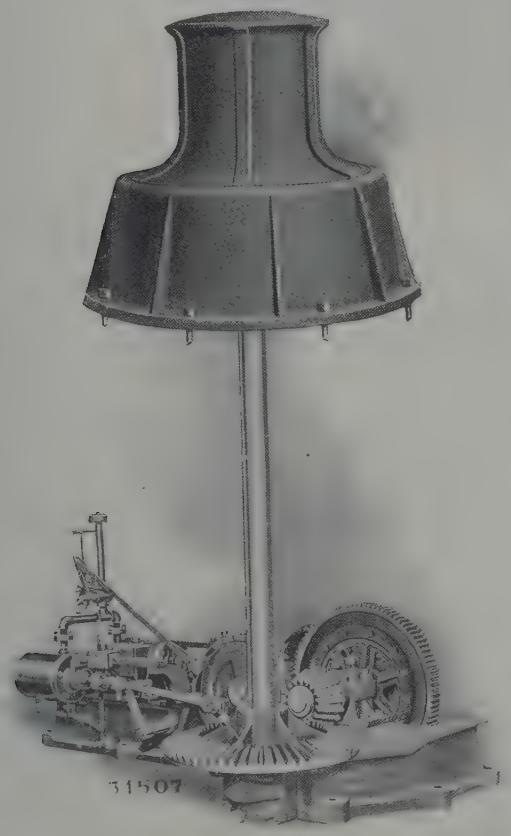
We build them in sizes ranging from 5 to 60 horsepower. The smaller sizes are spur and bevel gear driven while the larger ones are driven by spur and worm gears.

Like our Hoists the Capstans are built from accurate jigs and templates ensuring accurate fit of repair parts.

Capstans, Cranes and Derricks

Hawser Capstan

We illustrate below one of our Steam Hawser Pullers designed for handling tow lines on tugs, barges, etc. The driving engine is situated below deck so that only a small deck space is required for the Capstan. This machine is powerful and of rigid construction, designed for severe service. The winch head can be furnished plain or with whelps as shown. The base casting can be made of any desired height so that the Hawser may lead straight to the towing bitts. The engines are made reversing or non-reversing as desired. The operation is controlled by a single lever and the brakes on the crank



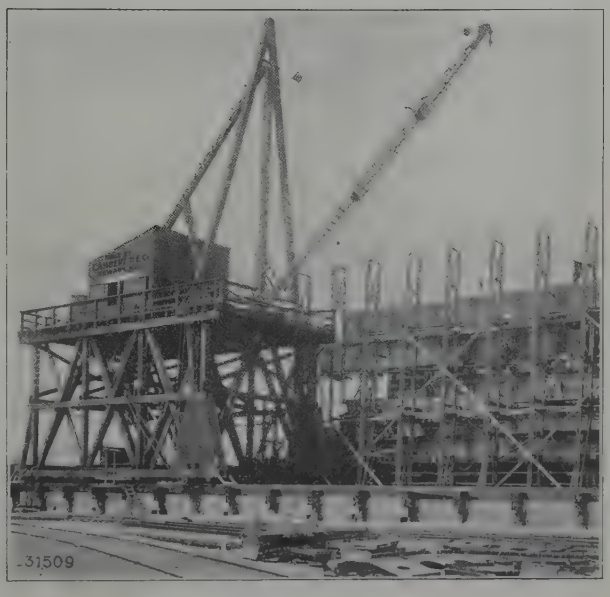
wheels are automatic in action being applied when the throttle is closed. We have eliminated the use of worm gears in this machine as only spur and bevel gears are used and these are of open hearth cast steel with cut teeth. The main spur gear is provided with a slip clutch insuring a steady strain on the hawser, and preventing broken lines should extra severe shocks be encountered.

All parts are easily accessible for inspection and lubrication. This Capstan is built in several sizes—send for catalogue.

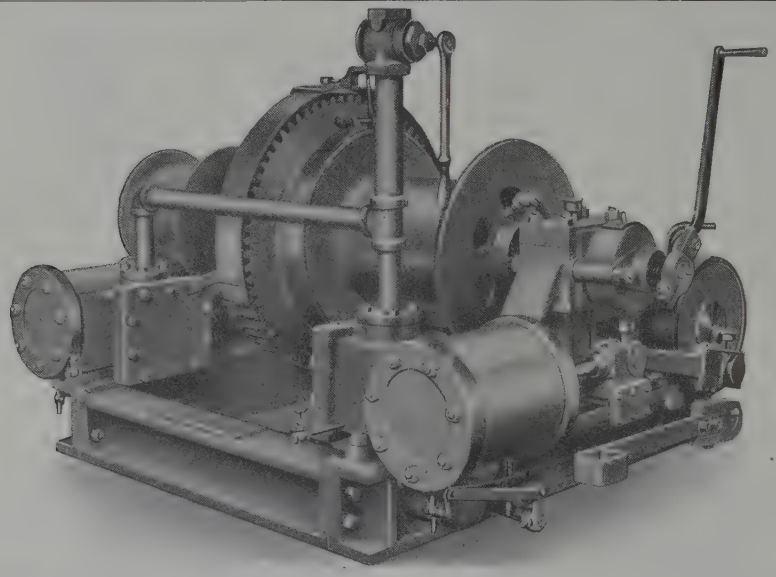
Cranes and Derricks

We design and build Stationary, Traveling and Floating Derricks of the stiff leg, "A" Frame and full circle revolving type. We build Steel Derricks and Fittings for timber derricks up to fifty tons capacity.

Illustrated above is one of our portal revolving cranes operating a grab bucket along a dock. We also build semi-portal traveling dock cranes for handling ship cargo. Below is shown one of our traveling "A" Frame derricks for ship construction. We also furnish this type having two or four derricks mounted on the same platform.



Double Cylinder Friction Drum Deck Winch

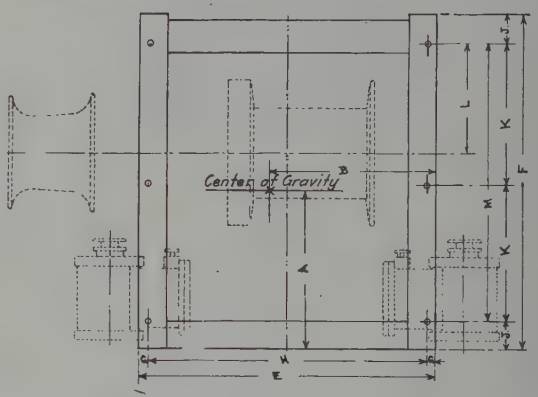


Wide Range of Service

The Orr & Sembower Double Cylinder, Friction Drum Deck Winch is built in a number of sizes as listed below, covering a wide range of cargo hoisting service. These winches admirably meet all requirements of this type of service, being compact, of rugged construction, simple and convenient to operate, and meeting shipboard limitations of least weight consistent with strength and durability.

Construction

The bedplate and frames are of special section designed for rigidity and strength and are amply reinforced. The drum is bushed with bronze bushings and equipped with double V friction. The gear and pinion have cut teeth to insure proper meshing, and the pinion is of steel.

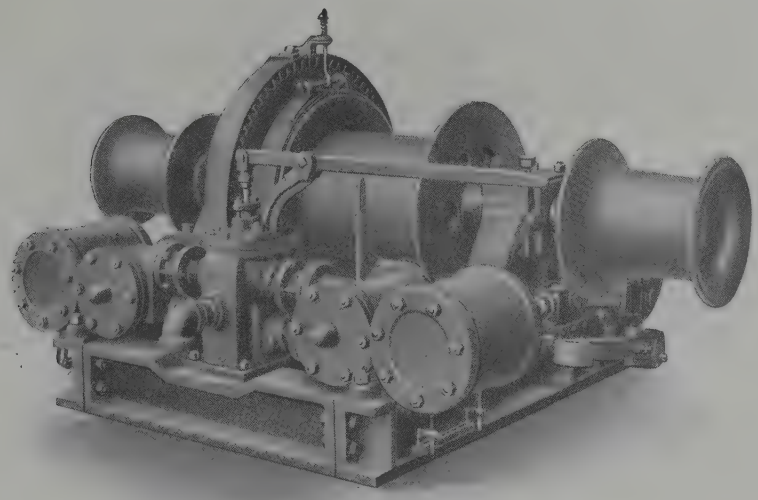


Plan View of Bedplate of Winch

TABLE OF SIZES, CAPACITIES AND DIMENSIONS

Size Number of Engine	733	734	735	735½	736	737
Horse-power usually rated	10	16	25	25	35	35
Diameter of Cylinder, inches	5	6¼	7½	8¼	8½	8½
Stroke, inches	7	9	10	8	10	10
Weight Hoisted, Single Rope, usual speed, pounds	2000	4000	6500	6500	8000	8500
Diameter of Drum, inches	12	14	14	14	16	14
Length of Drum, inches	20	25	28	28	20	28
Diameter of Flanges, inches	24	26	26	26	26	26
Estimated Net Weight, pounds	2200	2300	5500	5500	5900	6000
Dimensions over all, inches, Width	46	51	96	96	90	96
" " " " Length	49	52	62	62	62	62
" " " " Height	33	33	33	47½	47½	47½
Width of Bed Plate, inches	42½	47½	60½	60½	52½	60½
Length of Bed Plate, inches	41¾	41¾	58	58	58	58
Foundation Bolts—number	4	4	6	6	6	6
" " —size	⅞	⅞	1"	1	1	1
" " —dimension—G	1⅛	1⅛	1½"	1½	1½	1½
" " — " —H	40¼	45¼	45½"	49½	49½	49½
" " — " —J	6"	6"	6"	6"	6"	6"
" " — " —K	—	—	23	23	23	23
" " — " —L	11⅞	11⅞"	17⅛	17⅛	17⅛	17½
" " — " —M	29¼	29¼	46	46	46	46
Center of Gravity—Vertical Height	7	7	10"	10	10	10
" " " —Distance—A	20	20	28"	28	28	28
" " " — " —B	26	28	33	33	29	33

Double Cylinder Reversible Deck Winch



For Reversing Service

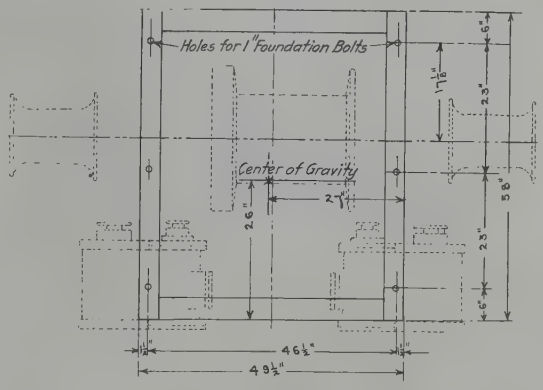
The Orr & Sembower Double Cylinder Reversible Deck Winch was designed to provide power control of the load when either lowering or raising. This type of winch is built in one size as shown in the data table below and has been found by experience to be exceptionally well fitted for the service, capacity and power required in installations of this nature.

TABLE OF CAPACITY AND DIMENSIONS

Size Number of Engine	741
Horse-power	25
Size of Cylinder, inches	8¼ x 8
Diameter of Drum, inches	16
Diameter of Flanges, inches	26
Length of Drum, between flanges, inches	20
Diameter of Crank-shaft, inches	3¼
Diameter of Drum-shaft,inches	4¼
Weight Hoisted, Single Rope, usual speed lbs.	5000
Approximate: Net Weight, pounds	6100
Overall Height	42
" Width	94½
" Length	62"

Operation

The operation of the Reversible Deck Winch is controlled by a throttle reversing valve placed at the forward end of the machine between the two cylinders and regulating the admission of steam to each. A valve lever of convenient height is placed so as to enable the operator to control the foot brake as well as the admission of steam to the cylinders without changing his position. When the valve lever is central, the winch is stopped. With the cable leading off the top of the drum, the winch will raise the load when the lever is lifted, and lower the load when the lever is lowered below the central position.



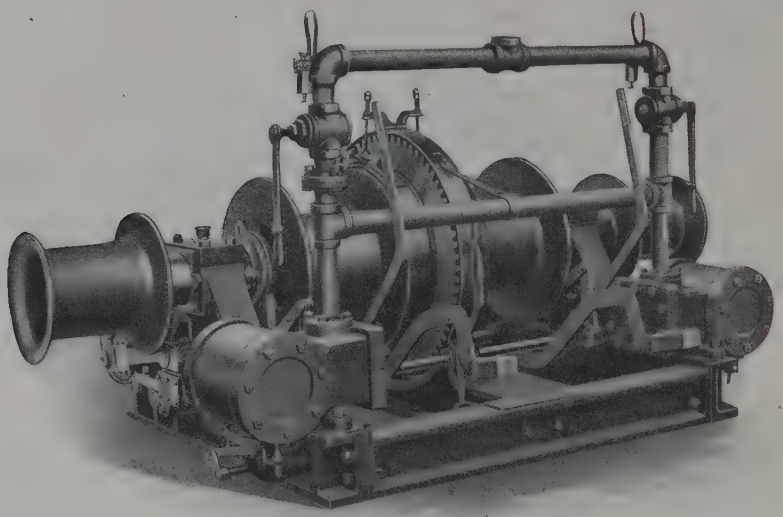
Plan View of Bedplate of Winch

Height of Center of Gravity Above Bottom of Bedplate—10"

Construction

The construction of the Orr & Sembower Double Cylinder Reversible Deck Winch is particularly simple and rugged throughout, as required by the severe service requirements to be met, including operation without protection from the elements, running at high speed with frequent and rapid changes of speed and direction, and liability of severe use if not actual abuse, with very little attention. All castings are amply strong, properly ribbed and stiffened where necessary, and all power transmitting parts are of a specially high grade of material, the pinions being of steel, and both gear and pinion having cut teeth to assure easy and quiet operation.

Double Friction Drum Deck Winch



For Rapid Cargo Handling

The Orr & Sembower Double Friction Drum Deck Winch was designed for hoisting cargo where speed is essential. It presents the advantages of a compact and convenient arrangement of two winches on a single bedplate and operating independently of each other or simultaneously under the control of two operators. This winch is built with 8¼ x 8 cylinders as shown in the accompany table and is of a capacity and power which have been shown by experience to meet best all usual cargo hoisting requirements.

Double Operation

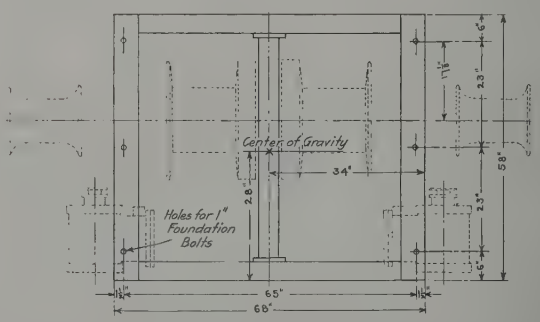
The foot levers, friction levers and throttle valve levers are located in the rear within easy reach of the operators. With two operators this hoist can be used for unloading two separate hatches or with two fixed booms, the one over the hatch and the other on the side of the vessel, the cargo may be lifted clear of the hatch with one line and taken over the side of the vessel and landed with the second line.

Construction

The contruction of the Orr & Sembower Double Friction Drum Deck Winch fully meets shipboard requirements of utmost compactness and minimum weight consistent with ruggedness and durability. The frames, cylinders and bedplates are built up of the strongest types of sections properly ribbed and reinforced where necessary to insure stiffness and strength. The pinion is of cast steel and both gear and pinion have cut teeth, providing proper fit and easy, quiet operation with minimum strain and wear. The drums are of the Orr & Sembower standard double V friction type, driven by a central gear, and each is equipped with a powerful foot brake. All machining and fitting is done to gage, insuring proper fit and interchangeability of parts.

TABLE OF CAPACITY AND DIMENSIONS

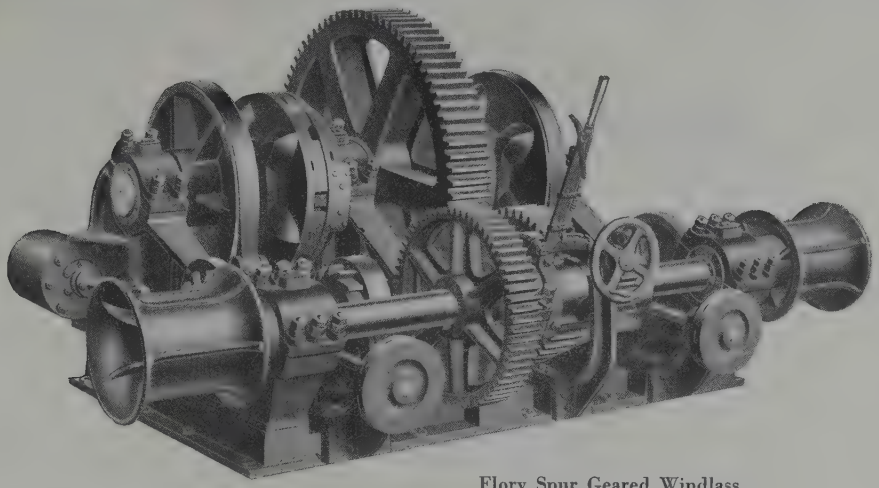
Size Number of Engine	740
Horse-power	25
Size of Cylinder, inches	8¼ x 8
Diameter of Drum, inches	14
Diameter of Flanges, inches	26
Length of Drum between Flanges, inches	14
Diameter of Crank-shaft, inches	3¼
Diameter of Drum-shaft, inches	4¼
Weight Hoisted, one drum working alone lbs.	4000
Weight Hoisted, both drums working, each drum, pounds	2000
Approximate Net, Weight, pounds	7600
Overall Height	46
" Width	113"
" Length	73"



Plan View of Bedplate of Winch

Height of Center of Gravity Above Bottom of Bedplate—10"

Windlasses, Winches, and Marine Auxiliaries



Flory Spur Geared Windlass

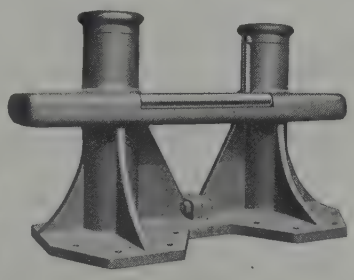
Windlasses

Flory Spur Gear Windlasses are built for all standard sizes of chain and for steam or electric drive. The construction of these windlasses is exceptionally rugged throughout in order to stand up under the severe service required of machines of this type.

The bedplates and housings are of massive proportions, ribbed where necessary for stiffness, and a liberal number of holding down bolts are provided to assure a firm foundation. The shafts are extra large, with ample bearing surfaces at the journals and with forged steel block keys for all gears, wheels and gypsy heads. The gears are all of steel with machine cut teeth, assuring strength and efficient operation. The wildcats are carefully designed to seat and hold the chain links properly, and the locking heads are keyed on the shaft near the center bearings, thus reducing the angle of twist. Brake bands of ample width are provided, and brake wheels, clutch and operating lever are all at the after end of the machine and placed with reference to the operator's convenience.

An experienced engineering department is at the service of shipbuilders for cooperation in the design and construction of standard or special windlasses or other marine auxiliaries, and a large plant equipped with the most up-to-date machinery assures prompt meeting of all requirements.

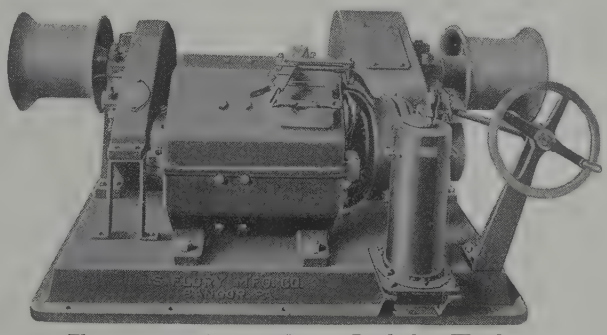
Chain Stopper



Towing Bitts

Winches

Flory Winches are built in a great number of sizes and types to meet all requirements. The type illustrated below was designed for the U. S. Navy, and is in successful operation on several of our ships of defense. This winch is of all steel construction with patent gear shaft and completely enclosed gears for protection from water and the weather. It will handle 20,000 pounds at 50 feet per minute or 5,000 pounds at 200 feet per minute.



Flory Double Geared Electric Battleship Winch

This type of winch, as well as all other Flory Winches, is built on the duplicate part system, assuring complete standardization. All parts are of the most improved design and best construction, and a wide experience and completely equipped factory place the Flory Manufacturing Co. in an exceptional position to handle machinery of this type.

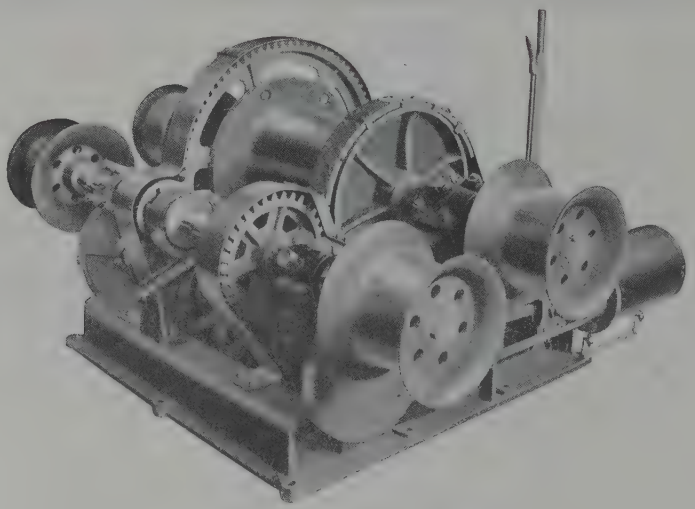
Other Products

The S. Flory Manufacturing Co. also manufacture a complete line of other marine auxiliaries of all types, such as Capstans, Dredging Machinery, Steering Engines, Towing Bitts. Dock Castings, Hoists, Cableways, etc., all of the same excellence of design and construction as the deck machinery described above.

S. FLORY MANUFACTURING COMPANY

95 LIBERTY ST., NEW YORK, N. Y.

Cargo Winch (Single and Double Geared)



Double Geared Cargo Winch

"Superior" Double Geared Cargo Winch

The winch shown above is the type of double geared hoist used on sea going vessels built extensively in this country for the United States Government. Its special feature is the saving of time at the dock.

All operations, including shifting of the clutches for change of gearing, are from the operator's stand at rear of the engine.

Gears are of the herring bone type thoroughly protected by suitable guards. Bored cross-head guides are cast as a part of the side frames making a compact, rigid machine with running parts well protected.

The drawing and table shown below give the overall and base plate dimensions, location of foundation bolts, the approximate height of the vertical center of gravity and the net weight.

Other "Superior" Machinery

For Trawl Boats:—Double Drum Trawl Winches, Cargo Hoists, Hand Capstans, and Steering Gears.

For Cargo Vessels:—Worm Geared Steam Steering Engines, Cargo Hoists, Ash Hoists, Hand Steering Gears and Mooring Winches.

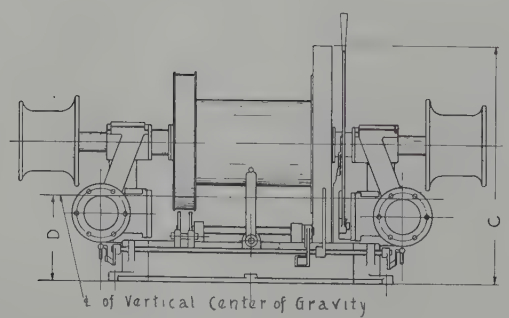
For Tugs:—Worm Geared Steam Steering Engines, Windlasses, Power Pawl Posts, and Steam Capstans.

For Sand Scows and Barges:—Steel and Wooden Derricks, Swinging Engines, Four Drum Pipe Hoists, Mooring Winches, and Anchor Hoists.

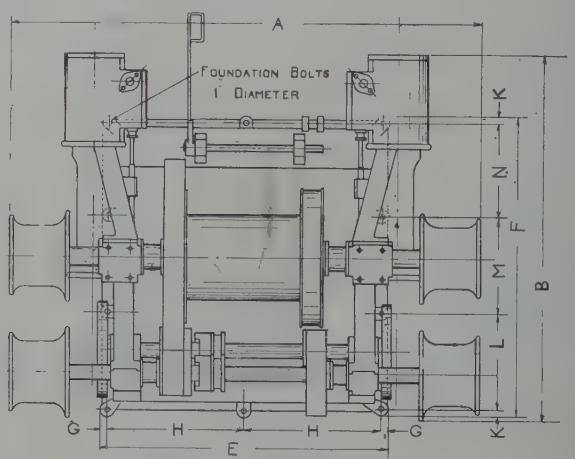
For Dredges and Drill Boats:—Deck Machines: with one, two and three drums, Anchor Hoists, and Drill Frame Hoists.

For Dump Scows:—Steam and Hand Winding Gears.

Electric Hoists, Winches and Car Pullers.



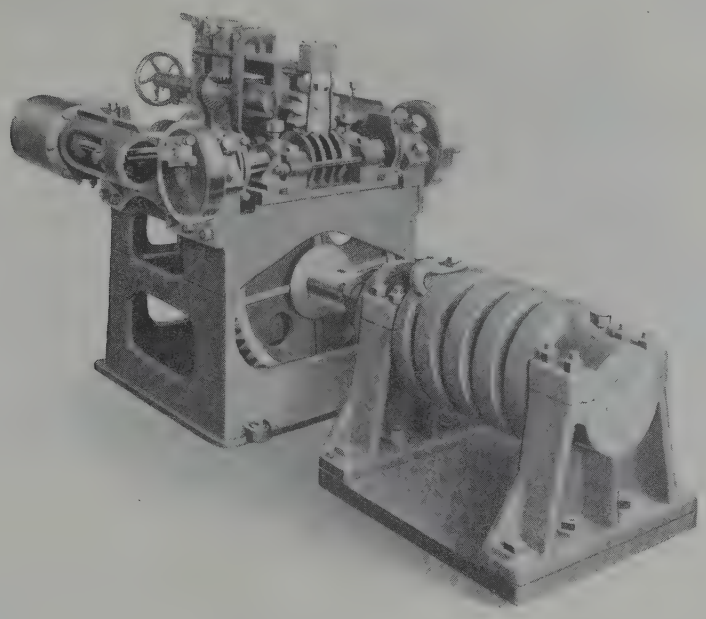
ELEVATION OF CARGO WINCH



PLAN VIEW OF CARGO WINCH

SIZE OF CYLINDER	SIZE OF DRUM	RATIO SINGLE GEARING	RATIO DOUBLE GEARING	DIMENSIONS IN INCHES												NET WEIGHT LBS
				A	B	C	D	E	F	G	H	K	L	M	N	
7 × 12	17 × 24	1 : 4.7	1 : 9.4	93	72	48	17	55½	59½	1¼	27⅞	1¼	19	19	19	7200
8 × 12	20 × 24	1 : 4.7	1 : 9.4	93	72	48	17	57	60	1¼	27⅞	1¼	19	19	19	7800

Steering Engines



Worm Geared Steering Engine

"Superior" Worm Geared Steering Engine

The Worm Geared Steering Engine shown above is particularly adapted for sea-going cargo vessels.

The arrangement is such that the engine can be placed inside the engine room of the vessel, while the chain drum is on the main deck, outside.

The worm thrust is taken by adjustable bearings at each end of the worm. The throttle valve connection and automatic control are of a design that permits ready inspection.

The drawing and table below give the technical data for the engine and chain drum separately.

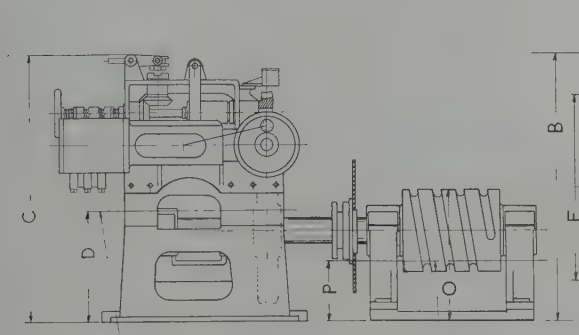
"Superior" Automatic Worm Geared Steering Engine

This Automatic Worm Geared Steam Steering Engine is used extensively by the U. S. Government for seagoing tugs.

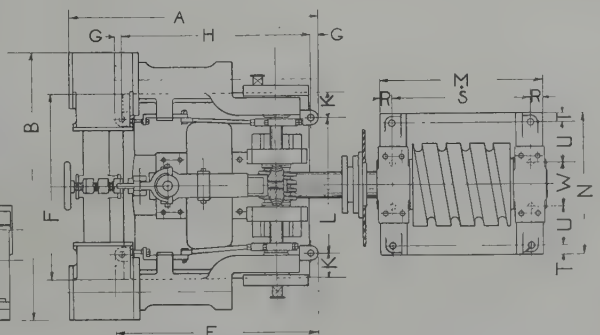
It is very rigid and compact and can be located in any convenient place on board ship.

This engine is built for either cable or shaft connections with the steering wheel stand in the pilot house.

The control throttle valve is of the piston type, perfectly balanced, and is so arranged that the engine responds instantly to every movement of the wheel in the pilot house.

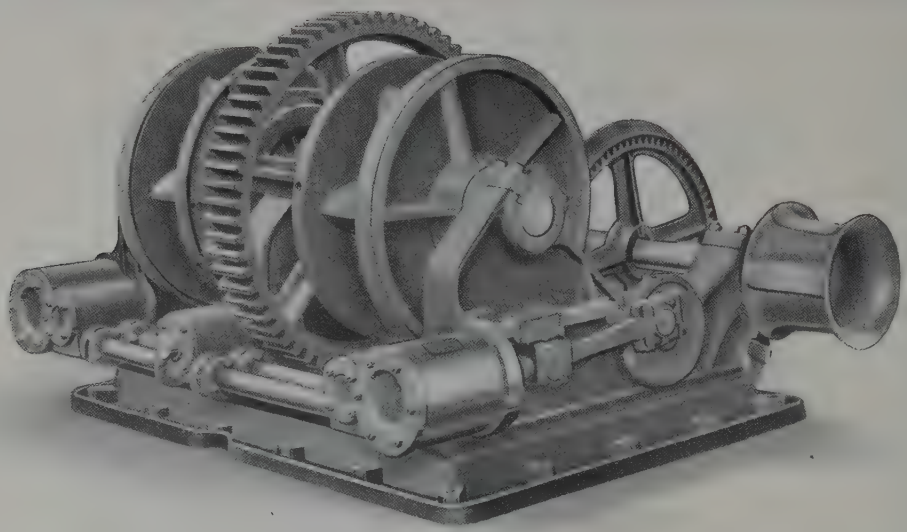


ELEVATION OF GEARED STEERING ENGINE



PLAN VIEW OF GEARED STEERING ENGINE.

Size of Cylinder	Size of Drum	Ratio of Gearing	Dimensions in Inches of Engine										Dimensions in Inches of Drum									Net Weight Lbs.	
			A	B	C	D	E	F	G	H	K	L	M	N	O	P	R	S	T	U	W	Engine	Drum
7 x 7	15.18	1 50	46	49	49	20	37½	34	1⅜	34½	4⅜	20⅜	30	26	24	11	2⅜	25	1⅜	7⅛	7⅛	5600	1800
8.8	16.20	1 50	52	50	54	21	40	37	1⅛	37	5	25	32	28	24½	11	2⅜	26½	1⅜	7⅛	9⅛	6000	2000



Spur Geared Steam Windlass

Dependable Deck Machinery

The illustrations show a number of units of deck machinery including Winches, Windlasses, Steering Engines, Capstans, etc. Each machine is of entirely new and improved design and is replete with satisfying features. Each unit is designed for efficient operation, is substantially built, of excellent material and superior workmanship. The line is quick acting and capable of carrying an overload beyond rated capacity. This line was designed in response to the desire of the United States Government for a strictly up-to-the-minute line of deck equipment and large government orders were received and filled. Every machine gave perfect satisfaction and the line has been highly recommended by those conversant with the design and quality.

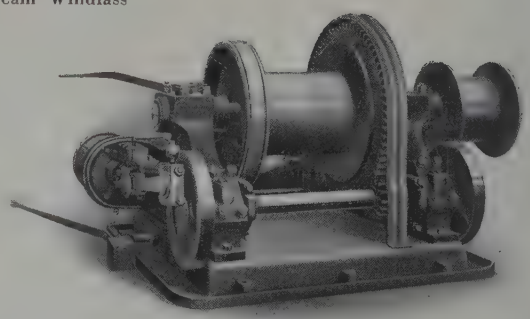
These machines are not built a few at a time, but are manufactured in large quantities. Every casting is made on a moulding machine in our own shops and every piece is machined in jigs and fixtures and made to minimum and maximum limit gauges and templets so that all parts are absolutely interchangeable. This is a very important feature should necessary repairs be required.

Our Windlasses are made in several sizes to suit either American or British standard chains.

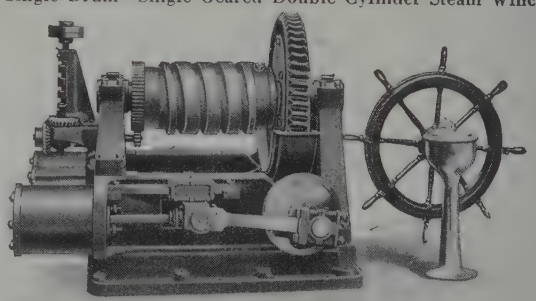
Only the best material and workmanship are used and each machine is designed to give the maximum of strength, based on the full power of the engine.

Full descriptions, prices and deliveries will be quoted upon application. We also make other types besides those illustrated, and can furnish any type desired.

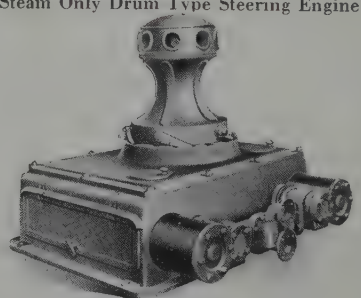
Our Marine Department is located at 516 Liberty Building, Philadelphia, Pa.



Single Drum –Single Geared Double Cylinder Steam Winch



Steam Only Drum Type Steering Engine



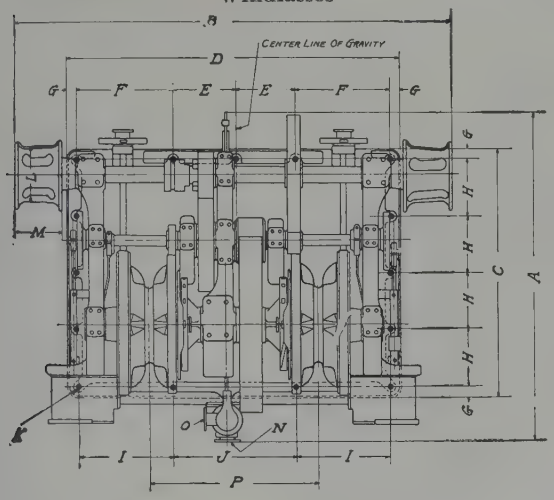
Self-Contained Steam Capstan

THE AMERICAN CLAY MACHINERY CO.

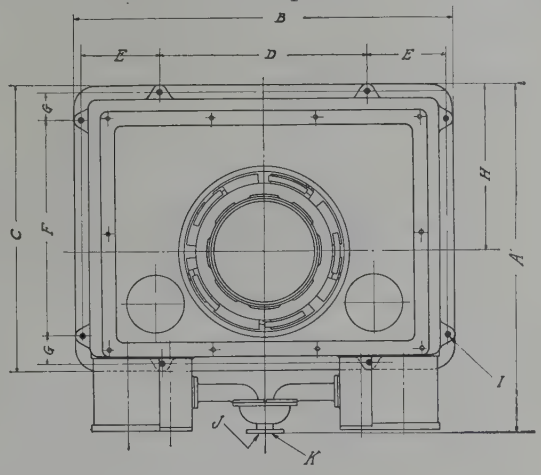
BUCYRUS, OHIO, U. S. A.

Steering Engines—Capstans

Windlasses



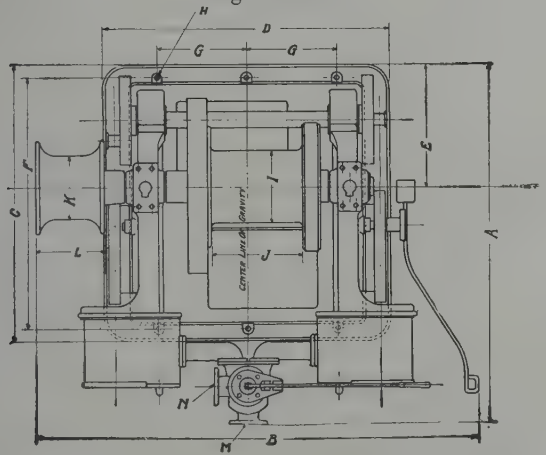
Steam Capstans



WINDLASSES
FOR STUD AND PLAIN LINK CHAIN
All Dimensions In Inches

Dimensions of Cyl.		Chain	Over All Dimension		Bed Plate		Anchor Bolt Centers					Anchor Bolt	Winch Head	C to C of Wildcat	From Floor to Center of Wildcat	Steam & Exhaust Pipe		Net Weight
Bore	Stroke		A	B	C	D	E	F	G	H	I	J	K	L	M	P		N	O	
5	5	1⅛	74¾	88¾	54¾	71¼	20½	19	1½	16	24½	20½	⅞	10	9	29¾	23½	1½	1½	7200
6	6	1⅜	88¾	93	65	81¾	26¼	20½	1½	20¾	26¼	24½	⅞	10	9	34	27½	1½	2	8200
8¼	8	2	101⅜	127⅛	76⅝	95	29	28⅜	4½	17⅛	17⅛	17⅜	1⅛	15	15	44⅛	36¾	2½	3	19400
9	9	2½	112⅝	144½	83	100	22½	30	3½	19	30	45	1½	16	16	58	41	3	3½	25900

Cargo Winches



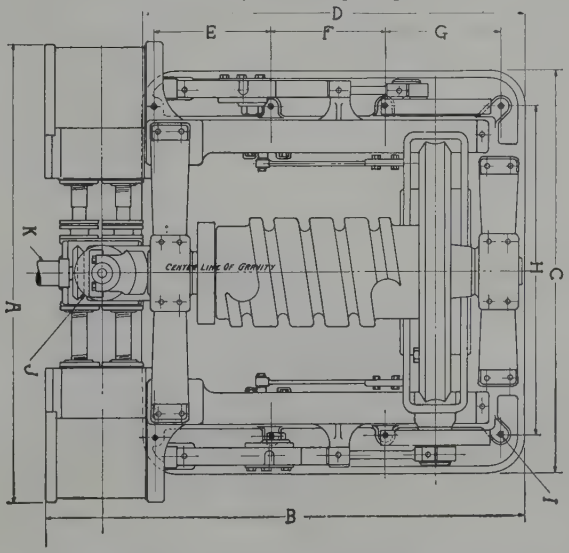
CARGO WINCHES

Dimensions of Cylinder		Over-All Dimensions		Bed Plate		E Fdn. & D.S.	E Fdn. H.	L Base & Fdn. Anchor Bolts	Drum Dimension		Winch Head Dimension		Steam and Exhaust Pipe		Net Weight	Lifting Capacity
Bore	Stroke	A	B	C	D	E	F	G	H	I	J	K	L	M	N	Lbs.	200 Ft. per Min.
8¼	8	69⅜	80	51½	70¼	22	49	20½	1	14	20	14	15	2	2½	5200	4000
9	9	79⅜	97⅛	61½	63¼	24⅝	55⅜	19¹¹⁄₁₆	⅛	16	20	14	15	3	3½	6250	6000

STEAM CAPSTANS
All Dimensions In Inches

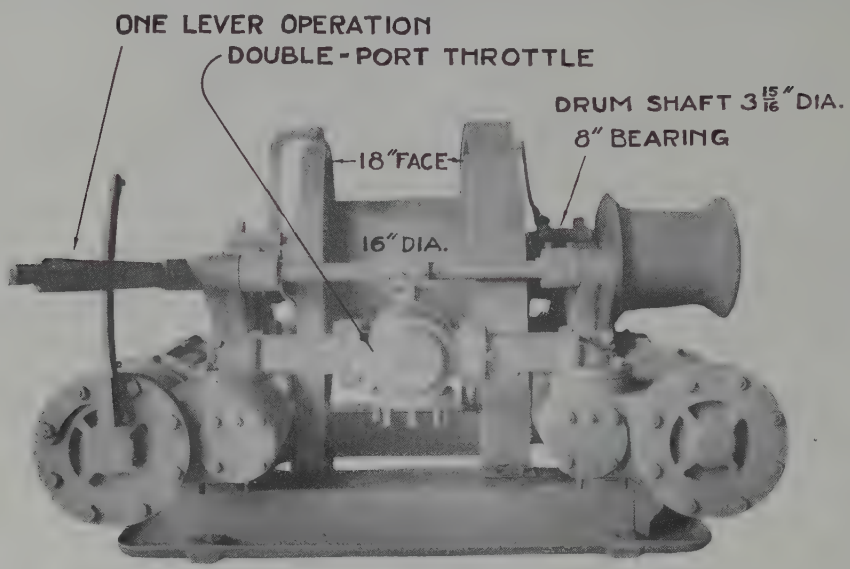
Dimensions of Cyl.		Over-All Dimension		Bedplate		Anchor Bolt Centers				C of Barrel to End of Bedplate	Anchor Bolt Hole	Steam & Exhaust Pipe		Height over All	Diameter of Barrel	Net Weight
Bore	Stroke	A	B	B	C	D	E	F	G	H	I	J	K			
6	6	50	50¾	50¾	40½	15½	16	38½		22¾	⅞	1¼	1½	44¼	9	4250
7	7	60⅝	66	66	50	36	13¾	37½	5	29¼	1⅛	2	2½	50⅜	11½	4950

Steam Only Steering Engines



STEAM STEERING ENGINES

Dimensions of Cylinder		Over-All Dimensions		Bed Plate		Location of Anchor Bolts				Anchor Bolt Hole	Steam and Exhaust Pipe		From Floor to Center of Drum	Net Weight
Bore	Stroke	A	B	C	D	E	F	G	H	I	J	K		
5	5	48	63	48	48¾	15	15⅜	15	45	1	1¼	1½	26½	3400
6	6	49	61¼	49	46⅛	15	14¼	14	46⅛	1	1½	2	27⅝	3850
8¼	8	66½	69¼	58	54⅝	16½	16½	16⅜	47	1⅛	2½	3	35¼	7400

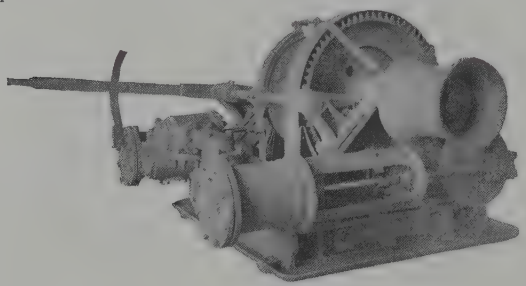


1-PIECE BOX-SECTION BEDPLATE

The Helser Cargo Winch

The new type 9 x 9 Helser Cargo Winch has been designed to meet the requirements of the Pacific Coast Yards which demand a heavy duty, strongly constructed winch. This winch has a box constructed base plate with oil pans and hold down bolt lugs cast in one piece, which eliminates the bolting together, and makes a more rigid base.

The Helser Winch is of the double cylinder type fitted with semi-steel links and brass link blocks, brass eccentric straps and brass cross head slippers. The steam throttle is a specially designed double ported piston valve with a cast iron liner, and two snap

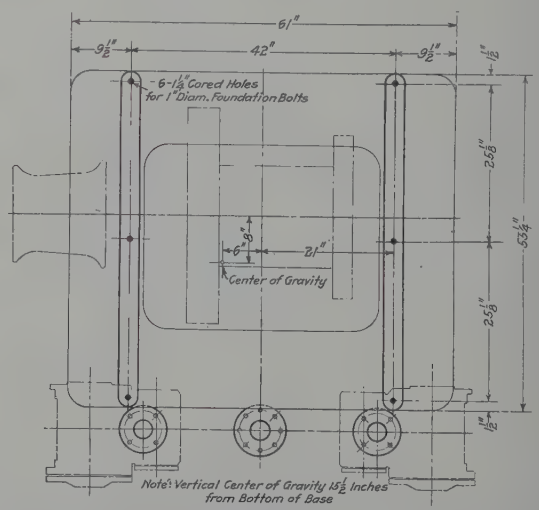


rings, connected to the link lifting lever shaft so that the one lever opens the throttle and raises the link at the same time. It is conveniently placed for one man to operate two winches.

This winch has a cast steel pinion and a semi-steel gear. The drum is 16" in diameter with an 18" face. The drum shaft is 3-15/16" in diameter fitted with a gypsy on end of the shaft, which can be extended for a gypsy on the other end, if desired.

This winch will lift 10,000 lbs. on a single line with ample brake lever and bands for holding and lowering the load without using the throttle. This winch weighs approximately 5600 lbs. It can be fitted with reverse throttle of the piston type instead of the link motion, if desired.

All parts for this winch are machined in duplicate and any part can be replaced. The fit is guaranteed as we have gauges and templates for all parts. The steam inlet is 2 1/2" with a 3" exhaust, which are drilled E. M. F. Standard. The cylinders are 9" bore 9" stroke. The valves are of the piston valve type, fitted with cast iron bushing which can be taken out and replaced when worn.



Plan View Showing Dimensions and Approximate Center of Gravity

WINCH DATA

Cylinders		Drum		Gypsy		Bed Plate		Over All Dimensions			Net Weight Apprx.	Flanges	
Bore	Stroke	Length	Dia.	Flanges Dia.	Body Dia.	Length	Width	Length	Height	Width		Steam	Exhaust
9"	9"	18"	16"	15¾" & 17"	12" to 13"	53¼"	61"	66"	45½"	72"	5600 lbs.	Dia. Inlet 2½" Bolt P. C. 6⅝" O. Dia. 8¼"	Dia. Outlet 3" Bolt P. C. 6" O. Dia. 7½"

Steering Gears

Edson hand operated Screw Steering Gears made in various designs for use on sailing craft, ships, schooners, fishermen, yachts, etc. Also Brass Stand Steerers fitted with mitre gears, rack and pinion, binnacle, compass and nighthood. Edson Steering Gears are particularly strong, compact, and efficient, with a minimum number of wearing parts thus helping to eliminate backlash, and are remarkably sensitive and quick in action.

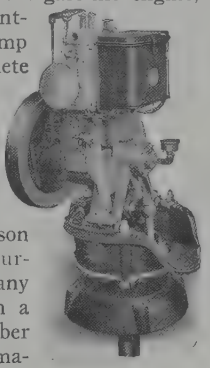
The Edson Improved Robinson Steerer, shown in detail below, can be arranged for iron rudder posts if desired. In this type of steerer, the rudder head is made in two parts, with bolts and nuts so arranged as to clamp and hold the steerer-hoop close to the rudder post, to be tightened whenever necessary, without wedging. When used for steamer relief gear, the arms are arranged to disconnect from the rudder head so as not to interfere with the steering from the wheel house.

Steering Wheels

For use with these steering gears the Edson Company manufacture steering wheels of improved modern construction. These wheels are made of well seasoned foreign and domestic woods with brass hubs, and they are fastened thoroughly with brass screws, making a handsome appearance.

Bilge Pumps

The Edson Gasoline Engine Driven Diaphragm Bilge Pump is especially adapted for use on vessels and barges, being simple and rugged in construction, compact in arrangement and easy to operate. It consists of a gasoline engine, air-cooled to prevent freezing, mounted directly over a diaphragm pump with 3-inch suction, the complete unit weighing less than 350 pounds. The engine and hand pump can be furnished separately, if desired.



Other Products

The Edson Manufacturing Company also furnish a large number of other marine appliances.

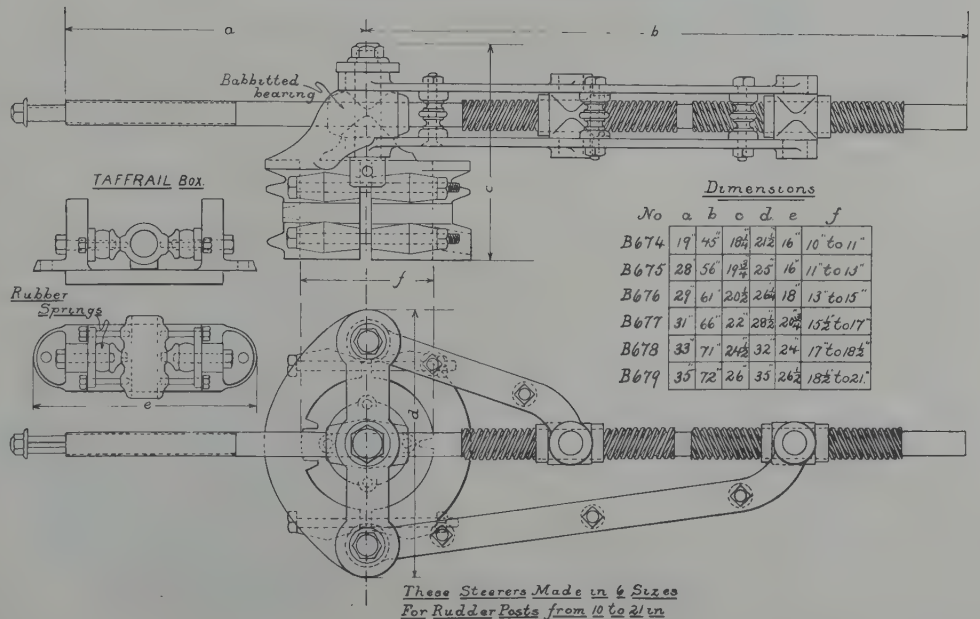
Diaphragm Free and Force Pumps for operation by hand and galley type force pumps can be furnished.

Power Capstans are built with single, triple and ratchet purchase all in the same combination, and in five sizes for wide limits of requirements.

Gypsy Winches with hand heavers, United States Signal Corps and Centerboard Winches are built of extra strong construction and proved serviceability.

The Edson line includes Ships' Bells, Port and Deck Lights, Boom Jibers, Deck Plates, Ventilators, Stanchions, etc.

EDSON IMPROVED PATENT ROBINSON STEERER
With Split Rudder Head Hoops.



Dimensions

No	a	b	c	d	e	f
B674	19"	45"	18¼"	21½"	16"	10" to 11"
B675	28"	56"	19¾"	25"	16"	11" to 13"
B676	29"	61"	20½"	26¼	18"	13" to 15"
B677	31"	66"	22"	28½	20¾"	15½" to 17"
B678	33"	71"	24½	32"	24"	17" to 18½"
B679	35"	72"	26"	35"	26½	18½" to 21"

These Steerers Made in 6 Sizes
For Rudder Posts from 10 to 21 in

Electric Telemotors

Ideal Control

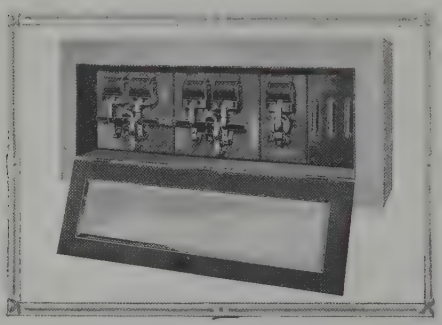
The Benson Electric Telemotor is the ideal control for the steam steering engine. More than 200 are in actual use and daily proving their superiority over any other method of rudder control.

Its absolute accuracy, the simplicity of construction and operation, its positive indication of the rudder position, quick response and reliability, recommend its use in every case where a telemotor is required.

It operates with so little exertion on the part of the quartermaster that a straight course is always kept. The largest liner is handled as easily and quickly as the smallest craft.

Equipment Operation

The Telemotor proper is located beside the steam steering engine. The Master Controller is located in the pilot house, or on the bridge if desired, and may be either a horizontally moving lever mounted upon a standard or a small wheel. The movement of the controller completes a circuit to a Relay Panel which is located either in the engine room or the fan-tail of the boat. Completing one of these circuits from the controller causes one of two relays to close which in turn completes a circuit



from the main generators of the ship, to the motor of the telemotor. This motor is connected, through a suitable train of gears, to a cross-head which in turn is mechanically connected to the valve arm of the steam steering engine. The electric follow-up is also connected to the motor through gears. The starting of the motor moves the cross-head and engine valve, starting the engine. This also moves the follow-up which whole movement continues until a position is reached by the follow-up corresponding to the position of the controller in the wheel house. At this point the circuit is automatically broken, releasing the relay and opening the circuit to the motor. This stops the movement of the steam steering engine and consequently the rudder stops at the desired point.

The whole system is connected by wires and conduit or cable, and receives its energy from the ship's generators. The motor is of one horse-power.

The factor of safety in the Benson Electric Telemotor is so great that accident and breakage are entirely eliminated.

Advantages

Aside from the disadvantages of other control, none of which are found in the electric telemotor, these special characteristics are exclusively found in the Benson Electric Telemotor:

Instantaneous response.
Uniform and positive action.
Impossibility of racing steering engine.
Positive rudder indicator.
Facility in handling boat.
Flexibility of installation.
Positive follow-up system.

The follow-up is automatic, and no reversing switch or watching of a rudder indicator is necessary. No new boat should be built without first investigating the Benson Electric Telemotor. It saves money in first cost, maintenance and operation of the vessel.

Electric Steeromotors

Steam Eliminated

The Steeromotor has eliminated the necessity of using a steam steering engine to operate the rudder. The entire control and power used in operating the rudder is electric and obtained from the ship's generators. The elimination of the complication of the steam engine and its follow-up, the condensation and sluggish response is done away with. In its place is substituted an electric telemotor with a motor large enough to swing the rudder under any required condition.

Equipment

The equipment consists of a master controller in the wheelhouse and an auxiliary controller on the bridge when desired, an operating panel located in the engine room and containing two control relays and one dynamic braking relay and an accelerator with resistances, then the Steeromotor proper which is located in the fan-tail of the boat and mechanically connected to the screw gear of the rudder by means of gears. The whole system is electrically connected by wires in conduit or electric cable.

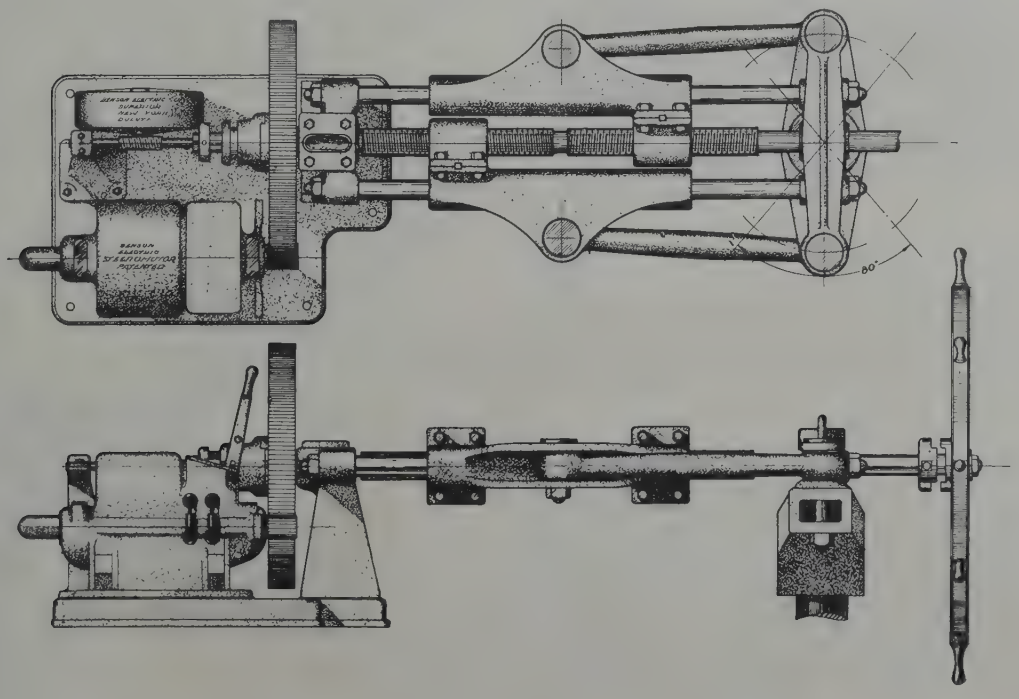
Advantages

The Steeromotor gives absolutely accurate control which is positive and instantaneous. The follow-up performs automatically the operation of opening or closing the relays that control the movement of the Steeromotor to port or starboard. No reversing switch is required in the wheel-house and over-travel and limit controls are incorporated in the follow-up. An overload relay with alarm signal is provided to give notice if a short-circuit or other accident should open the main circuit. No rudder indicator is used with the Steeromotor as the position of the controller handle is always a positive indication of the relative position of the rudder.

The Steeromotor is directly connected by gears to the screw gear of the vessel rudder. A movement of the controller handle in the pilot house to either port or starboard completes one of a number of electrical circuits and closes a relay in the engine room. The closing of this relay completes another circuit from the main generator of the boat to the motor of the Steeromotor through a five-step accelerator. The follow-up moves through a train of gears until a position that corresponds to the controller in the pilot house is reached. When this position is reached the circuit from the controller to the follow-up is opened and releases the relay which opens the main circuit and applies a dynamic brake.

A Motor Ship Necessity

The motor ship has maintained in addition to its power plant a high pressure boiler and steam steering engine simply for rudder operations. The Steeromotor, electrically operated and drawing its power from the ship's generators, eliminates all necessity of the steam plant and makes a motor ship a complete reality. Its reduction of operating expense is obvious.



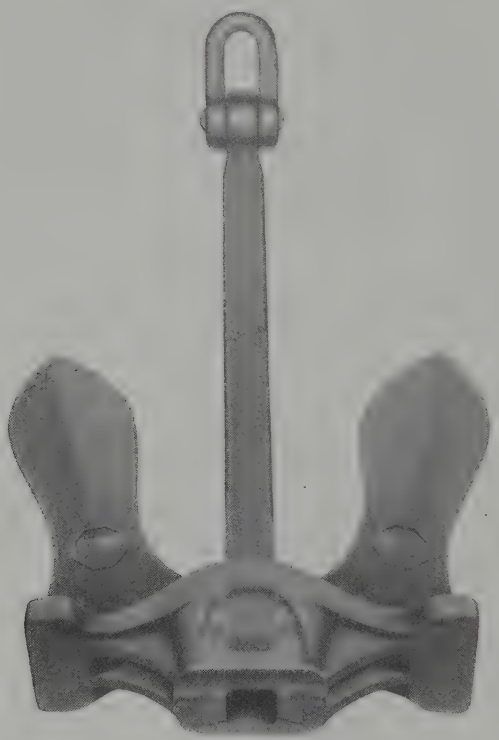
BENSON ELECTRIC COMPANY, SUPERIOR, WIS.

Dunn Stockless Anchors

Dunn Anchor

The Dunn Stockless Anchor was designed and patented in 1889, by Herbert O. Dunn, Rear Admiral, U. S. N. Additional patents have since been obtained covering improvements on the original invention, so that the Dunn Anchor today is the product of 30 years' experience and careful study of the subject of anchors under actual working conditions.

The Dunn Stockless Anchor has distinct advantages over the old type or stock anchor. Greater holding



power is obtained by the fact that both flukes embed themselves in the sea bottom. The elimination of the stock makes it possible for the shank of the anchor to be pulled into the hawse pipe, and as the flukes rotate freely, they draw up snugly against the side of the ship. The anchor is stowed quickly and conveniently and is ready for instant use.

Construction and Operation

The Dunn Anchor does not depend upon a pin to hold the shank and flukes together; the connection between the shank and the fluke casting is made by integral trunnions on the head of the shank. The shank piece, after being inserted through the opening in the bottom of the anchor, is drawn up into place and wedge-shaped filling pieces are riveted in behind it. The upper end of the filling piece, and the inner wall of the anchor itself, make smooth circular bearings for the shank trunnion. As a result of the wedge shape of the filling pieces, practically all strains on them are taken up by the wall of the anchor. These two wedge-shaped filling pieces are unique with the Dunn Anchor. Not only do they make a smooth and secure bearing for the shank trunnions, but also they permit the opening directly beneath the shank to be left free and unobstructed. Complete freedom of "washing through" is obtained and no lodging place is offered for foreign substances which might interfere with the mechanism of the anchor.

When the Dunn Anchor is in holding position, practically all of its weight is forward of the projecting ledges which tilt the flukes downward. The weight is thus thrown on the points, or "bills," of the flukes, which dig in as soon as the ship begins to pull on the cable.

To embed itself, the anchor, instead of plowing up the sea bottom, must permit the soil to close in around it. Curved lines and rounded surfaces on the Dunn Anchor make positive this desirable action. The flukes have ample holding surface and are set at the correct angle to give maximum holding power.

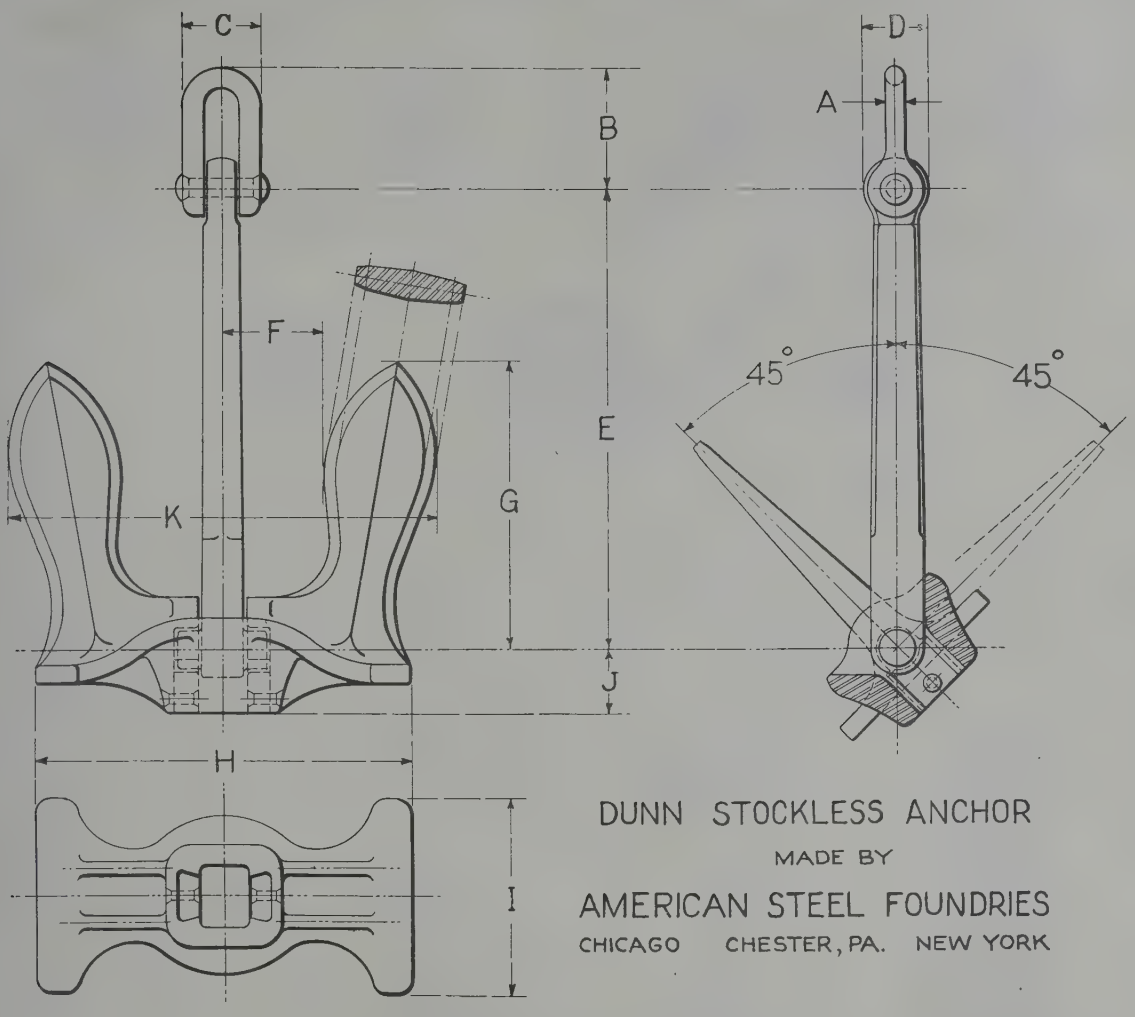
The shank is particularly strong, due to careful annealing and to the high standards of foundry practice of American Steel Foundries.

Dunn Stockless Anchors have an established reputation for "holding power." They have been in use for years on ships of the United States Navy; they are being used in large numbers by the United States Shipping Board Emergency Fleet Corporation on ships that were built under their supervision and are also used extensively by many important steamship companies of the world.

Dunn Anchors are approved by the American Bureau of Shipping, Lloyds Register of Shipping, Bureau Veritas and other classification societies.

Dunn Anchors are made in weights from 200 pounds to 20,000 pounds or heavier. A supply of various sizes is carried in stock from which prompt shipments can be made.

Dunn Stockless Anchors



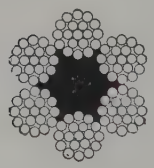
Drawing Showing Dunn Stockless Anchor

For dimensions refer to table below

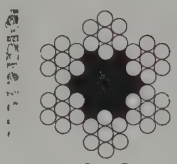
TABLE SHOWING GENERAL DIMENSIONS OF DUNN ANCHORS FOR VARIOUS WEIGHTS

Weight of Anchors Pounds	A	B	C	D	E	F	G	H	I	J	K
250—325	1½″	8½″	5½″	4¾″	30″	6½″	17″	23½″	11″	3½″	27½″
350—450	1½″	8½″	5½″	4¾″	33″	7½″	19″	26″	12″	4″	29½″
475—600	1½″	8½″	5½″	4⅝″	36″	8″	21″	29″	13¾″	4½″	32½″
650—750	2″	11¼″	7½″	5⅞″	39″	8¾″	23″	31″	15″	5½″	35½″
800—950	2″	11¼″	7¼″	5⅞″	42½″	9½″	25″	33″	16″	5½″	38½″
1000—1200	2″	11¼″	7¼″	5⅞″	45½″	10¼″	27″	36″	17″	6″	41″
1300—1500	2″	11¼″	7¼″	5⅞″	49″	11″	29″	40″	19″	6⅝″	44½″
1600—1900	2½″	14⅜″	9″	7½″	53″	12″	32″	43″	20½″	6⅞″	48″
2000—2300	2½″	14⅜″	9″	7½″	56″	12½″	34″	45″	22″	7½″	51″
2400—2700	2½″	14⅜″	9″	7½″	59½″	13½″	36″	48″	23″	7⅝″	54″
*2800—3200	2½″	14⅜″	9″	7½″	63″	13⅞″	39″	51″	24″	7½″	57″
3300—3600	3″	17½″	10⅞″	8⅞″	65½″	14½″	40″	52″	25″	7¾″	59¼″
3700—4000	3″	17½″	10⅞″	8⅞″	68″	15″	41″	53″	26″	8″	62″
4100—4600	3″	17½″	10⅞″	8⅞″	71″	16″	43″	56″	29″	8¼″	64½″
4700—5250	3″	17½″	10⅞″	8⅞″	74½″	16½″	45″	58½″	30″	8¾″	68″
5500—6000	3½″	20¼″	12¾″	10½″	78″	17⅜″	47″	62″	31½″	9″	71″
6250—6750	3½″	20¼″	12¾″	10½″	81″	17⅞″	49″	64″	33″	9⅝″	73½″
7000—7750	3½″	20¼″	12¾″	10½″	84½″	18⅞″	51″	67″	34½″	10¼″	76½″
8000—8750	3½″	20¼″	12¾″	10½″	88″	19½″	53″	69½″	36″	10¾″	80″
9000—9500	4″	22¾″	14⅜″	12″	90½″	20″	55″	72½″	38″	11½″	82″
9750—10500	4″	22¾″	14⅜″	12″	93½″	20¾″	56″	74½″	40″	12″	84½″
11000—12500	4″	22¾″	14⅜″	12″	99″	22″	60″	77½″	41″	12⅝″	90″
13000—15000	4½″	26½″	16¾″	13⅞″	105½″	23½″	64″	83½″	43″	13″	96″
15500—17500	4½″	26½″	16¾″	13⅞″	111½″	24⅝″	67″	87″	45″	13½″	102″
18000—20000	4½″	26½″	16¾″	13⅞″	116½″	26″	69″	91½″	47½″	14″	105″

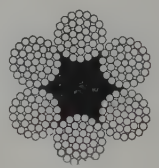
Wire Rope and Fittings



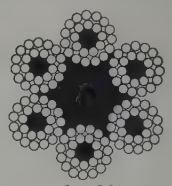
6 x 19
For Hoisting Ropes and Lifts



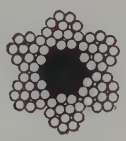
6 x 7
For Standing Rigging
¼" to 1" Dia.



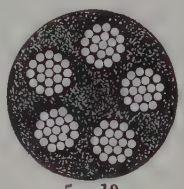
6 x 37
For Large Hawsers



6 x 24
For Mooring Lines and Small Hawsers



6 x 12
For Standing Rigging
1" Dia. and Larger



5 x 19
Fibre Clad for Hoists

6 x 12
For Running Ropes and Messengers

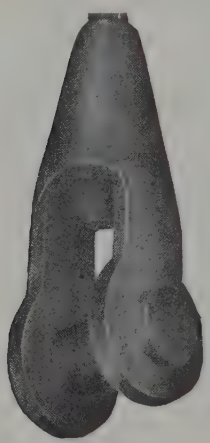
Wire Rope

The Wire Rope manufactured by the Upson-Walton Company is made of Iron, Crucible Steel, U-W Steel or Perfection quality. It is uniform in quality, the core is properly proportioned and the rope as a whole is laid up so scientifically that each single wire bears its exact proportion of the general load.

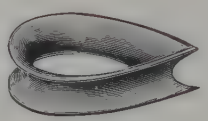
Upson-Walton Wire Rope is made in a large variety of types, each specially designed for the work to be performed.

Nubian Black treatment on bright ropes not only lubricates the individual wires, but protects them against corrosion better than an external application. The latter statement applies especially to the inside wires, which, after the rope is built, cannot be reached.

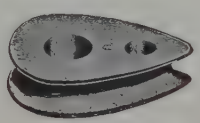
U-W Pearl Gray makes the finest of galvanized finishes.



Socket



Thimble



Thimble

Wire Rope Fittings

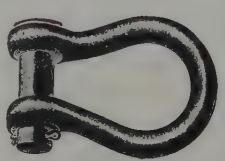
The Upson-Walton Company, makers of Wire Rope and Fittings, has fitted out, during the past forty-nine years, over one thousand ships of all sizes in addition to the refitting of many others. Naturally their organization is in a position to furnish valuable advice concerning fittings for all purposes.

Their stock of Turnbuckles, Shackles and Thimbles, in standard listed dimensions, is large and complete, as well as that of Hooks, Eyes and Jaws on Turnbuckles and various designs of connections for Shackles.

Their products include Forgings of various kinds such as Chain Plates, Pad Eyes, Boom and Mast Bands, all of which are carried in stock or made according to blue prints.

Their staff includes a large force of skilled riggers, working under competent foremen, to install equipment on ships or on land.

Shackle



Shackle

Turnbuckles

THE UPSON-WALTON CO.

1294-1310 W. ELEVENTH STREET, CLEVELAND, OHIO

Anchors, Blocks and Sheaves

National Anchor

Anchors

National Stockless Anchors, as illustrated above, are furnished tested to Lloyd's Register of Shipping, American Bureau of Shipping, Bureau Veritas, or not tested, as desired.

Over 10,000 tons of National Anchors have been produced and are in use today all over the world. They are approved by the U. S. government, the Emergency Fleet Corporation having used several million pounds.

National Anchors are made in sizes from 300 to 20,000 pounds.

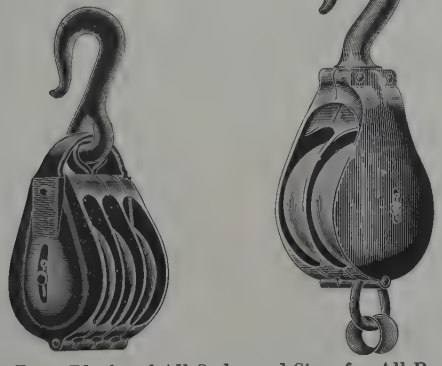
An average stock of about 600,000 pounds is kept on hand for prompt shipment.

Blocks and Sheaves

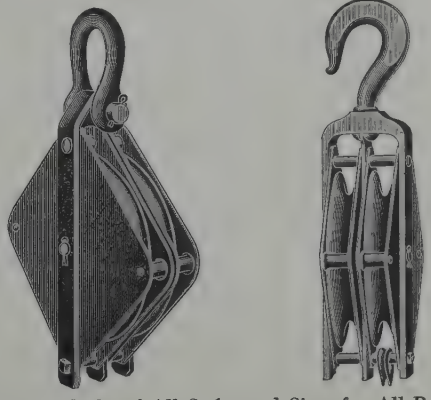
The Upson-Walton Company is the oldest manufacturer of Steel and Iron Blocks in the United States.

Blocks for Manila Rope from ⅜ inches to 4 inches in diameter are carried in stock. Blocks for Wire Rope from ¼ inch to 1½ inches in diameter are carried in stock. Larger sizes of Wire Rope Blocks can be made to order.

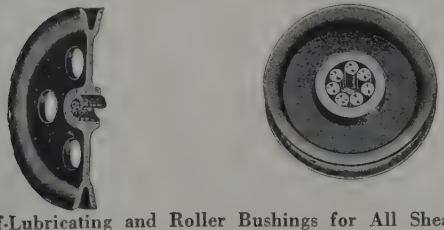
The Sheaves are Self-Lubricating. The bushings are composed of special phosphor bronze and they carry a scientific lubricating compound which reduces the pin wear to a minimum.



Manila Rope Blocks of All Styles and Sizes for All Purposes



Wire Rope Blocks of All Styles and Sizes for All Purposes



Self-Lubricating and Roller Bushings for All Sheaves

Branch Offices

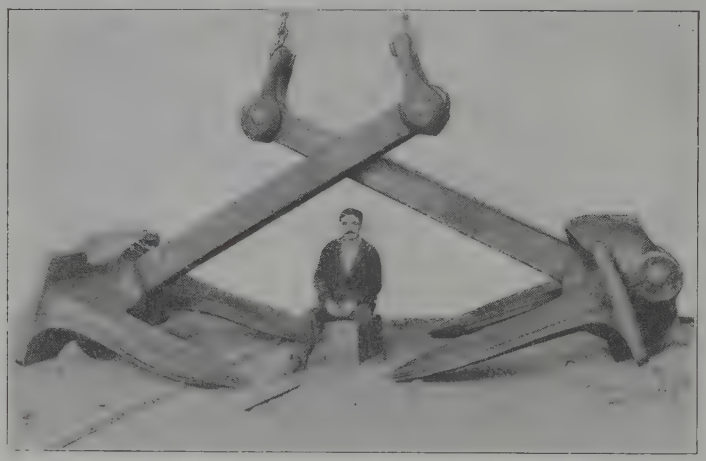
In addition to the Main Office and Factory in Cleveland, Ohio, The Upson-Walton Company maintains the following Branch Offices where any information regarding Upson-Walton products may be obtained:

New York, N. Y.—291 Broadway.
Chicago, Ill.—711 So. Wells St.
Pittsburgh, Pa.—1103 Bessemer Bldg.
Detroit, Mich.—Boston, Mass.—New Orleans, La.
Denver, Colo.—Newark, N. J., Wire Rope Mill.

THE UPSON-WALTON CO.

1294-1310 W. ELEVENTH STREET, CLEVELAND, OHIO

Anchors and Chains



Baldt Stockless Anchors for All Requirements

Baldt Stockless Anchors are built in all sizes from 200 pounds to 30,000 or above if desired. They are used extensively by the United States Navy. They are in equally wide use on merchant and passenger ships throughout the world, and are in general use for mooring purposes.

A particularly large stock is carried, tested to any requirements. The large manufacturing facilities of the Baldt Anchor Company permit immediate deliveries of most standard sizes.

Features of the Baldt Stockless Anchor

The Baldt Patent Stockless Anchor is cast in two parts, the head, or crown and flukes, forming one part, and the shank the other. The two parts are connected on the ball-and-socket principle, and so arranged that the flukes are always at an angle of 45 degrees to the side of the shank lying next to the bottom.

The head is permitted to move freely on the shank, and the ball and socket is so arranged that the anchor cannot pull apart.

All anchors fitted with forged shanks in place of cast steel. Forged shanks are much superior.

Advantages of the Baldt Stockless Anchor

First—No matter how the anchor falls, both flukes are always down and take hold simultaneously, giving greater holding power than any other anchor made.

Second—The Baldt Stockless Anchor is absolutely sure of taking hold the moment the strain comes upon the cable.

Third—As the two flukes are always down, the cable cannot foul.

Fourth—The anchor cannot drag because it will not roll over.

Fifth—It cannot become fouled; there are no pins to break, loose or bend, and no trunnions to jam.

Sixth—Its great strength and durability; all parts are made of the finest grade of open-hearth steel, and each anchor is submitted to exhaustive tests.

Seventh—No dirt or stones can accumulate in the socket.

Eighth—It is exceedingly simple in construction.

Ninth—Excels all others in stowing. In a recent test made by the U. S. Navy, when foreign and domestic anchors were considered, the Baldt Stockless Anchor was adopted over all others on account of its stowing qualities and strength.

Tenth—The Baldt Stockless Anchor costs less to buy and less to keep in service than any other stockless anchor made.

Tests

The following tests are employed to insure the highest grade of steel being used in the Baldt Stockless Anchors:

1—Test bars, taken from each heat, must show 60,000 to 70,000 pounds tensile strength, with 15 to 25 per cent elongation in eight inches and 20 to 30 per cent reduction of area.

2—A test bar one inch square is required to bend cold to an angle of 90 degrees.

3—No metal must run above .05 in phosphorus and .05 in sulphur.

4—Every anchor is subjected to a drop-test of 12 to 15 feet on steel blocks.

All anchors in heats varying in any particular from the above specifications are rejected.

We make the Baldt Anchor to any specifications required. It is approved by the U. S. Navy, U. S. Army, Lloyds Register of British and foreign shipping, American Bureau of Shipping, Bureau Veritas, United States Standard, the Lakes' Register, and all other bureaus of test.

Stud Link Chains

We manufacture 1 7/8" up to 2 1/2" Stud Link Chain. This is made under drop hammers, and every link is uniform, fitting the wildcat of the ship like a glove. Hand made chain varies so much that often the links will not fit the sprocket in the wildcat. The uniformity of Baldt Stud Link Chain insures perfect working qualities.

BALDT ANCHOR CO., CHESTER, PA.

Admiral Anchors

All Types and Sizes

Admiral Anchors are manufactured from the best grade acid open hearth steel, and are furnished in all sizes up to 30,000 lbs. in weight. The Admiral Anchor Company, in addition to manufacturing the "Admiral Stockless Anchor," are also manufacturers of Old Style Stock, Mushroom, Mooring and Trotman Anchors. Standard sizes are kept in stock for immediate shipment.

Distinctive Features

The Admiral Stockless Anchor is of the simplest possible construction, being made of but five parts. It is assembled by drawing the shank through the opening in the fluke, forcing the fluke pin through the cored hole in the fluke and shank and upsetting its end. The shackle and pin are then placed in position, the pin ends upset, and the anchor is complete.

The shank is held to the fluke of the anchor by means of lugs on the shank. There are no angular surfaces on which a chain can foul, and the anchor is designed so that both flukes will take hold simultaneously and will not break mud in entering it. The anchor will not roll, and when drawn into the hawse pipe will house close to the ship's side.

Every step in the process of the manufacture of Admiral Anchors is made with the most modern methods and appliances and is carefully supervised and checked, resulting in a product that is unexcelled for dependability and workmanship.

Approved by All Inspection Bureaus

Admiral Anchors are made subject to specifications for chemical and physical tests as required by Lloyd's Register of Shipping, American Bureau of Shipping, United States Navy and Bureau Veritas, and have been approved and accepted by all of these organizations. These anchors are made of acid open hearth cast steel having a tensile strength of 60,000 to 70,000 pounds per square inch, elastic limit of 45 per cent of tensile strength, elongation of 15 to 25 per cent, and 20 to 30 per cent reduction of area. Every part is more than twice as strong as the cable for any given sized anchor, and Admiral Anchors have never lost a ship.

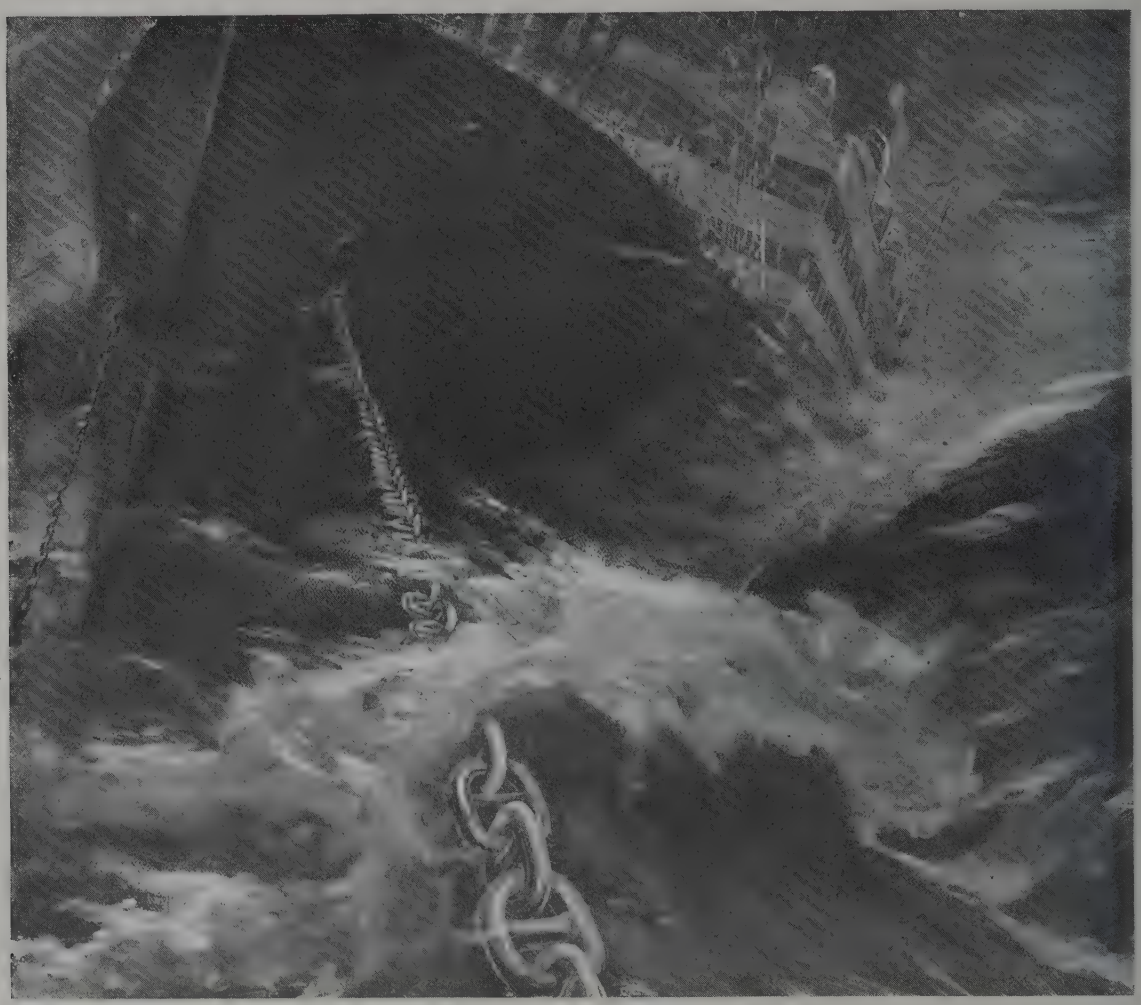
Steel Castings

The Admiral Anchor Company is a subsidiary of the Penn Seaboard Steel Corporation which is in a position to furnish steel castings of any design. The Penn Works of this Corporation are equipped with pattern and machine shops and are situated at Chester, Pa., in the heart of the shipbuilding industry.

THE ADMIRAL ANCHOR CO.

1417 SANSOM ST., PHILADELPHIA, PA.

Acco Ship Chains



Where Acco Chains Mean Safety

Acco Chains

We illustrate and describe in these pages a few of the special chains and attachments that apply to ship and shipyard equipment. It is impossible in the limit of space available to give adequate information and details on our complete line of chain products, for which we must refer to our general catalog, which we shall be glad to supply upon application.

We manufacture all types of chain ranging from Plumbers' Safety Chain to Ships' Cable Chain in the largest sizes, and are prepared to manufacture chain of any type to special dimensions or for special purposes.

We maintain an Experimental Department, which is constantly on the alert to increase the efficiency of chain—exhaustive tests and experiments being at all times carried on in our own rolling mills to develop material which will best withstand the severe usage to which large chains are subjected.

Send us your drawings and specifications, and we assure you of attractive prices, prompt service and chain of quality, all of which are the result of our enormous production and efficient methods of manufacture.

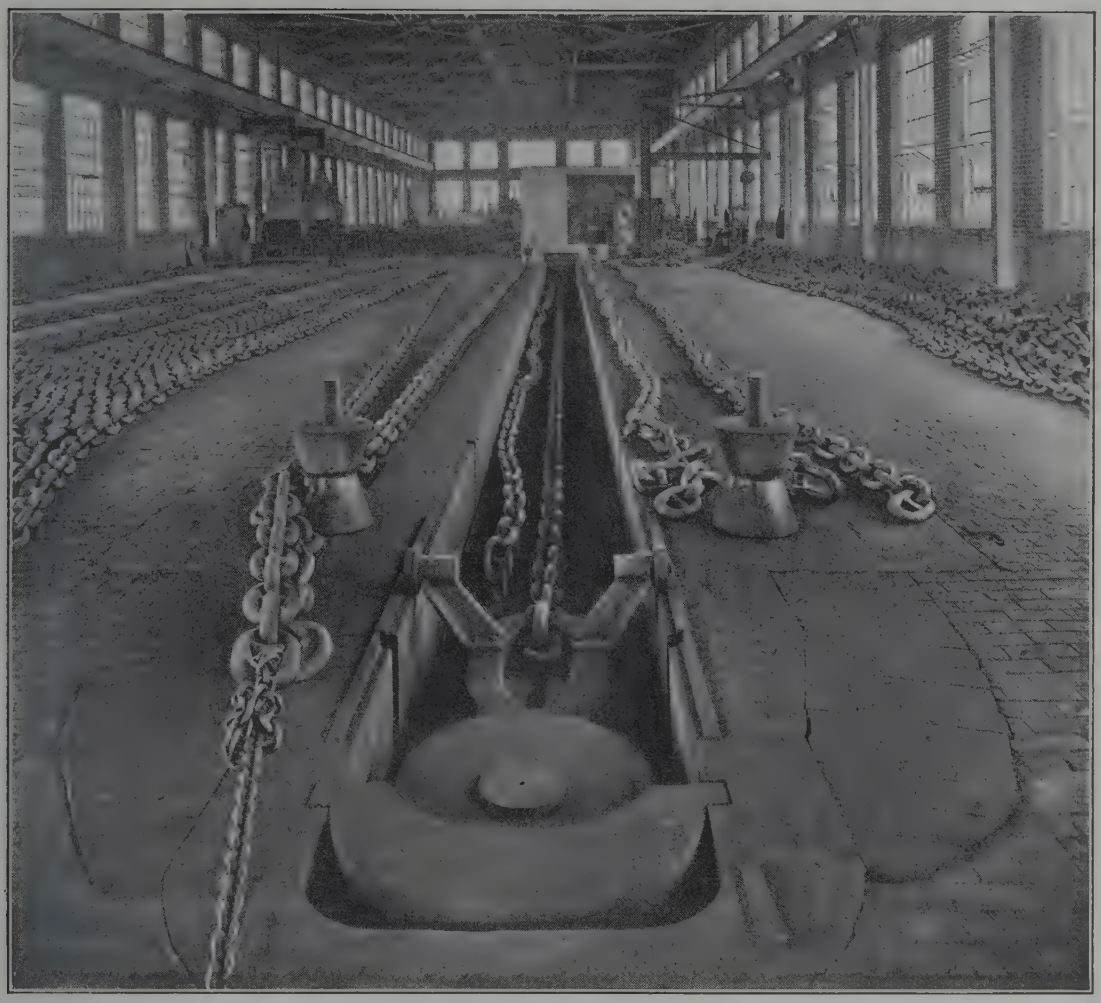
The proof testing of every link is, without question, a very important factor in the manufacturing of Ship's Cable Chain. One defective link may cause an anchor chain to fail at a critical moment.

In the hour of peril, human life and human suffering cannot be measured in dollars and cents. Ocean travel demands safety, and safety can only be assured when the anchor chains are made and tested to hold in any emergency.

Before a seaman can secure a pilot's license he must pass the examiner's test. Before an Acco Chain can get a "commission" it must prove its Strength—every link must test up to its rated capacity to make Safety Absolute.

Acco Chains are tested with the largest and most modern type of chain tester in the world, as illustrated and described on the opposite page.

Acco Ship Chains



End View of Testing Machine Showing Chain in Position Ready for Testing

Chain Testing

The illustration above is an end view of the testing machine showing chain in position ready for testing. No chain is absolutely safe unless it is actually proof tested. There is always a possibility of a chain having a link improperly welded, burnt, or otherwise defective, and this can be detected only by testing. We actually test every pound of chain made in our plants.

Chain is proof-tested to about one-half the average breaking strain. The ordinary safe working load should not exceed one-third of the breaking strain, or a little over one-half the proof-test. Therefore, the size chain required for a given safe working strain can be easily determined by constructing tables showing proof tests and breaking strains on the various chains.

Stud Link Anchor Chain

All our stud link anchor chain is made from the highest grade refined iron, rolled in our own rolling mills. Our many years of experience in producing chain iron insures an even quality throughout, tough and fibrous, and possessing hard-wearing qualities.

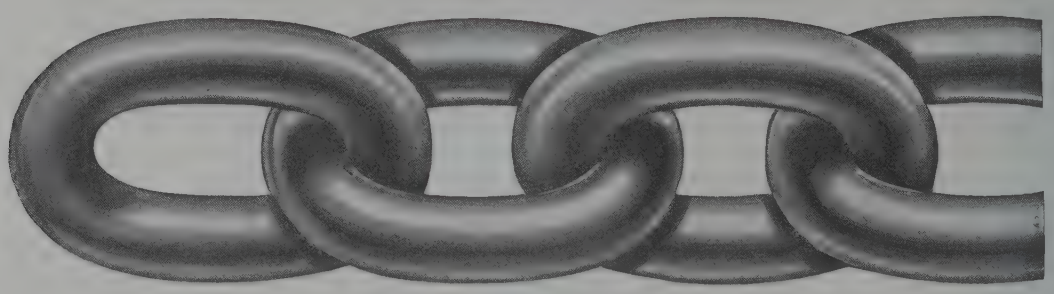
We are prepared to furnish Stud Link Chain in all sizes to Lloyd's approved Standards and specifications, and will furnish Lloyd's test and inspection certificates with any chains so ordered. Lloyd's Surveyers are in constant attendance at our factories and conduct all tests.

Stud Link Chain is also made to the latest approved standards and specifications of the American Bureau of Shipping. Chains for use on vessels of American Registry should be furnished with chain to these standards. With few exceptions these specifications are practically the same as Lloyd's. Test and inspection certificate by the American Bureau of Shipping furnished.

We are also prepared to furnish Stud Link Chain tested to Bureau Veritas requirements.

Stud Link Chain subject to our own test and inspection is made to the same specifications as that of the American Bureau of Shipping. The same grade of material is used and the tests are identically the same.

Acco Ship Chains



½-inch Proof Coil Chain—Exact Size

Close Link or Stream Chain

Close Link or Stream Chain is for use as mooring and anchor chain on small and medium-size ships. It is carefully made from the highest grade double-refined iron obtainable. We are prepared to furnish this type of chain in all sizes.

Proof Coil Chain

This grade of chain is made of open-hearth basic steel or iron, as ordered. It is proof tested to strains as shown in the table below. Supplied self-color, as it comes from the forge, or blacked if desired, at no extra charge. Furnished in continuous lengths, or in short sections as required.

B B Coil Chain

B B Coil Chain is made of open-hearth basic steel or iron as ordered. This is a closer link chain than the common grade, or Proof Coil, and greater care is exercised in its manufacture, making a good strong chain for general use. Furnished in self color, blacked or hot galvanized.

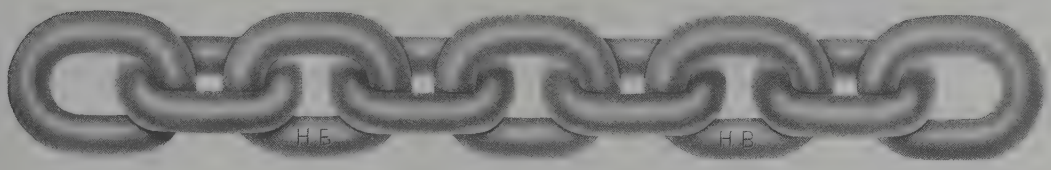
B B B Coil Chain

This chain is closer link than the B B. Where strength and durability are required, we recommend this grade. Enlarged end links can be furnished on one or both ends of chain. This grade is supplied in self color, blacked or hot galvanized. No extra charge for blacking.

CHAIN TABLE

	Proof						B B						B B B					
Size in Inches	Approximate Number of Links per Foot	Outside Length of Link in Inches	Outside Width of Link in Inches	Weight Per 100 Ft. Lbs.	Actual Proof Test Pounds	Approx. Breaking Strain Pounds	Approximate Number of Links per Foot	Outside Length of Link in Inches	Outside Width of Link in Inches	Weight Per 100 Ft. Lbs.	Actual Proof Test Pounds	Approx. Breaking Strain Pounds	Approximate Number of Links per Foot	Outside Length of Link in Inches	Outside Width of Link in Inches	Weight per 100 Ft. Lbs.	Actual Proof Test Pounds	Approx. Breaking Strain Pounds
⅛	13	59/64	11/32	18½	450	900	15	13/16	11/32	20½	475	950	17	23/32	11/32	21¾	500	1,000
3/16	13	1⅜	⅞	46	1,000	2,000	14	1¼	¾	50	1,100	2,200	16	1⅛	¾	52	1,200	2,400
¼	12	1½	1 1/16	75	1,500	3,300	13	1 7/16	15/16	80	1,650	3,800	14	1⅜	15/16	83	1,750	4,500
5/16	11	1⅞	1¼	110	2,600	5,200	12	1¾	1⅛	115	3,000	5,600	13	1⅝	1⅛	118	3,400	7,000
⅜	9½	2⅛	1½	155	3,600	7,200	10½	1 15/16	1 7/16	160	4,000	8,000	11½	1⅞	1 7/16	166	4,500	9,000
7/16	9	2¼	1 11/16	200	4,500	10,000	9½	2 3/16	1 9/16	210	5,500	11,500	10	2⅛	1 9/16	215	6,300	12,500
½	8	2½	1⅞	260	6,500	13,000	8½	2 7/16	1¾	265	7,000	15,000	9	2⅜	1¾	268	8,000	16,500
9/16	7½	2⅞	2⅛	325	8,000	16,000	8	2 13/16	2	335	8,800	18,500	8¼	2¾	2	340	10,000	22,000
⅝	6½	3⅜	2¼	400	9,500	20,000	7	3⅛	2⅛	410	10,750	23,000	7¼	3	2⅛	420	12,500	25,000
¾	6	3⅞	2 11/16	590	13,500	28,800	6¼	3⅝	2 9/16	600	15,500	33,500	6½	3½	2 9/16	610	17,750	35,000
⅞	5	4⅜	3⅛	800	18,500	39,000	5¼	4⅛	3	820	21,000	44,000	5½	4 1/16	3	830	24,000	47,500
1	4	5	3⅝	1,000	24,000	51,500	4¼	4¾	3½	1,030	28,500	59,000	4½	4⅝	3½	1040	31,350	64,500
1⅛	3¾	5½	4	1,300	29,000	60,000	4	5¼	3⅞	1,350	36,000	74,000	4⅛	5⅛	3⅞	1400	38,000	78,000
1¼	3⅜	6⅛	4⅜	1,500	39,000	80,000	3½	5⅞	4¼	1,550	43,000	86,000	3⅝	5¾	4¼	1600	47,000	95,000

Ajax Quality Dredge Chain



H. B. Quality Dredge Chain

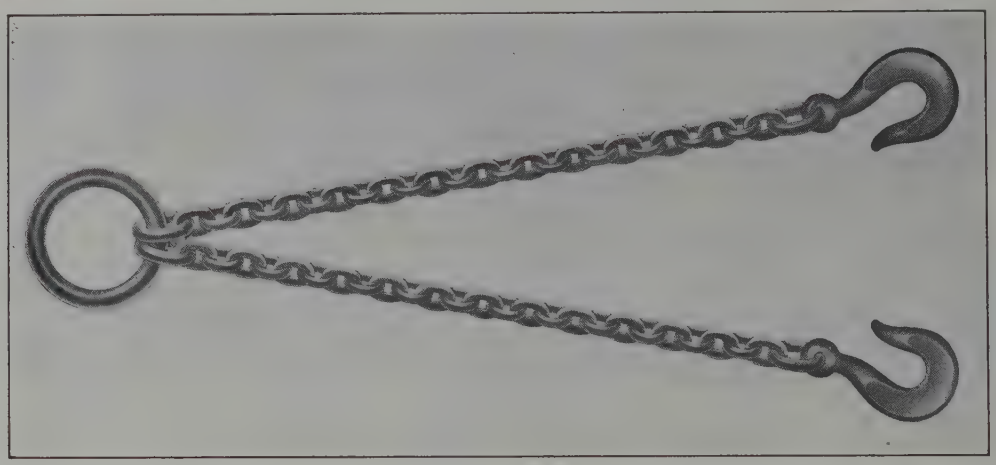
Dredge Chain

We manufacture Dredge Chain in three qualities, which differ in the character of construction of the iron that is used. H. B. quality is equal to any other Dredge Chain made, but where price is not a special object but quality is the prime factor, we recommend either our Ajax or Ajax Special, which are manufactured from specially rolled and refined iron, the result of long years of experiment and experience in our own rolling mills to produce grades of iron that will withstand the heavy strain put upon this class of material.

A table of tests and dimensions of the different grades is given herewith.

CHAIN TABLE

	H. B. Dredge						Ajax Dredge			
Size, Inches	Standard Pitch	Outside Length in Inches	Outside Width in Inches	Proof Test	Approximate Breaking Strain	Average Safe Working Load	Proof Test	Approximate Breaking Strain	Average Safe Working Load	Average Wt. per Foot
5/8	1 11/16	3	2 1/8	12,000	25,000	7,200	14,000	27,000	8,000	4
3/4	1 15/16	3 1/2	2 1/2	18,000	36,000	10,800	20,000	40,000	12,200	6 1/4
7/8	2 3/16	4	2 7/8	24,500	48,000	14,700	26,000	52,000	16,100	8
1	2 1/2	4 5/8	3 1/4	32,000	61,000	19,200	33,750	67,500	20,500	10
1 1/8	2 3/4	5 1/8	3 3/4	40,000	78,000	24,000	41,500	83,000	25,500	13
1 1/4	3 1/8	5 3/4	4 1/8	49,000	95,000	29,400	52,000	104,000	31,200	16
1 3/8	3 9/16	6 7/16	4 9/16	58,000	114,000	34,800	60,000	120,000	36,100	19
1 1/2	3 7/8	7	5	67,000	134,000	40,200	70,400	140,800	43,400	23
1 5/8	4 1/4	7 3/4	5 1/2	77,000	154,000	46,200	81,500	163,000	50,200	28
1 3/4	4 3/4	8 1/2	5 7/8	83,000	166,000	49,800	87,500	175,000	52,500	31
1 7/8	5 1/4	9 1/4	6 3/8	95,000	190,000	57,000	100,000	200,000	60,000	35
2	5 3/4	10	6 3/4	108,000	216,000	64,800	114,000	228,000	69,600	40
2 1/8	6 1/4	10 3/4	7 1/8	122,000	244,000	73,200	129,000	258,000	77,400	47
2 1/4	6 3/4	11 1/2	7 5/8	136,500	273,000	81,900	143,000	286,000	85,800	53
2 3/8	6 7/8	11 7/8	8	152,000	304,000	91,200	159,500	319,000	95,700	58 1/2
2 1/2	7	12 1/4	8 3/8	168,500	337,000	102,100	180,000	360,000	108,000	65



Double Pattern Sling Chain

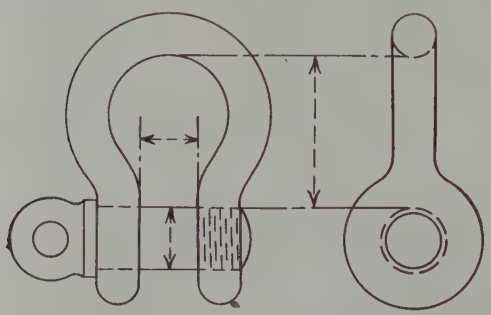
Sling Chains

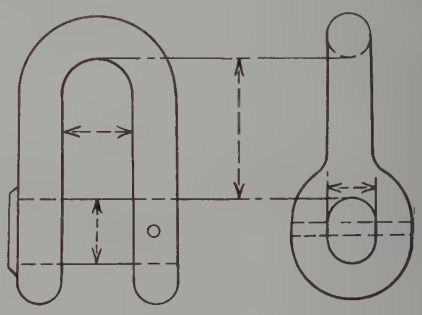
Sling Chains are made in two patterns, double and single. The illustration above shows the double pattern. These chains are for work of all kinds where it is necessary to use cranes, derricks, etc., and are particularly adapted for loading material on ships. Sling Chain should always be made from H. B. quality, Ajax, or Special Ajax quality Dredge Chain. Hooks and rings are made in proportion to the size of chain ordered. We will quote on special constructions upon receipt of definite specifications.

Shackles

We are prepared to supply Anchor and Joiner Shackles, both Screw Pin and Round Pin, in sizes from 3/16 inch to 2 inch. Also Shackles for Stud Link Cables made to American Bureau of Shipping or Lloyd's standard dimensions.

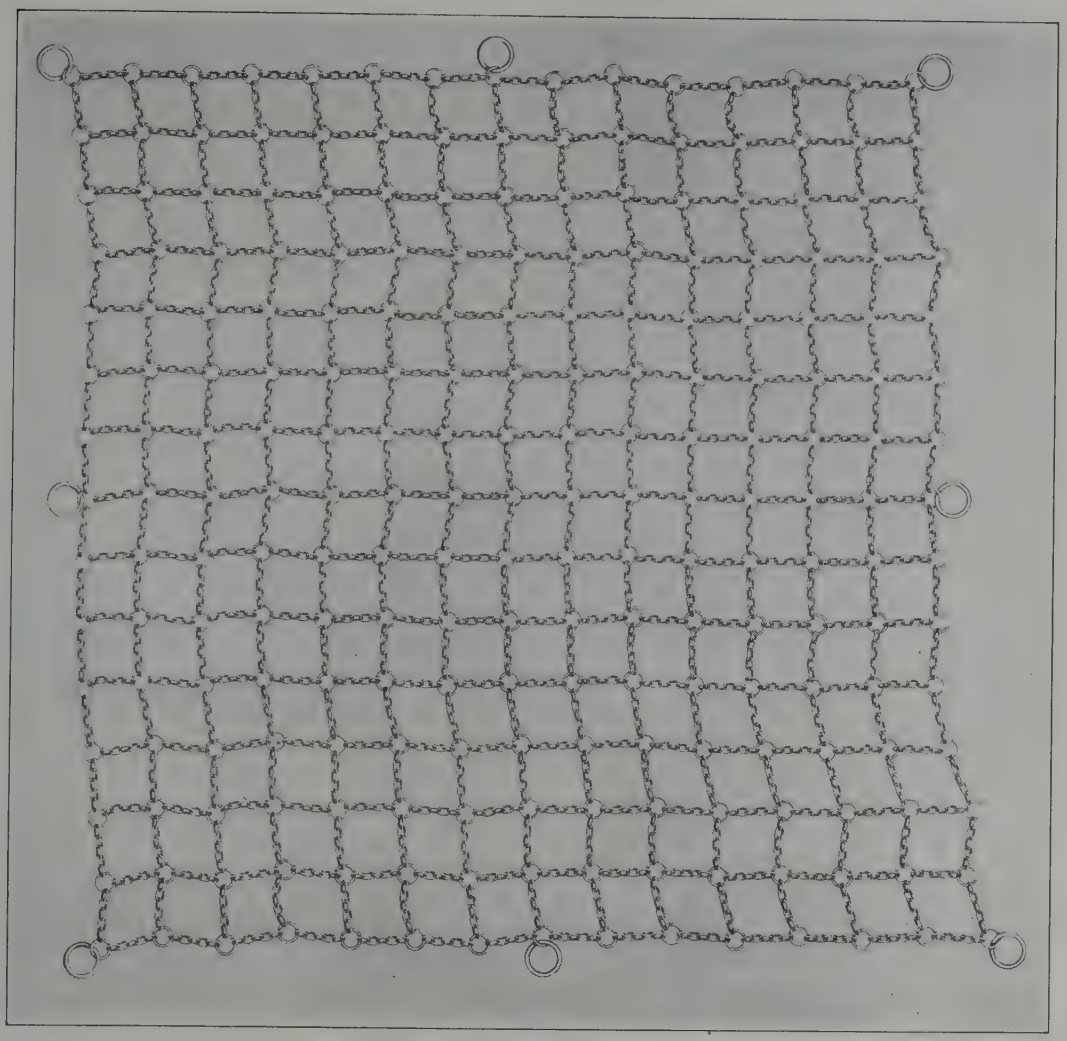
The tables below show approximate weights and dimensions.





WEIGHT AND DIMENSIONS OF SHACKLES

Screw Pin Anchor Shackles.					Oval Pin Chain Shackles.				
Size	Inside Length	Width Between Eyes	Diam. Pin	Weight per 100	Inside Length	Inside Width	Oval Pin Thickness	Oval Pin Width	Weight per 100
3/16	13/16	5/16	¼	7	—	—	—	—	—
¼	1	7/16	5/16	12	13/16	½	¼	⅜	12
5/16	1 3/16	½	⅜	19	1	½	5/16	7/16	18½
⅜	1 7/16	⅝	7/16	31	1 3/16	⅝	⅜	½	27
7/16	1⅝	¾	½	49	1⅜	⅝	7/16	9/16	44½
½	1 13/16	13/16	9/16	71	1⅝	¾	½	⅝	68½
9/16	2⅛	15/16	⅝	92	1 13/16	⅞	9/16	11/16	88
⅝	2⅜	1⅛	¾	151	2	1	⅝	13/16	130
¾	2¾	1¼	⅞	226	2 7/16	1¼	¾	1	201½
⅞	3⅛	1 7/16	1	340	2⅞	1⅜	⅞	1⅛	292
1	3½	1⅝	1⅛	495	3¼	1½	1	1¼	441½
1⅛	3⅞	1 13/16	1¼	657	3⅝	1¾	1⅛	1½	575
1¼	4¼	2	1⅜	899	4	1⅞	1¼	1⅝	801½
1⅜	4¾	2¼	1½	1219	4⅜	2⅛	1⅜	1 13/16	1109
1½	5¼	2 7/16	1⅝	1595	4¾	2¼	1½	1⅞	1472
1⅝	5¾	2⅝	1¾	1892	5¼	2⅜	1⅝	2	1635
1¾	6¼	2⅞	1⅞	2401	5¾	2½	1¾	2¼	1819
2	7	3¼	2⅛	3860	6¾	2¾	2	2⅝	2800



Cargo Net

Cargo Nets

These Cargo Nets are made for general ship's use in any size or shape desired. The regular sizes and dimensions are: chain —¼, 5/16 and ⅜ inch; mesh —7 inches square; complete net, 8 x 8, 9 x 9 or 10 x 10 feet square. In ordering indicate the size net required by giving the length and width in feet, also the size chain and mesh wanted. The chain is furnished self color unless otherwise ordered.

Finishes

Our modern and up-to-date finishing and metal-treating equipment, to which we are constantly adding new devices and processes of our own, as well as others that come to our attention, enables us to furnish, at additional net prices, any finish or special-treated chain that may be called for.

Bright finish is obtained by tumbling the product in especially constructed revolving barrels. All scales and rough spots are removed, leaving a smooth, polished surface.

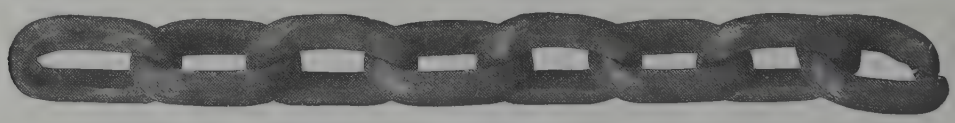
Black finish is obtained by immersing the product in asphaltum diluted with benzine. It gives a dull black coating which will prevent early rusting. This finish is used mostly on heavy welded chain.

Nickel finish is obtained by nickel electro-plating and is absolutely rust-proof.

Cold galvanized finish is obtained by zinc electro-plating. This finish prevents deterioration, but is not absolutely rust-proof.

Hot galvanized finish is obtained by immersing the product in a hot bath of zinc, which leaves a heavy coating on same. This finish is the best rust preventive possible.

Woodhouse Chain



Dredge Chain as Worn and Stretched After 16 Months' Continuous Work

Hand Made Chain

The Woodhouse Chains described on this page are guaranteed strictly hand-made. On board ship, where strength and safety are of paramount importance, the Woodhouse quality of hand forged chain is an assurance of reliability.

In the forming of links by the cold bending process, many of the fibres in the metal are deformed or fractured, whereas in the hot bending process, used in the making of Woodhouse Chain, the fibres are not disturbed, thus maintaining the full strength of the metal.

To insure the finest material being used in Woodhouse Chain, all iron is subjected to exhaustive tests and selected according to the work a chain is required to perform.

Sling Chain

Dredge Chain

Woodhouse Special Dredge Chain is made of scientifically and chemically selected pure pig iron, treble worked and re-rolled. It withstands shocks and strains without crystallization longer than any other known iron.

Due to the pronounced superiority of this chain, the links are clearly stamped "Woodhouse Trenton" on every six foot section.

The iron from which this chain is produced shows the following laboratory test results: (1 inch round—8 inches long) Tensile strength 50,880 to 51,600 lbs. per sq. in.; elastic limit 34,710 to 35,640 lbs. per sq. in.; elongation 33.25 per cent; reduction of area at fracture 51.70 per cent.

Crane Chain

The various grades of Woodhouse Crane chain conform in every way to the high standard —Woodhouse quality.

In the XB 3-B Crane Chain the same high-grade refined iron that is used in the English Lloyd's Test Chain, with long, well-finished laps.

In the H & P BBB Crane Chain only high-grade pure, best refined iron with a tensile strength of 49,000 lbs. per sq. in. is used. During the twenty-three years which this chain has been used it has invariably given utmost satisfaction.

Crane Chain

Sling Chain

Sling Chains can be made from any grade of chain desired, with single, double or quadruple chains. These chains can be furnished with hook and ring, two rings, two oval links, or other fittings as required.

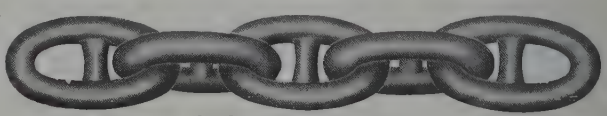
If so desired, the chains can be made from Genuine Norway or Swedish Iron.

Stud Link Cable Chain

Woodhouse Stud Link Cable Chain is made to the American Bureau of Shipping Standard Dimensions, unless otherwise specified. Stud Link Cable Chains can be furnished to the latest approved standards and specifications of the American Bureau of Shipping, Lloyds, and Bureau Veritas.

Every chain is proof tested before leaving the factory. If a defective link is discovered it is removed, a perfect link inserted, and the chain re-tested.

The iron used in the Woodhouse Stud Link Cable Chain is specially selected, of a quality suited to the requirements. Its exceptionally high quality and the excellence of the chain made from it, is shown by the fact that a Woodhouse Stud Link Cable Chain has never been rejected by an Inspector.

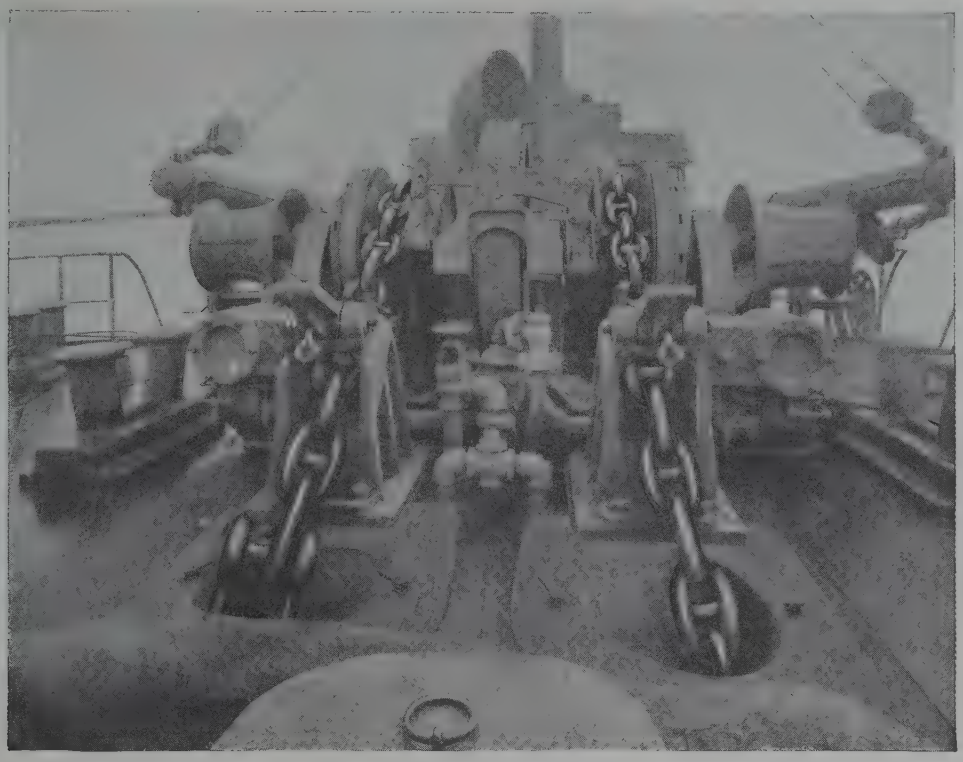


Stud Link Cable Chain

WOODHOUSE CHAIN WORKS

540 THIRD ST., TRENTON, N. J.

Ship's Chains



Stud Link Chain Passing Over Windlass

Anchor Chains

The Stud Link Ship's Cable Chain manufactured by the United States Chain and Forging Company is made in all sizes to fit standard wildcats as adopted by the United States Shipping Board and manufactured by all standard windlass manufacturers. Details of dimensions and weights will be furnished on request.

Specifications

United States Ship's Cable Chain is made to meet in all respects the specifications of the American Bureau of Shipping, Lloyd's Register, Bureau of Veritas, or to Navy Specifications. Each link is proof tested in the company's factories on approved testing machines to strains required by these testing societies and a certificate is furnished the purchaser.

Construction

United States Ship's Cable Chain is made from the best grade of iron obtainable, and is rolled, shaped, welded and proved in the company's mills. The utmost care is observed in every step of its manufacture to obtain links of absolute regularity and uniformity. Improved methods and careful workmanship throughout the process of construction result in a cable which exceeds all requirements of strength and which works perfectly over standard wildcats.

Repair Chains

The ample manufacturing facilities and large amount of chain of all sizes continually being made up by the United States Chain and Forging Company enables them to supply repair chains, in case of loss of part of the cable, at short notice, and for quick delivery. In ordering chain for this purpose, in case the wildcat is not of the present standard, it will be necessary to specify inside width and length of link in order to assure exact duplication.

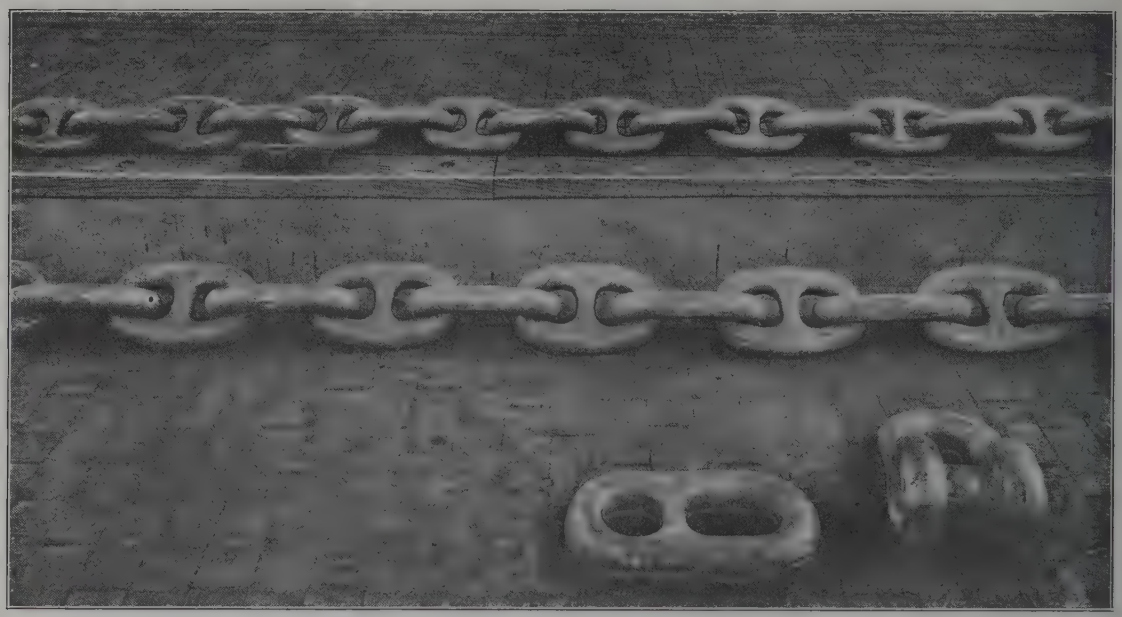
Chain for Other Purposes

The United States Chain and Forging Company also manufacture chains of all types and sizes for a large number of other shipboard and shipyard purposes such as steering gear chain, sling chains, chain nets, towing chains, cargo chains, etc. Shackles and hooks of all types are also manufactured. All of these products are of the same high grade of material and workmanship as the anchor chains and can be depended upon to give the best possible service.

UNITED STATES CHAIN & FORGING COMPANY

UNION ARCADE, PITTSBURG, PA.

Naco Electric Steel Anchor Chain Cable



"Naco" Electric Steel Anchor Chain Cable Ready for Inspection

Features of "Naco" Anchor Chain Cable

The outstanding features of "Naco" Electric Steel Anchor Chain Cable are Strength and Uniformity.

The combination of superior quality of material with design of link in which the stud is cast integral with the link (thus entirely eliminating loose or lost studs) makes "Naco" Chain the strongest Anchor Chain manufactured.

The exact uniformity of size and shape of links gives perfect operation over Wildcats of standard design, making it unnecessary to provide for such variations and tolerances as are required for forged chain.

Specifications

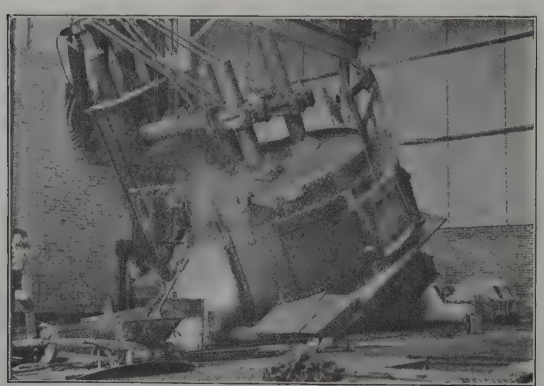
Lloyd's Register of Shipping and the American Bureau of Shipping, approve the use of "Naco" Electric Steel Anchor Chain. The proof test on "Naco" Chain is set at the breaking load on Wrought Iron Chain, 40% being added to arrive at a higher figure for the break test on Steel Chain.

Inspection

The thorough inspection and testing of "Naco" Electric Steel Anchor Chain Cable together with its great strength guarantee full service, and assure safety when life and property are at stake.

Emergency Fleet Corporation Orders

More than 6,000 tons of "Naco" Electric Steel Anchor Chain Cable were furnished to the Emergency Fleet Corporation during the year 1919 under the dual inspection of the American Bureau of Shipping and Lloyd's Register of Shipping.



Electric Furnace Used in Making "Naco" Steel

750,000 Lb. Chain Testing Machine

THE NATIONAL MALLEABLE CASTINGS CO.

CLEVELAND, OHIO

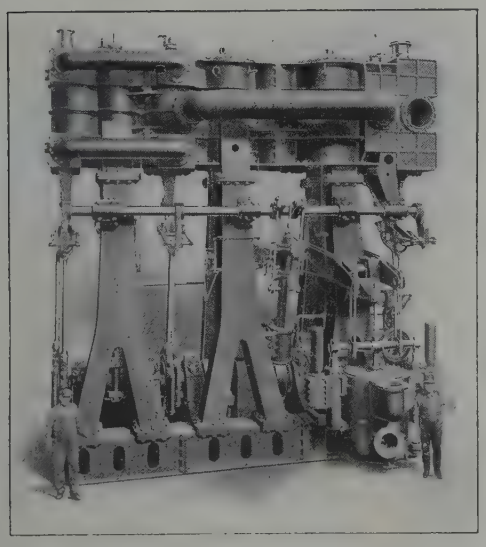
Propellers and Marine Engines

General Information

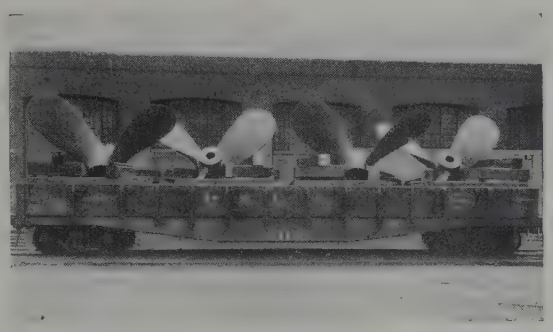
The H. G. Trout Co. has been in operation for half a century, as manufacturers of Marine Steam Engines and Propeller wheels, during which time they have earned an enviable reputation for high grade workmanship and material used in connection with both of the aforementioned products.

Their plant consists of a large Semi-Steel and Bronze Foundry, with melting capacity sufficient to take care of the largest requirements in those lines. In addition they have large and modern Machine and Pattern Shops, which enables them to handle all the work necessary for the construction of both engines and propellers.

Birdseye View of H. G. Trout Co.



One of the Twelve Triple Expansion Engines Made for the Texas S. S. Co. Size 26½″ x 44″ x 74″—51″ Stroke.

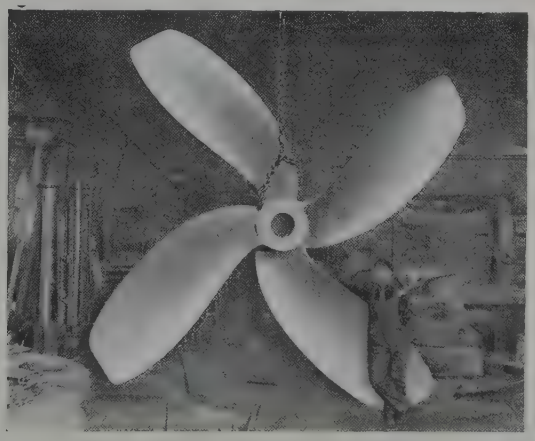


Carload of 17′ Diameter Propellers. Weighing 18,000 lbs. Each. Made by H. G. Trout Co. for One of the Leading Shipyards.

Semi-Steel and Bronze Propellers

The H. G. Trout Co. are undoubtedly the leading makers of built-up and solid Semi-Steel propellers in America. In addition to their large Semi-Steel business, they are fully equipped to make the largest Bronze propellers and Blades.

The Trout Co. are in a position to meet with the requirements of the various Ship Classification Societies, in connection with accuracy of work and Physical requirements of their Metal.



Semi-Steel Propeller 17′ 3″ Diameter. Made by H. G. Trout for the Norwegian S. S. "Trold."

We invite correspondence from all those interested in Semi-Steel and Bronze propellers and blades of all sizes, as well as Steam Engines.

In addition to our large propeller and engine business, we are equipped to handle both large and small Bronze and Semi-Steel Castings.

H. G. TROUT CO.

220-248 OHIO ST., BUFFALO, N. Y.

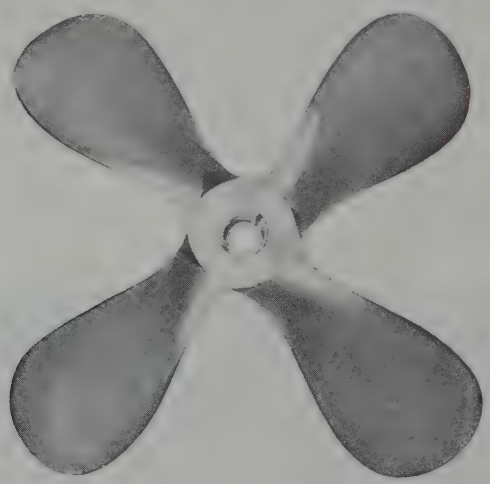
Propellers, Manifolds, Valves and Winches

Electric Driven Pumps

The Kerr Vortex Turbine Pump is made in both vertical and horizontal models, especially adapted to motor ships. These pumps are made in one or more stages depending on the service that is required of them.

Propeller Wheels

Kerr Propeller Wheels are made from a special high-grade of semi-steel, insuring a close grained casting of unusual strength. The efficiency of Kerr wheels is assured by their correct design, pitch, blade angle and smooth surface. Each blade is cast in the exactly proper relation to all of the others, and the surfaces are finished so as to be absolutely true and parallel.



Kerr Solid Propeller Wheels are made in two sizes, as shown in the following table:

Diameter.	Pitch	Weight
14 ft.	12 ft.— 5 in.	12,000 lbs.
15 ft.	13 ft.—10 in.	14,000 lbs.

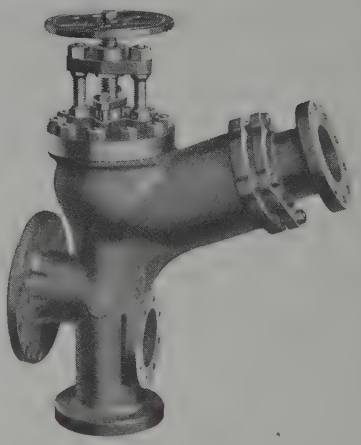
Special wheels, of any diameter, from three feet up to the largest sizes, can be supplied, suitable for all special needs.

Manifolds

In the Kerr Manifolds, maximum strength is combined with minimum space. They are machined with accurate jigs and templates, making parts interchangeable. A special grade of semi-steel is used, insuring a close grained metal of unusual strength.

Special manifolds will be furnished to pattern or specification, and parts of standard manifolds may be reduced or flanges altered or drilled to meet special requirements.

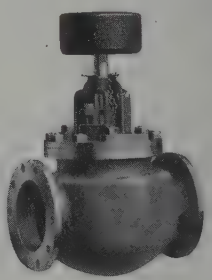
Valves may be of screw lift or non-return type. All fittings are of brass or bronze as desired.



Special Valves

Special Valves can be made according to specification from 2″ to 14″. The more common types are overboard discharge valves, sea cocks, blow off cocks, stop valves, screw-down check valves, three and four-way plug cocks, weighted check type of angle and globe valves. They are made of brass or iron as ordered. When necessary to use spigots with overboard discharge valves, special designs are required to meet individual requirements.

Flanges of all kinds are also manufactured, including bulkhead, double boss, and lead and copper pipe flanges. Flanges may be drilled to standard requirements or for special use.

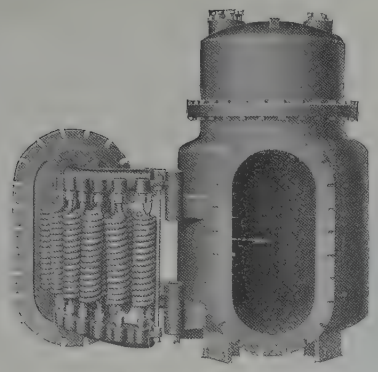


Strainers of all descriptions can also be furnished.

Winches

Kerr Winches are built in a number of sizes for right or left hand operation and suitable for handling both heavy and light loads and combining all necessary features for efficient and rapid handling of steamer cargos. They are of the single drum type, with reversible engine, and one or two gypsy heads as desired. All parts are made to gages, jigs and templates and the design and construction are of the best throughout.

Engine operated ash hoists or steam ejector type ash guns may also be furnished.



Evaporators

Kerr Evaporators are built in all sizes up to 50 tons per 24 hours, and larger, and provide a supply of absolutely pure distilled water for boiler feeding, drinking and culinary purposes.

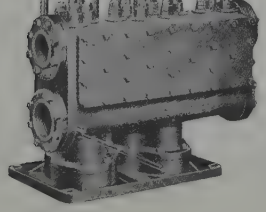
The general design consists of a shell with a new arc type of manifold and heating coils mounted on a hinged door which enables it to be swung outside for convenient inspection, cleaning or repair.

The evaporator is equipped with safety valve, pressure gages, water gage glass and salinometer cock. The coils are of seamless drawn copper and are helical in shape to take care of natural expansion and contraction. This permits the scale to be removed by suddenly flooding the evaporator with cold water, and blowing down at intervals, to a great extent eliminating scaling by hand.

The shell is tested to 50 lbs. and the coils and manifolds to 500 lbs. hydrostatic pressure.

Steam Pumps

Vertical and horizontal, simplex and duplex boiler feed pumps, vertical and horizontal simplex vacuum pumps, steam and centrifugal ballast pumps, engine driven centrifugal circulating pumps, general service pumps, mate's pumps, pony feed pumps, deck pumps, evaporator feed pumps, duplex fresh water pumps, oil filter and oil transfer pumps other types are included in the Kerr line.

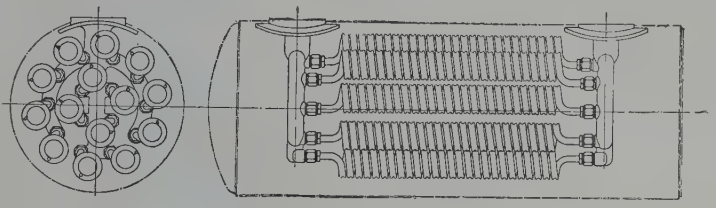


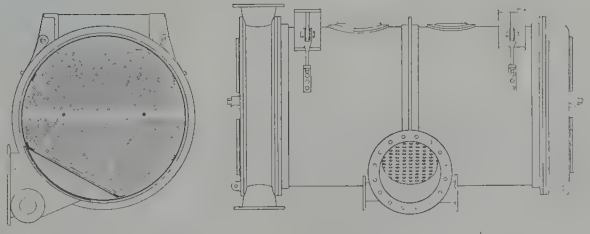
The Kerr Three Piston Type Deck Pump is made in one size only, but the lift can be arranged to suit requirements. Its normal displacement is 50 gallons per minute. Suction 3″, discharge 2″, bore 5″, stroke 4″. The weight is approximately 400 lbs.

Condensers

Condensers will be furnished in either cast iron or steel shell types in all ordinary sizes. They are of the two-pass model, provided with baffle plates, suitable flange connections for exhaust and auxiliary steam, condensate, clean-out, blow-off, circulating water inlet and outlet and soda cock.

The head and shell are bolted with Muntz metal tube plates between them. Brass tubes of special composition to resist the corrosive action of sea water conduct the cooling water from one end of the condenser to the other. These tubes are held in place in the tube plates by means of packing glands. The head at which the





cooling water enters is provided with a baffle, in order that the circulating water will make two passes through the tubes of the condenser.

Feed Water Heaters

The heating surface of Kerr Feed Water Heaters is composed of coils of seamless drawn copper tubing, connected to top and bottom manifolds by screwed union joints free from brazing. Each coil acts as a spring preventing expansion strains on the headers. All coils are interchangeable and easily accessible through the large door in the shell without breaking any pipe joints. An equal flow of water and a thorough agitation through all joints are provided for.

Propellers and Marine Hardware

Compelling Facts

The "Thacher Patent Process" Wheel shown in the photograph has just come from the foundry and is being balanced preparatory to being bored and keyseated.

It is accurate in every detail and requires no machining or chipping other than the bore and keyway for driving shaft.

The tip of every blade is true to a circle equal to propeller diameter.

The thickness of each blade at a given point on an arc corresponds by caliper measure with the thickness at a similarly located point on every other blade.

There are no measurable variations in any blade.

The wheel as cast is more accurate than the present machine-finished wheel. Our built up propellers either in bronze or iron are just as accurate.

Patented Process

By no other known process are such accurate results obtained. A "Thacher Propeller" means elimination of vibration and excessive wear and tear on expensive machinery, increased efficiency at lower maintenance cost, and very often increased speed without increase of power.

To those users of propellers who realize the importance of propeller wheel efficiency, we offer a perfect screw propeller made by our own exclusive patented process and the services of our designing and engineering department.

Price comparison can only show that "Thacher Patented Process Propellers" are economically superior to any wheel ever before produced.

Dyson Method Designs

Propeller design is a subject that can be mastered only by constant study and wide experience. We have a department which specializes exclusively in propeller design. All of our designs are based on the Dyson Method, and we are glad to be able to say that our force of Propeller Designers has worked in close touch with Admiral Dyson for many years and has had all the advantages to be obtained by close association, both as to instruction and experience. Our files contain the most complete and accurate data of propeller design, performance and operation in existence, and if you have any propulsion problems to solve we would be pleased to have you call on us.

The Thacher Propeller and Foundry Corporation was established in 1852 and has had nearly 70 years' experience in the manufacture of propellers and other ship equipment.

Balancing a Thacher Process Propeller

Deck Fittings

We also manufacture deck fittings and heavy marine hardware, such as Hawse Reels, Capstans, Bitts, Cleats, Chocks, Hawse Pipes, Scuttles, Manholes, Deck Irons, Ventilators, Gratings and Anchors.

Boiler Grates

"The Albany Sectional Shaking Grate" for either Marine or Stationary Boilers, is exclusively manufactured by us. The results obtained by these grates in the saving of coal is attested to by hundreds of users.

For further information write for the following booklets:

"Thacher Process Propellers."
"Efficiency in the Screw Propeller."
"The Albany Sectional Shaking Grate."
"Catalog M."

THACHER PROPELLER & FOUNDRY CORPORATION

ALBANY, N. Y.

Bronze Propellers and Blades

Material Wheels and Blades

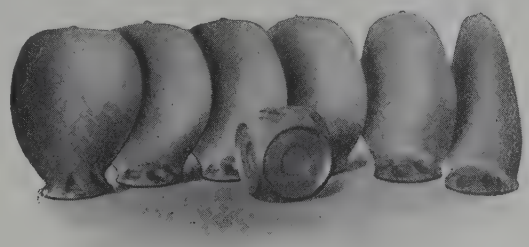
We recommend that the specifications for Bronze Propellers should be, as follows:—

Minimum Tensile Strenth—65,000 lbs. per square inch.

Elongation in 2″ of 25%.

Guarantees

We guarantee when accepting orders under the above specifications, that the wheels or blades furnished by us, will not break, due to defective material, within a period of one year.



Group of Small Propeller Blades Made by Us.

Hubs on Built-up Propellers

We recommend that the hubs of built-up propellers be made of the best grade of gray iron. Included in this should be from 25% to 35% of good steel scrap; said steel scrap to be introduced into the iron when in the cupola.

We further guarantee that the pitch of our propeller will be within 2% of the designed pitch, if the pattern is made by us.

On built-up propellers we guarantee that the finished weight between any blades for the same wheel, will not be more than 2%.

On solid wheels we will guarantee a balance of within .001% of the total weight.

We are equipped to make propellers in sizes of from 8″ to 20′ in diameter.

Our offices and works are at Holmesburg Junction, which is within the city limits of Philadelphia on the main line of the Pennslyvania R. R. to New York City.

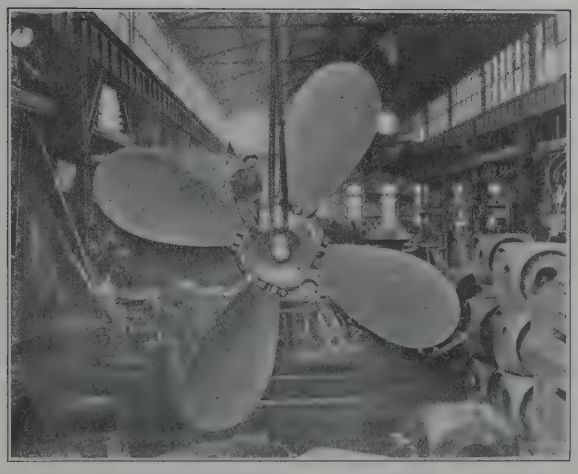
16′ 9″ Diameter—Weight 18,000 lbs. Cast in Our Foundry

Studs on Built-up Propellers

The studs should be of forged steel of a guaranteed Tensile Strength of not less than 60,000 lbs., with an elongation of 30% in 2 inches.

Nuts and Locking Bolts on Built-up Propellers

Nuts should be of same material as the blades. Locking bolts should be of rolled Manganese Bronze.



One of 40 Built-up Propellers Ordered from Us by Hog Island. Weight, 34,000 lbs. Diameter 18′ 6″.

AMERICAN MANGANESE BRONZE CO.

HOLMESBURG, PHILADELPHIA, PA.

Cramp's Shipyard. Established in 1830 by William Cramp. Incorporated in 1872 Under the Present Name.

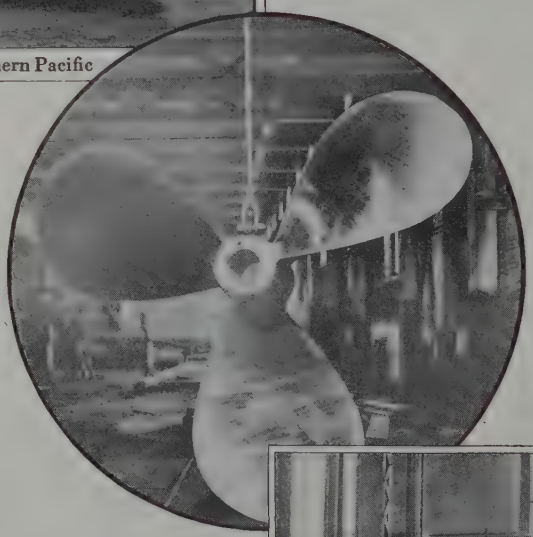
S. S. Great Northern and Northern Pacific

No Cast Unmachined Driving Surface Is Accurate

On all vessels, as in the case of the Great Northern, in which maximum speed with least expenditure of horse power and the greatest economy of fuel are to be attained, the propeller should have all the qualities of pitch accuracy, smoothness of surface and designed thickness of blade mentioned above. These results are obtained only by the use of a special patented machine owned by the Cramp Company and operated only in the Cramp Company's shops.

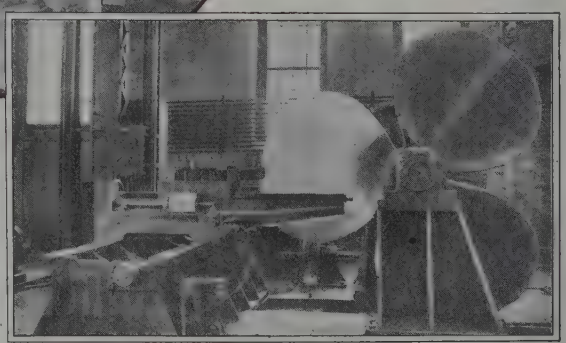
Both Ships Turbine Driven

The Great Northern, a turbine driven express steamer, used by the United States Government as a transport during the War, established a new world's round-trip record from New York to Brest and back again in 12 days, 1 hour and 35 minutes, an average speed of 21.3 knots. During America's participation in the War she made 20 trips through the War Zone and landed more American troops in France per day per ton than any other troop ship.



No Cast Thickness is Accurate Unless Machined

One of these machines is shown here. It was designed entirely by the Superintendent of Shops of the Cramp Company.



Both Ships Equipped with Cramp Machined Propellers

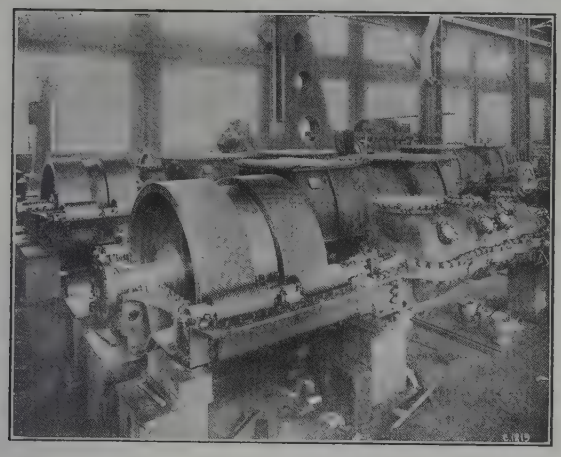
The propeller shown is of the same type as those on the Great Northern. It is cast of Parsons' Manganese Bronze, 14 ft., 6 ins. diameter; weighs 13,000 lbs. It is Cramp machined on all surfaces, which means that it is perfect in accuracy of pitch, has true helical driving surfaces, absolutely smooth, and the thicknesses of blades at all points are as designed. It is consequently in exact static and dynamic balance. No method of casting has ever been devised that will produce these results.

With it the driving faces of the propeller are machined to a true helical surface and by a special attachment the backs of the blades are machined to the exact required thickness. During the War this machine in the Cramp Shop machined over 500 propellers for Cramp built ships and for vessels built by other ship builders all over the United States.

THE WM. CRAMP & SONS SHIP & ENGINE BUILDING CO.

PHILADELPHIA, PA.

Steam Turbines—Diesel Engines



Parsons' and Impulse Turbines

The William Cramp & Sons Ship and Engine Building Company are designers and builders of Parsons' and Impulse Turbines; both the direct drive and the geared types. These turbines are suitable for installation in the following types of vessels—battleships, scout cruisers, destroyers, ocean liners, transports, sound steamers, tankers, cargo-ships and yachts.

A special feature of Cramp built equipment is the complete freedom from mechanical troubles in the reduction gearing.

Cramp's Turbine Shops

The photograph above shows two main propelling turbines assembled with reduction gears for 35 knot destroyers. Each of these sets delivers 14,000 horse power at 340 R. P. M. of the large gear.

Two of these units are installed in each destroyer developing a total of 28,000 horsepower.

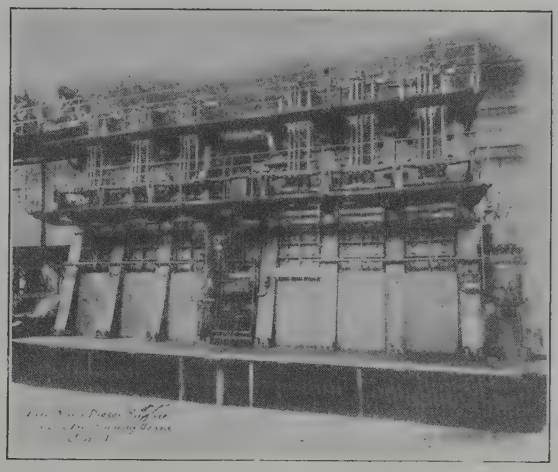
The photograph below shows a section of the Cramp's shops where steam turbines are constructed. In this shop there have been completed in recent years, steam turbines totalling 1,313,000 shaft horsepower as follows:

Turbines built with direct drive 377,000 S.H.P.
Turbine built with gear drive 936,000 S.H.P.

There is also under contract at the present time (1920) turbines of the gear type totalling 898,000 S.H.P.

Burmeister & Wain Diesel Engines

The William Cramp & Sons Ship and Engine Building Company is U. S. Licensee for the Burmeister & Wain Motor Ship Propulsion. The photograph below shows one of two 2250 I.H.P. engines for installation in an 11,000 Ton D.W. 12 knot motorship.



Up to the present time this system has been installed in 42 cargo and semi-cargo vessels from 6500 to 13,000 tons D. W. and 1600 to 6000 I.H.P.

This system is giving most excellent results as to reliability and greatly increased earning capacity compared with steam engines.

Low Speed Diesel Engines

The following is a table showing types of Standard Slow Speed B. & W. Diesel Engines making 100 to 150 revolutions per minute for twin screw vessels.

Type No.	Number Cylinders Per Engine	Total I.H.P. Diesel	Equivalent I.H.P. Steam
6-125	6	1600	1400
6-150	6	2100	1800
6-200	6	2800	2400
6-250	6	3100	2700
6-275	6	3800	3300
6-300	6	4500	3900
8-275	8	5000	4300
8-300	8	6000	5200
8-400	8	8000	7000

Castings–Welding Rods–Ingots

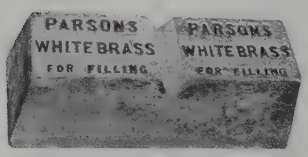
High-Grade Castings

The Cramp foundry facilities for making brass, steel and iron castings of every size and kind have been developed to the point of highest efficiency. The principle bronze compositions made are Parsons' Manganese Bronze, Cramp's Special Bearing Bronze, Parsons' White Brass, Hydraulic Bronze, Cramp's Gear Bronzes, Cramp's Pivot Disc Metal and all Government non-ferrous compositions. These compositions are furnished either as castings or ingots. Steel castings are made by the open hearth process and iron castings are furnished of gray iron or semi-steel.

Sole Makers

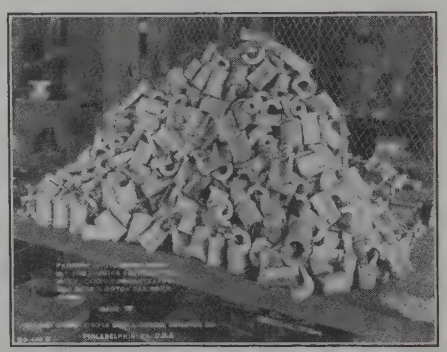
The Cramp Company is the sole maker in the United States, Canada, Mexico and Cuba of Parsons' White Brass and Parsons' Manganese Bronze, the most widely known non-ferrous metals in the world.

All brass and bronze furnished by the Cramp Company whether in the form of machined castings or in the rough is of the same uniform quality that has made Cramp brass and bronze products famous throughout the United States, Canada and England. The strong metals have the highest tensile strength and elongation and the bearing metals the highest compressive strength and anti-friction qualities of any manufactured in this country.

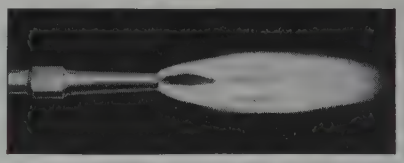


Cramp Quality

Bearings and bushings made from Cramp's Special Bearing Bronze and Parsons' White Brass have been proven in exhaustive tests to have the highest compressive strength and the best anti-friction qualities. The White Brass is the nearest approach to an oilless bearing yet discovered.



Parsons' White Brass Bearing Castings

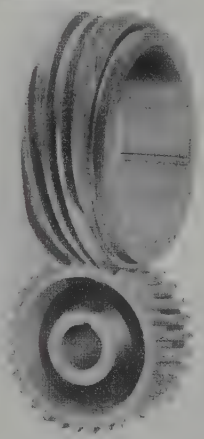


Welding Rods—Bronze, Iron, Steel and Aluminum

Parsons' Manganese Bronze Rolled Welding Rods for high fire brazing and oxy-acetylene welding of bronze, brass or malleable iron castings, assure a faultless, flawless job. This scientifically perfected metal is the result of long years of experience. It is the strongest bronze made and its fine physical properties make it especially suitable for welding purposes. Tensile strength of the metal 70,000 lbs. per sq. inch, strength of weld often 60,000 lbs. per sq. inch. In addition to Parsons' Manganese Bronze for welding malleable iron, brass and bronze castings the Cramp Company uses and keeps in stock high grade iron, steel and aluminum rods, which are extensively used with remarkably satisfactory results.

Bronze Gearing

The Cramp Company manufactures bronze gear wheels for hoisting engines, water turbines, turret turning gear, steering gear, elevators, lifting bridges, drawbridges, locomotive drop tables, marine railways, automobiles.



Metals used:—

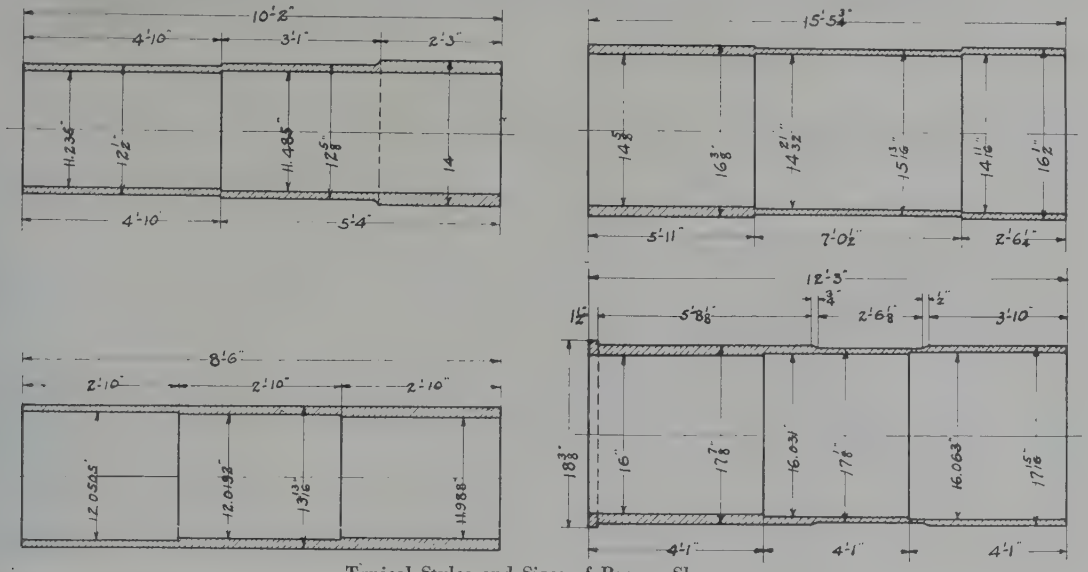
Gear Metals Nos. 1 to 5 for various special purposes.

The super bronze — Pivot Disc Metal when unbreakable gears are required. Tensile strength 120,000 lbs. per sq. inch. Elastic Limit 80,000 lbs. per sq. inch. Elongation 15 per cent. Either cast or forged.

The Strongest Bronze Made

Test pieces of Parsons' Manganese Bronze cast on or with castings show a tensile strength of 65,000 lbs. per square inch, an elastic limit of 30,000 lbs. per square inch, an elongation in 2 inches of 25% and a reduction of area of 25%. These figures are often exceeded, the tensile strength running sometimes as high as 75,000 to 80,000, the elastic limit 35,000 to 40,000, the elongation 35 to 40%, and the reduction of area 35 to 40%. This metal will take the place of steel castings when emergency deliveries are required or where non-corrodibility in water and acids is essential.

Seamless Fluid-Compressed Tubing



Typical Styles and Sizes of Bronze Sleeves

For Propeller Shaft Sleeves, Etc.

The many advantages of Fluid-Compressed Tubing have led to its widespread use for the following purposes: Propeller Shaft Sleeves, Rudder Stock Bushings, Bearing Liners, Bushings, Cylinder Liners for Pumps and Presses, etc. Liners and sleeves are usually furnished accurately bored, ready for shrinking or pressing on. Special machinery insures the accuracy of machined tubes within tolerances of .001 inch plus or minus. The tubing can be supplied in practically any non-ferrous metal, rough or finished bored and turned, as desired.

The range of sizes in which tubing can be supplied is from 4 to 30 inch outside diameter, ¼ to 1½ inch wall thickness, lengths up to about 230 inches, depending on diameter.

Guaranteed Soundness of Metal

The patented process used in manufacturing Fluid-Compressed Tubing enables the manufacturer to guarantee absolutely its freedom from defects. The tubing is made by compressing the metal while it is still in a fluid state, thus freeing it entirely of all gases and impurities which might form imperfections. The result is a casting free from blow holes, sand holes, or hard and soft spots. The metal is close grained, homogeneous and dense, and its specific gravity and tensile strength are increased as a result of compression.

The internal stresses being uniformly distributed by the compressive action, expansion and contraction take place uniformly without undue distortion of the tubes. Where the tubing is used for sleeves, this feature eliminates warping and insures an even grip on the shaft.

Advantages to Ship and Engine Builders

All risks of loss from defective sleeves and liners can be eliminated by purchasing Fluid-Compressed Tubing, finish-bored and either finish- or rough-turned, ready for shrinking or pressing into place. It is difficult to make by ordinary methods seamless tubing of 4 inch to 30 inch diameter, free from imperfections. Frequently it becomes necessary to recast and re-machine ordinary cast tubes which did not show signs of defects until the last stages of machining were almost completed. The result is a big loss of labor, material and time.

All uncertainties are removed by the use of Fluid-Compressed Tubing—guaranteed free from defects.

Quick Delivery

No patterns are required. This fact enables very prompt deliveries to be made, an important feature in case of repair or emergency work. Excellent shipping facilities are available by either water or rail, five important trunk line railroads coming direct to the plant.

Inquiries will receive prompt and careful attention.

TWO COMPOSITIONS RECOMMENDED

No. 1 Sandusky Standard

85% Cu., 6% Sn., 6% Zn., 3% Pb. and Ni. Average ultimate tensile 40,000 lbs. per square inch. Average elongation in 2" —24%. Used for propeller shaft sleeves, liners, bushings, and roll covers.

Comp. "G" Navy Specif. 46M6a

88% Cu., 10% Sn., 2% Zn. Average ultimate tensile 41,000 lbs. per square inch. Average elongation in 2"—32%. A tough and hard mixture for sleeves, bearings and liners.

Note: Almost any non-ferrous composition may be furnished, in accordance with customers' specifications.

A FEW USERS OF FLUID-COMPRESSED TUBING

U. S. Navy Department
U. S. Shipping Board
Federal Shipbuilding Co.
N. Y. Shipbuilding Corp.
Wm. Cramp & Sons Ship & Engine Building Co.
Newport News S. B. & D. D. Co.
Bethlehem Shipbuilding Corp.
Submarine Boat Corp.
Amer. International Shipbuilding Corp.
Merchant Shipbuilding Corp.
Todd Shipyards Corp.
Robins Dry Dock & Repair Co.
Buffalo Dry Dock Co.
Electric Boat Co.
Texas Steamship Co.
American Shipbuilding Co.
Toledo Shipbuilding Co.
McDougall-Duluth Co.
Saginaw Shipbuilding Co.
Grant-Smith-Porter Ship Co.
Pacific Coast Shipbuilding Co.
Seattle North Pacific S. B. Co.
International Shipbuilding Co.
Westinghouse Elec. & Mfg. Co.
Worthington Pump & Mach'y Corp.
Crane Company
W. & A. Fletcher Co.
Hardie-Tynes Mfg. Co.
H. G. Trout Co.
James Robertson Co., Ltd.

THE SANDUSKY FOUNDRY & MACHINE COMPANY
SANDUSKY, OHIO

Camden Forgings

Plant of The Camden Forge Company

Products

Marine Forgings, Solid and Hollow-bored Marine Shafting, Engine Forgings, Forgings for Builders of Heavy Mill Machinery, Hydraulic Machinery and Machine Tools, Forgings for Builders of Locomotives, Cars and Trucks.

Manufacturing Facilities

"Camden Forgings" are made in thoroughly equipped modern shops. They are of any type or weight and made to any specification.

Steam Hammers and steam-hydraulic Presses are used for forging, and large rugged machine tools for machining. These include roughing, finishing and boring lathes; planers, slotters, drills and boring-mills.

Interior of Machine Shop

Engineering Service

An engineering department is maintained for the purpose of studying and solving all problems in the manufacture of "Camden Forgings" which must meet difficult conditions, such as uncommon design or unusual physical requirements.

This Engineering Department has rendered invaluable aid to many customers and its services are offered to prospective buyers.

Accuracy in Selection and Treatment of Steel

Laboratory Facilities

Large and well equipped laboratories for physical, chemical and photomicrographic work afford unusual facilities for the careful selection of the raw materials. These laboratories are also responsible for the heat-treatment and inspection of all "Camden Forgings," assuring the customer of the right forging, correct in size and structure. The accompanying cut shows a corner in the photomicro-

CAMDEN FORGE COMPANY

CAMDEN, NEW JERSEY

graphic laboratory where a photograph is being taken of the structure of a forging, magnified 100 times.

Machine Shop Equipment

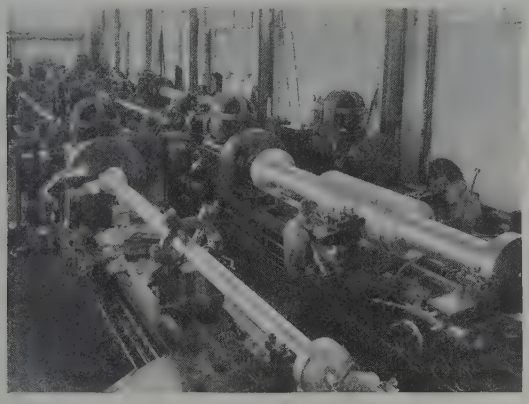
The Machine Shop is equipped with the most modern tools for producing "Camden Forgings," of any weight or description, with the utmost despatch.

The turning equipment includes lathes up to 72" (1829 mm.) diameter swing and a length of 55'-0" (17 m.) between centers.

Planers up to 60" x 60" (1524 x 1524 mm.) by 20'-0" (6 m.), and slotters up to 42" (1067 mm.) take care of the flat surfaces.

The hollow-boring of long marine shafts is done on special boring lathes up to 48" (1219 mm.) diameter swing and 80'-0" (24 m.) in length.

All this equipment, with a miscellany of smaller tools, insures the buyer of "Camden Forgings" of the acme of service, either in rough or finished-machined product.



Equipment for Machining Large Forgings

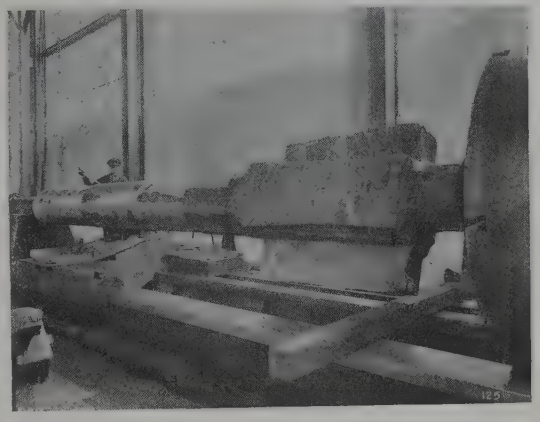
Forgings for Every Purpose

So wide is the range of this company's equipment that it can, and does, in fact, manufacture at the present time forgings for all the industries.

The Hammer, Press, Machine, Annealing, and Heat-Treatment Departments (equipped with both horizontal and vertical furnaces and quenching tanks) provide the diversity of equipment necessary in the solution of the daily problems presented and enable the Camden Forge Company to maintain its ability to handle every type and size of forging.

Marine Work

Located in the heart of the shipbuilding district, the Camden Forge Company has developed an organization thoroughly versed in the forging requirements of ship and marine engine builders. The company has particularly specialized for a number of years in the manufacture of forgings for naval work and the large demands made upon it during the World War required a concentration of effort and an expansion of facilities that have placed its production upon a remarkably efficient basis, and have given it an unexcelled experience in successfully meeting difficult marine forging requirements.



Rudder Stock Forging in Lathe

"Camden Forgings" are found in successful operation in hundreds of steam ships built to the specifications of the American Bureau of Shipping, Lloyd's Register of Shipping and the Bureau Veritas, and in war vessels of the United States of America. "Camden Forgings" have exceeded the physical and chemical requirements imposed by the United States Naval Inspection Service

Hollow Bored Forgings

as well as those by the various Surveying Bureaus, and the Company's large experience with actual naval requirements assures intelligent and satisfactory service in the production of forgings for this class of work.

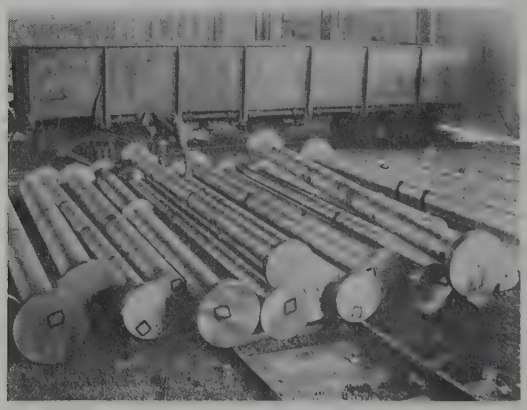
CAMDEN FORGE COMPANY

CAMDEN, NEW JERSEY

Camden Forgings

Heavy Marine Forgings

The Camden Forge Company is manufacturing heavy marine forgings such as stems, stern frames, rudder stocks, turbine and generator shafts for all sizes and classes of vessels. Forgings of this type, which occasionally present difficulties, due to their size and form, are made and handled with



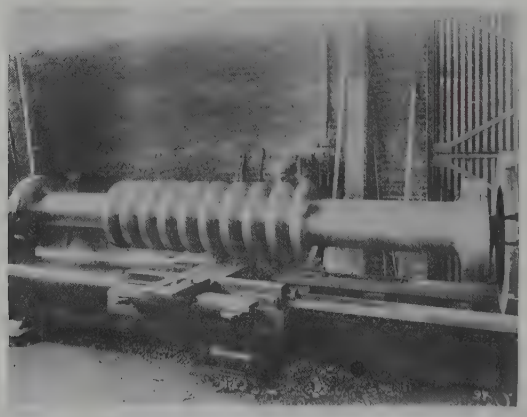
Marine Shafting

special equipment designed for their manufacture, and which assure excellent results quickly obtained. Chemical and physical tests prove the uniformity of structure throughout the largest pieces guaranteeing the strength and elasticity of the material.

Marine Shaft Forgings

Marine Shafts of all types and sizes can be either rough turned or finished complete. Accompanying illustrations show the machining of line and thrust shafts and indicate the large size of this class of work which is handled daily.

Special equipment is provided for heat-treating both



Thrust Shafting Being Machined

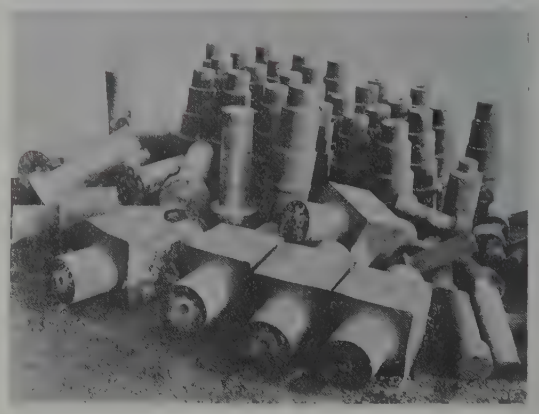
solid and hollow bored shafts for torsional strains and the machine equipment is admirably suited for furnishing this material in a short period of time for delivery.

Forgings for Engine Builders

The Camden Forge Company is also in a position to supply "Camden Forgings" to marine and stationary engine builders. Triple expansion, and internal combustion engine crank shafts, turbine rotors and piston rod forgings are made and treated to withstand the severe stresses to which they will be subjected in each case, and are also either rough-turned or finished complete. The Camden Forge Company has furnished many different types of forgings for these purposes and their experience in making such

Heavy Crank Shaft Forging

parts enables them to meet any unusual requirement and to provide a satisfactory solution of difficult problems of construction or quick delivery.



Small Forgings for Machine Tool Builders

Forgings for Machine Tool Builders

"Camden Forgings" are made for both large and small machine tools. The Company's facilities are particularly adapted to making forgings for all that class of machine tools used in the manufacture of ship and engine construction and equipment.

CAMDEN FORGE COMPANY

CAMDEN, NEW JERSEY

Camden Forgings

Forgings for Heavy Mill Machinery

Owing to the Camden Forge Company's facilities for making and heat-treating heavy forgings for severe service, large plate bending rolls and other forgings for heavy mill machinery can be furnished to meet the most rigid requirements.

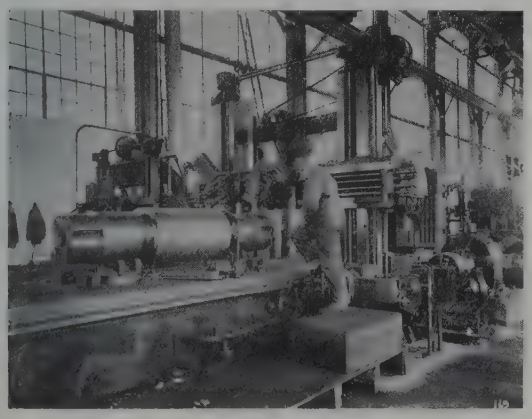
These forgings, regardless of size, are machined accurately to specified dimensions, and delivered finished, ready for installation.

The accompanying illustrations show some of the

Plate Bending Rolls

plate bending rolls made in these shops, and also the facilities for machining forgings of this character.

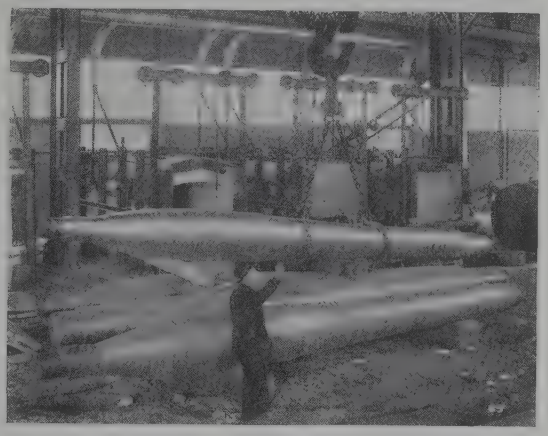
Large forgings for mill machinery of special design or which must meet unusual requirements will receive the special attention of the engineers who will make recommendations based on experience, tests and experiments.



Forgings for Heavy Mill Machinery

Heat Treating Facilities

The Heat Treating and Annealing Departments are housed in a specially constructed building, which contains the annealing and heat-treating furnaces and quenching tanks. The furnaces are arranged to assure properly controlled heating throughout the product and are equipped with the most improved and positive-acting heat control and temperature-measuring devices which can be secured. All equipment is ample in capacity to handle the largest forgings, and exhaustive tests have provided a basis of heat-treating operations that give unexcelled and uniform results. The annealing and heat-treating is carried on under the personal supervision of men thoroughly experienced in proper adjustment of temperature and duration of treatment necessary to obtain the best results.



Heat Treated Forgings

Shipping Facilities

The location of the Camden Forge Company assures excellent facilities for quick shipment to all ports by water or to any point by trunk line connections. The works are located in Camden, N. J., on the Philadelphia and Reading Railroad and within hauling distance of the Pennsylvania Railroad and steamship lines.

Difficult Forgings Heat Treated

CAMDEN FORGE COMPANY

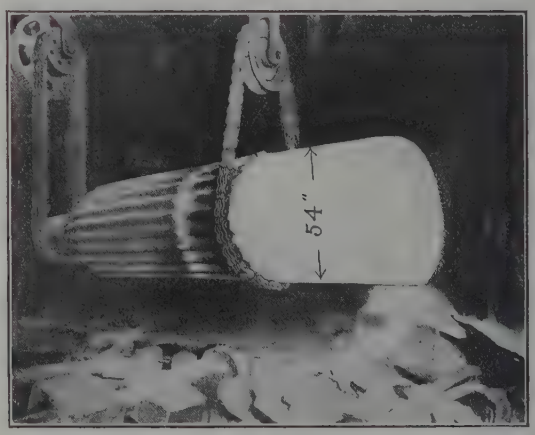
CAMDEN, NEW JERSEY

A Few of the Heating Furnaces in the Main Bay

Steam Hydraulic Press Forgings

The plant of the Pacific Construction & Engineering Co., 2917 E. Marginal Way, Seattle, situated as it is on the East Water-Way, thus giving it both water and rail facilities, marks another firm step in the industrial development of the West Coast. The layout and efficiency of this plant during the emergent period of ship construction played a most important part in the name the West Coast won for speed in ship construction. The yards on the Coast could not have achieved the success which stands to their credit had not the heavy forgings and all of the other essential items been so readily obtainable. The plant has been devoted almost entirely to marine forgings; principally: Stern Frames, Thrust Shafts, Line Shafts, Tail Shafts, Rudder Stocks, Rudder Posts, Rudder Arms, Crank Shafts, Connecting Rods, Piston Rods, and Plate Bending Rolls; also, Eccentric Rods, Valve Stems, Columns, Cross Heads, Links, Link Blocks, Dummy Turbines, Couplings (Hollow), Coupling Bolts, and Flanges.

The Skinner & Eddy Corporation, J. F. Duthie & Co. and the Ames Shipbuilding & Dry Dock Company of Seattle, as well as the Columbia River Shipbuilding Corporation and the G. M. Standifer Construction Corporation of Portland, the Moore Shipbuilding Company of San Francisco, and other important steel and wood yards secured all their heavy forgings from the Pacific Construction & Engineering Co. The plant at this time was humming night and day to cope with the demands upon it, and great as these were, the organization of the Pacific Construction & Engineering Co. rose to the occasion and splendidly earned the confidence of all the yards in its ability to produce the work.



101,000 lb. Ingot on Its Way to One of the Big Presses. The Forging Is for the Top Roll of a Set of Plate Bending Rolls.

PACIFIC CONSTRUCTION & ENGINEERING COMPANY

2917 E. MARGINAL WAY, SEATTLE, WASHINGTON

A General View of the Main Bay of the Forge Shop

Forged Stern Frame, Welded Up and Ready for Shipment. Weight 36,000 lbs.

The superiority and desirability of forged stern frames over cast frames and the adoption of the former by so many builders has resulted in a great demand for these forgings from concerns equipped to turn them out. The Pacific Construction & Engineering Co. has forged many and at a cost hardly above cast frame prices.

Plant and Equipment

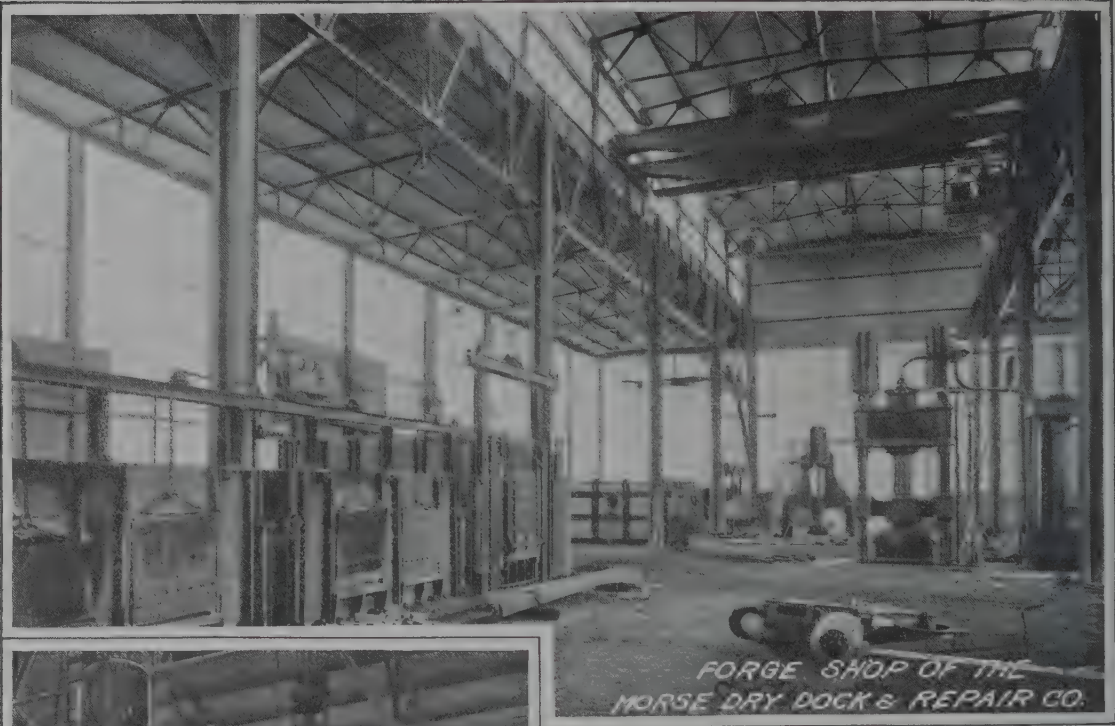
The main bay of the plant is 700 feet long and contains the most up-to-date equipment, including three big steam hydraulic presses, twenty-one heating furnaces as well as two large annealing furnaces, and ten overhead traveling cranes in the forge shop. In the machine shop are eight powerful hogging lathes, motor driven, in addition to all the smaller equipment to make the shops complete and all laid out in the most practical arrangement.

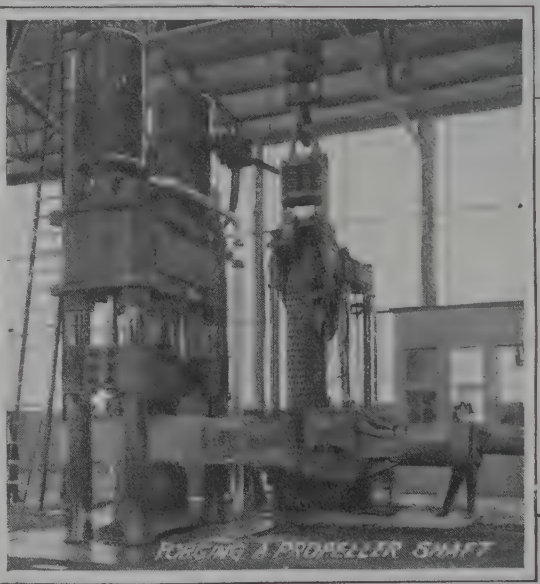
Robert C. Monteagle, President, General Manager and founder of the company, is eminently known in shipbuilding circles as a naval architect and mechanical engineer. Under his able direction the Pacific Construction & Engineering Co. has demonstrated its right to have and hold the good name which courtesy in dealings, with faithful attention to detail and excellent workmanship have brought to its products.

PACIFIC CONSTRUCTION & ENGINEERING COMPANY

2917 E. MARGINAL WAY, SEATTLE, WASHINGTON

Marine Forgings



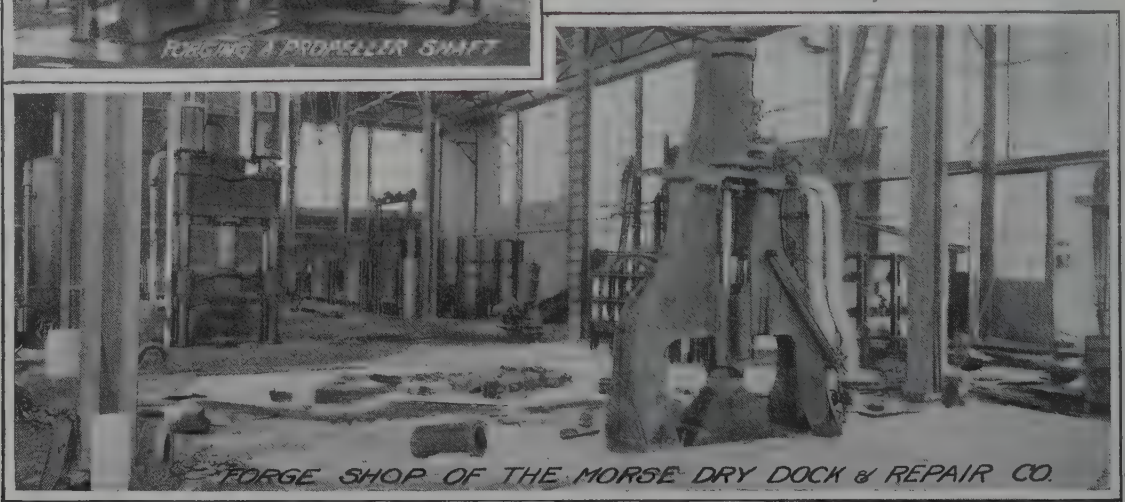


Ship Forgings

The Morse Dry Dock and Repair Company's Forge Shop is prepared to furnish forgings of any size required by ship-builders. Through long experience the Morse Company is thoroughly familiar with ship-yard requirements. Ship-builders are invited to submit blueprints for estimates. Emergency work a specialty.

Speeding Ship Repairs

This Forge Shop minimizes the time required for making ship repairs. If a new propeller shaft, stem, stern frame, or any other forging is needed, it is forged immediately in the Morse yard.



MORSE DRY DOCK & REPAIR COMPANY

FOOT OF 54th—57th STREETS, BROOKLYN, N. Y.

Wheeling Mold One Piece Rudders and Stern Frames

Advantages of One-Piece Cast Steel Rudders

Why purchase rudders of the built up type when you can obtain them of one piece cast steel with more strength, at practically the same price?

The above views are typical of one piece cast steel rudders and four piece stern frames recently completed for use on United States Shipping Board vessels.

Manufacturing Methods

We employ special foundry methods in molding and casting all stern frames and rudders which insure castings, perfect, both in structure and shape.

We also have specially built machines by which all gudgeon holes can be bored at one operation thus guaranteeing perfect fit when assembled on ship.

Types of Castings

We can furnish stern frames in one, two or four sections. We also produce rudder stocks, crossheads and tillers, stem castings and rudder bearings either rough or completely machined.

All steel castings are made by Acid Open Hearth Process, thoroughly and carefully annealed.

All iron castings are made from Air Furnace Melted Iron of high tensile strength.

WHEELING MOLD AND FOUNDRY COMPANY

WHEELING, WEST VIRGINIA

Nelseco Installations

The New London Ship & Engine Co. has furnished many commercial Diesel Engines for installation in Cargo and Passenger Vessels, Tugs and Fishing Vessels, on both the Atlantic and Pacific Coasts.

Hundreds of engines have also been built for the U. S. and foreign Governments. The uniform service rendered establishes the reliability and economy of the Nelseco Diesel Engine.

Long Experience in Diesel Manufacture

The New London Ship & Engine Co. was the first builder of marine Diesel engines in the United States. Since 1911 the manufacturing facilities have been rapidly expanded until, at the present time, the company can practically fabricate the entire engine from the raw material to the finished product.

The plant includes Machine Shop, Forge Shop, Pattern Shop, Foundry, Coppersmith Shop, and Screw and Bolt Shop. Equipped throughout with the most modern machinery and tools, work of the highest grade is uniformly produced.

The completeness of this equipment has permitted the development of the Nelseco Engine to the highest degree of reliability and efficiency.

Economy of the Nelseco Diesel

The Diesel Engine is universally recognized as the most efficient prime mover, in fuel consumption. The Nelseco Diesel operates on the full Diesel principle, securing very low operating costs.

It uses cheap crude or fuel oil. At full power the fuel consumption is less than .07 gallons per horsepower hour. Lubricating oil requirements are very small.

Operation of the Nelseco Diesel

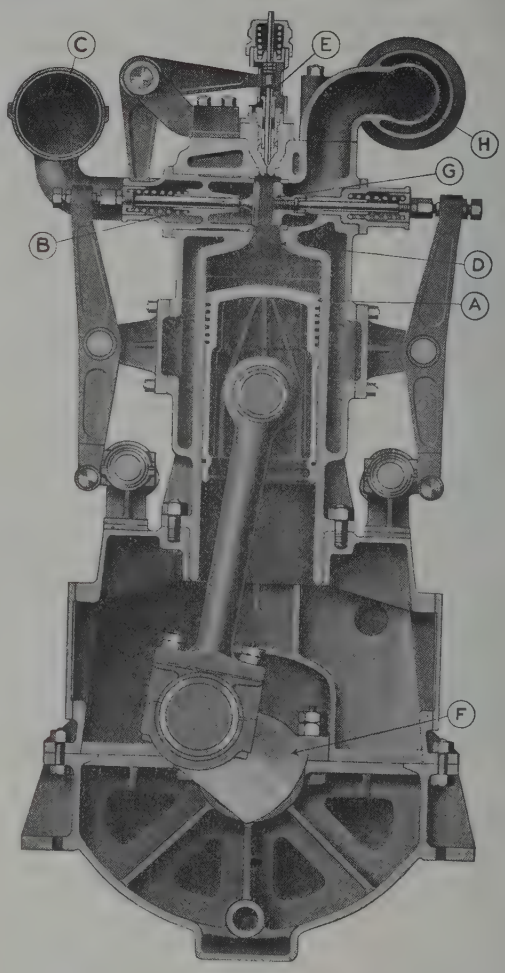
Nelseco Diesels are of the slow speed, heavy duty type—the proven and accepted type for all commercial motor vessels. They operate on the four cycle principle, the piston making four strokes—two up and two down, for every combustion that takes place in the cylinder.

Intake Stroke

During the first downward stroke of the piston (A) the intake valve (B) on the working side of the engine opens, and through the intake (C) pure air is drawn into the cylinder (D) by the downward or "suction" stroke of the piston (A).

Compression Stroke

When the downward stroke is complete the intake valve (B) closes, and the upward stroke of the piston (A) compresses the air, thereby raising its temperature to the point where it will ignite and completely burn fuel or crude oil. This compression continues until the piston (A) reaches the limit of its upward travel.



Cross Section of Nelseco Diesel Engine

A. Piston
B. Intake Valve
C. Intake Manifold
D. Cylinder
E. Fuel Valve
F. Crankshaft
G. Exhaust Valve
H. Exhaust Manifold

Combustion Stroke

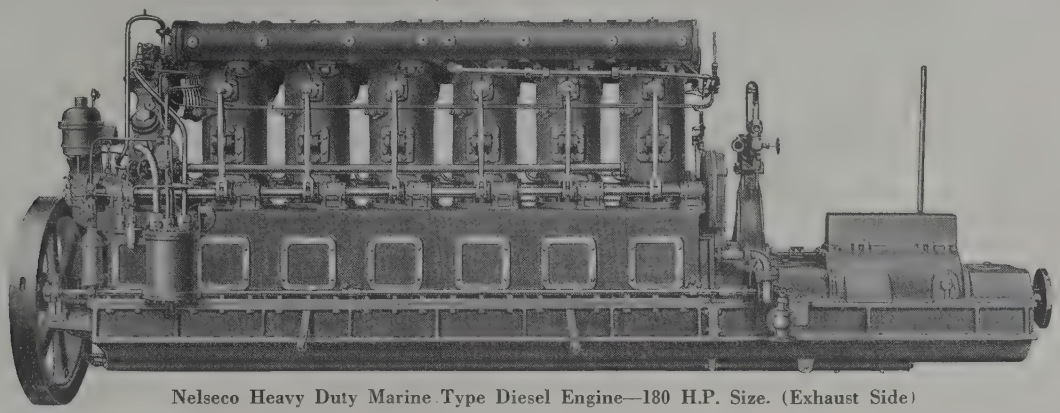
At this moment the fuel valve (E) opens, a charge of fuel oil is sprayed into the hot air in the cylinder (D), the oil ignites, and the expansion of the burning gas forces the piston (A) downward, turning the crankshaft (F). This is the "power" stroke.

Exhaust Stroke

The momentum of the flywheel causes the crankshaft (F) to continue to turn, and again forces the piston (A) upward. During this upward stroke the exhaust valve (G) on the back of the engine opens, and the upward movement of the piston (A) forces the "exhaust" or burnt gases out of

the combustion chamber through the exhaust manifold (H).

This four stroke cycle is repeated in each cylinder of the engine once in every two revolutions of the crankshaft.



Nelseco Heavy Duty Marine Type Diesel Engine—180 H.P. Size. (Exhaust Side)

Diesel Engines Up to 2000 H.P.

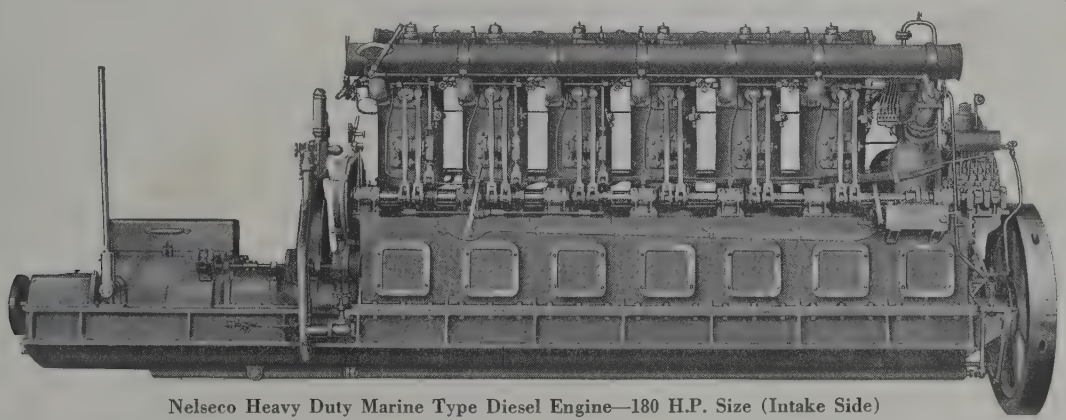
Nelseco Diesel Engines are built in sizes up to 2000 H. P. on the pages following are given the principal data for the following sizes:—120, 180, 240 and 360 H. P.

For any specific conditions we will be pleased to submit recommendations.

place any part which fails during that period due to defects in material or poor workmanship, but will not be responsible for any failures, breakage, or accident, due to negligence of any employee of the purchaser. All defective parts to be replaced, must be returned to our Works, at Groton, Conn., U. S. A., carriage prepaid.

Partial Specifications 120 H.P. Engine

The engine is of the heavy duty, four-cycle, reversing gear type, working on the Diesel principle and using crude or fuel oil for fuel. Engine has 4 cylinders 9″ diameter and 12½″ stroke, developing 120 H. P. at 350 R. P. M. There is an air compressor for supplying air for injecting fuel and for starting purposes, provision being made on two cylinders for air starting. The compressor is of the two stage tandem type, and provision is made for regulating pressure carried on spray air by means of throttle on first stage suction.



Nelseco Heavy Duty Marine Type Diesel Engine—180 H.P. Size (Intake Side)

Diesel Electric Drive

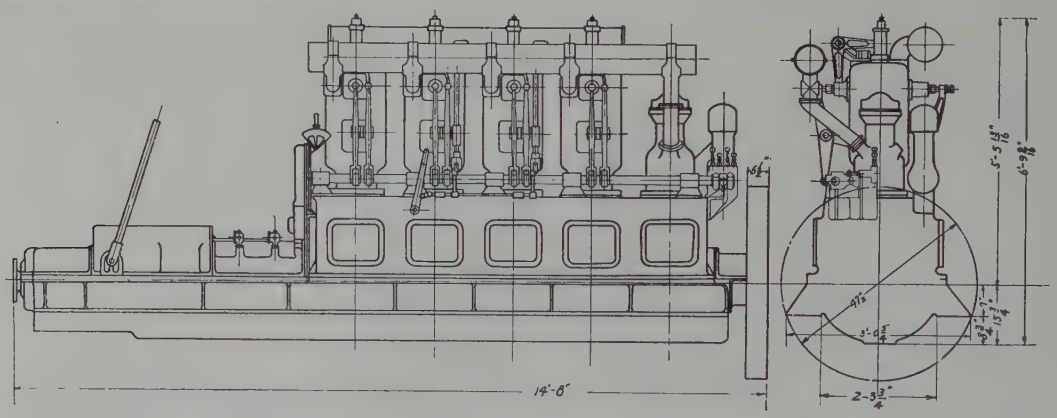
We are also prepared to submit complete proposals for Diesel Electric Drive. Nelseco Diesel Engines are well adapted for use with generators and have been supplied for electric ship propulsion. The satisfactory service of Nelseco Engines, in driving generators for the charging of storage batteries aboard submarines, establishes their superiority for Diesel Electric Drive.

Guarantee

We guarantee that our engines, on regular shop test, will develop a continuous output of their rated horsepower at rated revolutions, and that the fuel consumption will not exceed one half pound per horsepower hour, during such test. We also guarantee the material and workmanship for a period of one year from date of delivery, and will re-

The bedplate is in one piece, of cast iron, and is enclosed to catch all oil draining from bearings. Flanges are provided for bolting to foundation and housing. Cross girders are provided for main bearings for crankshaft. These have cast iron shells lined with white metal, with semicircular lower brasses so that they may be rolled out after removing weight of crankshaft. The bedplate is extended aft to take reverse clutch and thrust bearing.

The following equipment is furnished in addition to the complete engine with all its attached parts:



Outline Drawing Showing 120 H.P., 4 Cylinder, 350 R.P.M., Nelseco Diesel Engine

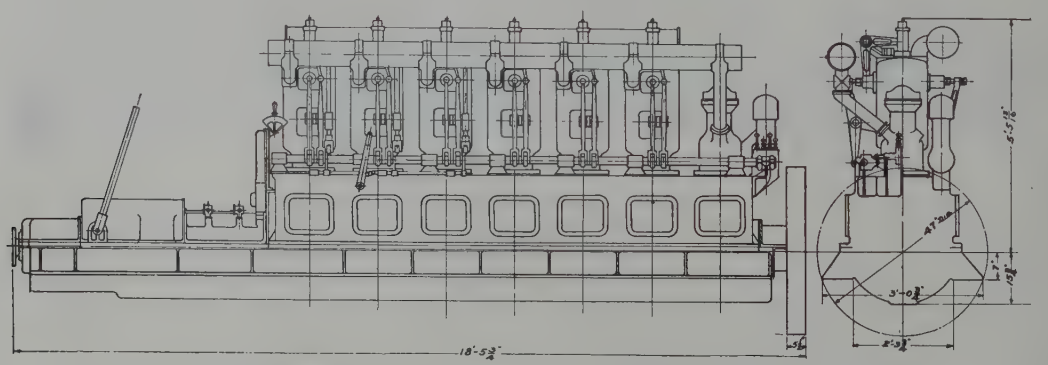
Approximate Height of center of gravity from center line of crank shaft	18"
Approximate Distance of center of gravity from center line of fly wheel	60"
Thrust shaft diameter	4¼"
Intermediate shaft diameter	4¼"
Propeller shaft diameter	4¾"
Propeller diameter (approximate)	50"
Weight of engine (net approximate)	16,500 lbs.

2 Starting Air Flasks
1 Emergency Air Compressor
1 Fuel Oil Gravity Tank
1 Lubricating Oil Gravity Tank
1 Muffler.
1 Set of Tools

The emergency air compressor is used for giving the starting flasks their initial charge and for re-charging the flasks in case of the loss of all the starting air from any cause.

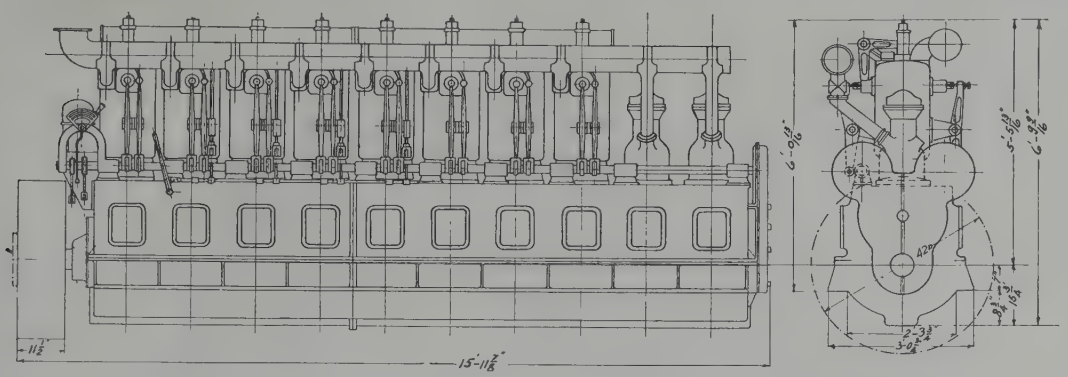
Partial Specifications 180 H.P. Engine

The engine is of the heavy duty, four-cycle, reversing gear type, working on the Diesel principle and using crude or fuel oil for fuel. Engine has 6 cylinders, 9" dia. and 12½" stroke, developing 180 H. P. at 350 R. P. M. There is an air compressor for supplying air for injecting fuel and for starting purposes, provision being made on three cylinders for air starting. The compressor is of the two stage tandem type, and provision is made for regulating pressure carried on spray air by means of throttle on first stage suction.



Outline Drawing Showing 180 H.P., 6 Cylinder, 350 R.P.M., Nelseco Diesel Engine

Approximate Height of center of gravity from center line of crank shaft	18"
Approximate Distance of center of gravity from center line of fly wheel	63"
Thrust shaft diameter	4¼"
Intermediate shaft diameter	4¼"
Propeller shaft diameter	4¾"
Propeller diameter (approximate)	54"
Weight of engine (net approximate)	21,800 lbs.



Outline Drawing Showing 240 H.P., 8 Cylinder, 350 R.P.M., Nelseco Diesel Engine

Approximate Height of center of gravity from center line of crank shaft	19″
Approximate Distance of center of gravity from center line of fly wheel	72″
Thrust shaft diameter	4¼″
Intermediate shaft diameter	4¼″
Propeller shaft diameter	4¾″
Propeller diameter (approximate)	60″
Weight of engine (net approximate) with reverse clutch	28,200 lbs.

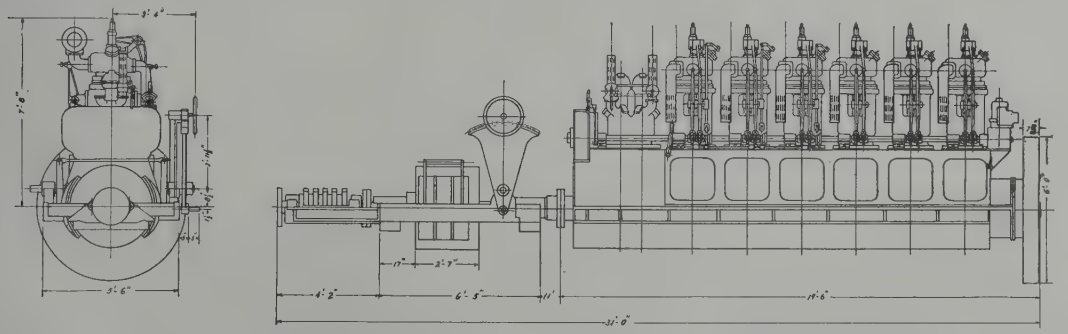
Partial Specifications 240 H.P. Engine

The engine is of the heavy duty, four-cycle, reversing gear type, working on the Diesel principle and using crude or fuel oil for fuel. Engine has 8 working cylinders, 9″ dia. and 12½″ stroke, developing 240 H. P. at 350 R. P. M. At the forward end of the engine, there are two compressors for supplying air for injecting the fuel, and for starting purposes, provision being made on 4 working cylinders for starting the engine by means of compressed air. The compressors are of the two-stage tandem type, and provision is made for regulating the pressure carried on the spray air by means of a throttle on the first stage suction.

The bedplate is in two pieces, of cast iron. In all other essential details of construction it is similar to the 120 H. P. Engine.

Partial Specifications 360 H.P. Engine

The engine is of the heavy duty, four-cycle, reversing gear type, working on the Diesel principle and using crude or fuel oil for fuel. Engine has 6 working cylinders 13″ in diameter and 18″ stroke, and develops 360 B. H. P. at 240 R. P. M.



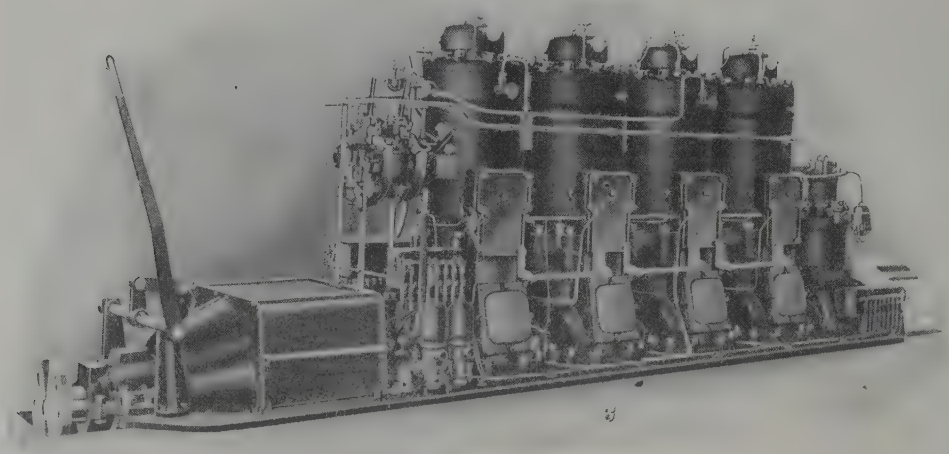
Outline Drawing Showing 360 H.P., 6 Cylinder, 240 R.P.M., Nelseco Diesel Engine

Approximate Height of center of gravity from center line of crank shaft	26″
Approximate Distance of center of gravity from center line of flywheel	114″
Thrust shaft diameter	6¼″
Intermediate shaft diameter	5⅞″
Propeller shaft diameter	6⅝″
Propeller diameter (approximate)	75″
Weight of engine (net approximate)	48,700 lbs.

At the after end of the engine, there is a twin air compressor for supplying air for injecting fuel and for starting purposes, provision being made on 3 cylinders for air starting. The compressor is of the two stage tandem type, and provision is made for regulating pressure carried on spray air by means of throttles on the first stage suction.

The bedplate is in one piece, of cast iron. The engine is furnished complete with all auxiliaries.

Marine Heavy Oil Engines



Model M II

Description

The Bolinder Engine is a two-cycle hot bulb heavy oil engine, which runs on heavy crude oil, residue fuel oil, or kerosene. The engine operates on the two-cycle principle, or in other words, there is one power impulse to each revolution. When the piston, at the end of its downward stroke, is moving up toward the ignition chamber, the necessary air for combustion is drawn through the air valves into the closed crank case, and at the same time the air in the cylinder is being compressed.

When the piston has reached its extreme upward position, a certain amount of oil is injected into the ignition chamber through the injection nozzle and the fuel charge ignites, resulting in the expansion of the gases driving the piston downward toward the shaft. During this downward stroke of the piston, the air in the crank case is compressed. As the piston nears the end of its stroke, the exhaust port opens, and immediately afterwards the inlet air port. The burnt gases escape through the exhaust port, while the compressed air in the crank case which enters the cylinder by the air inlet port completes the scavenging work, and furnishes the cylinder with air necessary to make up the next charge.

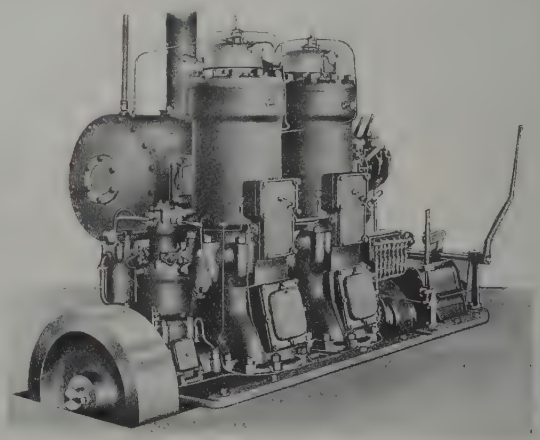
Features

Apart from the general qualities which have made the Bolinder Marine Heavy Oil Engines famous all over the world. these engines possess certain distinctive features which place them on a different standing compared with most other internal combustion engines.

In the first place, Bolinder Engines are Direct Reversible. Reversing is effected by pre-ignition. Secondly, no water is needed in the engines of the M type for the internal cooling of the hot balls and cylinders. Thirdly, owing to the compact construction of these engines, the space occupied by the engine room will be a minimum, and the space available for the cargo is thus very much increased. In the fourth place, the amount of lubricating oil used is considerably reduced owing to the elimination of water injection.

Working under easy conditions of pressure and temperature, and without the need of injection water, the Bolinder Engines are free from many sources of trouble which are usually present in internal combustion engines of large size. The successful running of Bolinder Engines requires only the care and intelligence that is necessary to successfully run any ordinary marine engines of the same size. There are on the Bolinder Engines no cams, valves, gears, electric igniters or vaporizers to get out of order.

The Bolinder Engine is made to a standard gage. Therefore all parts are interchangeable and new parts



Model M I

will fit accurately, whether they are delivered directly from the factory or from one of the numerous branch offices or agents, which are located all over the world.

Additional improvements are made in such a way that new parts can be attached to older models at very little additional cost or trouble.

Marine Heavy Oil Engines

Superior Qualities

In addition to the distinctive features of Bolinder Marine Engines which have already been discussed, there are a number of superior qualities possessed by Models M I and M II which are important.

Perfect combustion results from each explosion. Therefore the cylinders are kept very clean, thereby lessening the friction and increasing the life of the entire engine.

The ignition bulb, which as a rule is subject to great variations in temperature, is never above a red heat even when running with an overload. It is black while the engine is running with a normal load. These facts prove that the bulb is not subject to any undue wear.

The engines of the newest types are very flexible. It is a well-known fact that with the ordinary internal combustion engine, the power rapidly decreases should the engine be brought to reduced speed by means of an overload or otherwise; the power, in fact, falling much more rapidly than the speed. This is not the case at all with the Bolinder Engine, which adapts itself to much broader running conditions than can generally be obtained.

The working pressure of a Bolinder Engine is about one-third that of an engine built on the Diesel principle. Almost all the trouble to which Diesel type engines are subject can be traced to the abnormally high pressure under which these engines work. If the air compressor is rendered useless, it is possible to operate a Bolinder Engine at a reduced load without using the air compressor. It would be impossible to run a Diesel type engine under these conditions.

Small Engines

The Bolinders Company also manufactures small types of heavy oil engines; marine engines from 5 horsepower up, and stationary from 3 horsepower up. The stationary engines are built in both horizontal and vertical types and are used for generating electricity, pumping and other auxiliary work.

Equipment

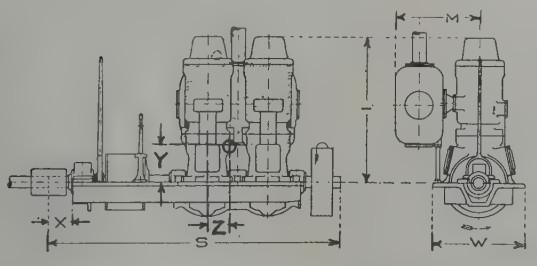
The Bolinder Engines are delivered complete with starting device, silencer and thrust block, and also with a set of spares and tools. Propeller equipment is not included with the larger sizes, but can upon special request be delivered with the engine. Tanks and piping, that have to be modified in accordance with the purposes and the design of the vessel are not being delivered with the engines.

The Bolinder Engines are very moderately rated, They are therefore guaranteed to carry a continuous overload of 10 per cent as against engines of many other makes that are sold and rated to their maximum power.

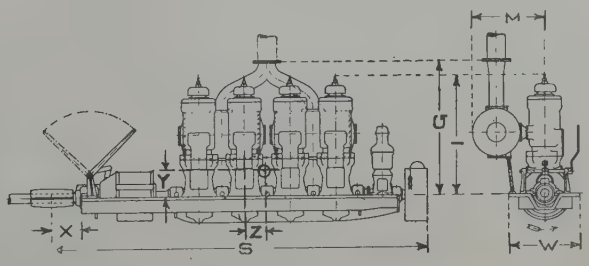
Technical Data

The compactness of the Bolinder Marine Heavy Oil Engine is shown in the outline drawings below. The letters G, M, X, etc., on the drawings refer to the table at the bottom of the page which gives the principal dimensions of the engines, the location of the center of gravity, etc. These tables also include revolutions per minute, net and gross weights, etc.

Model M I



Model M II



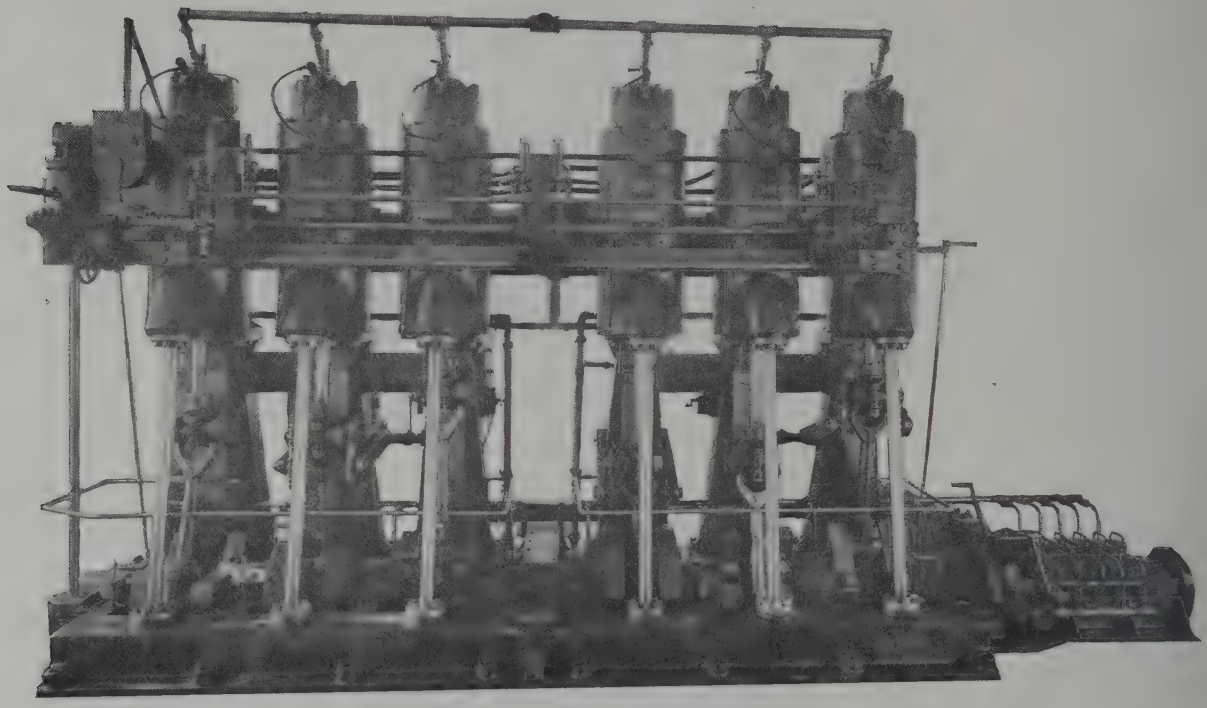
SPECIFICATIONS—MODELS M I AND M II

Model		M I.			M II.		
B. H. P.		90	120	160	240	320	500
Revolutions per Minute		300	250	225	250	225	160
Weight net in cwts.—approximate		112	173	230	337	456	1016
Vertical C. G. Dimension Y		13"	15⅝"	17¾"	14½"	17¾"	22½"
Horizontal C. G. Dimension Z		8"	9"	10⅝"	8¼"	13"	13½"
Dimensions of Engine in inches	Length S	130	147	175	236	266	322
	Width W	38	43	49	47	51	71
	Width M	34	38	52	38	52	72
	Height I	65	76	86	76	86	121
	Height G	—	—	—	88	97	132
	Length X	9½	5½	13¾	8½	14	10¾
Diameter in Inches	Fly Wheel D	27¾	33½	36½	35½	39½	55
	Propeller (3 blades)	47½	59	67	67	79	102
	Propeller shaft	4.921	5.708	6.3	6.69	7.48	10.04
Shipping dimensions and Approximate Weight	Vol. Cub. Ft.	424	600	813	1130	1480	3310
	Weight cwts.	140	206	287	417	540	1179
	Weight Kgs.	7500	10800	14600	21200	28000	62000
Type		R-300	R-400	R-500	R-400	R-500	R-600
Code Word		Penelope	Per	Paul	Pontus	Pluto	Poseidon

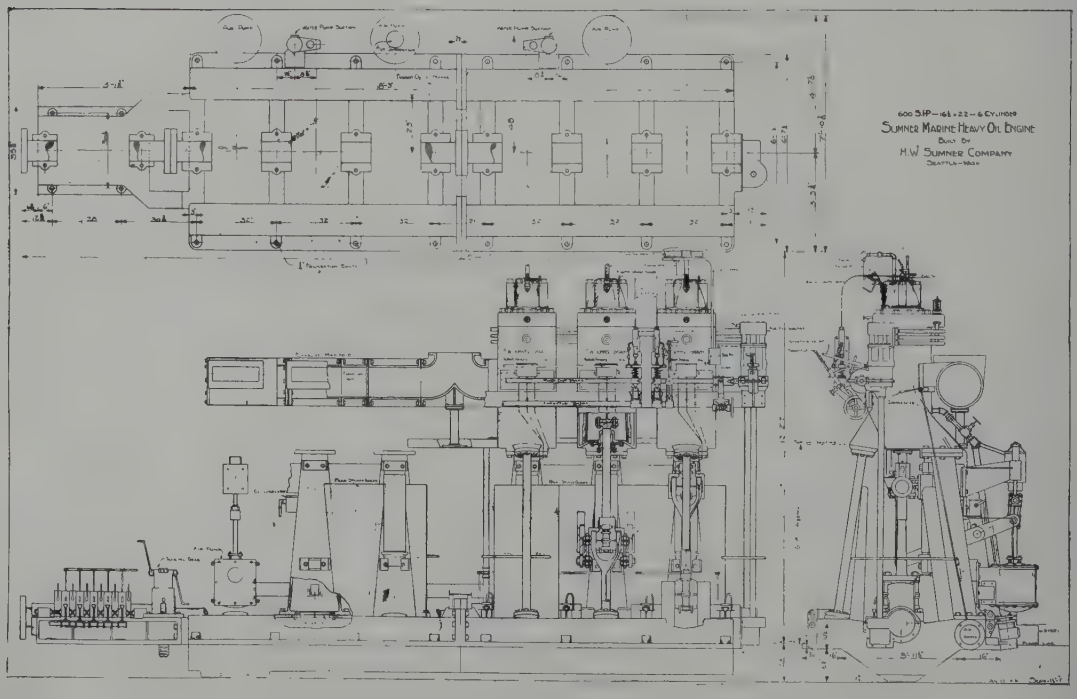
BOLINDERS COMPANY, 30 CHURCH ST., NEW YORK

Marine Heavy Oil Engines

H. W. Sumner Company 600 S.H.P. Marine Heavy Oil Engine



Front View



General Assembly

H. W. SUMNER COMPANY, SEATTLE, WASH.

A CO-PARTNERSHIP: H. W. SUMNER, ALBERT E. PARKER

Marine Heavy Oil Engines

Type

The Sumner Marine Heavy Oil Engine is of the vertical two cycle oil injection type, built in four sizes as listed below, with open column and crosshead.

These engines have a fuel oil consumption of approximately 75 United States gallons per 1000 brake horse power hours at rated full speed. Normal speeds are as given in the table, but the engines may be run as slow as 100 RPM and are readily reversed by means of compressed air followed by oil injection, the operation being as rapid as in the case of steam engines.

General Construction

The Sumner Heavy Oil Engine is in highly successful use in merchant ships operating under United States, French and Norwegian Flags. All parts are properly designed and carefully built with reference to the maximum service requirements to be met, resulting in a rugged, reliable and efficient marine propelling unit, of ample strength for rigidity and durability, at the same time of least possible weight to satisfy the restrictions of marine installations.

Frames

Each cylinder is supported at the front by a forged steel column and at the rear by a cast iron column, carrying the crosshead slide, and with flanges at the top and bottom secured to the cylinder and to the bedplate by through bolts and cap screws.

The bedplates of the 250 and 400 S. H. P. engines are in one casting and of cast iron. The bedplates of the 600 and 1000 S. H. P. engines are cast in two sections and consist of box-shaped guides.

Cylinders

The cylinders are of special hard close grain cast iron, with jacket cast on and stuffing boxes cast separately. The heads are water jacketed and carry the injection nozzle and combustion chamber. Holes are provided for cleaning out the water jackets and inlet ports, and the exhaust ports are made accessible by removing the exhaust manifold cover. Forced lubrication is provided by a pump.

Pistons, Crossheads, Cranks

The pistons are of cast iron designed to avoid distortion under temperature changes. Cast iron snap rings are provided, secured in grooves against rotation. The piston rods are secured to the piston by through bolts and to the crosshead by a key. They are of forged steel and machined all over.

The crossheads are of the locomotive type, made of cast steel with babbitted working face. They contain bronze bearings for the gudgeon pin which is case hardened, ground, and shrunk into the fork of the connecting rod. The crosshead slippers are of cast steel with babbitted working face, and the crosshead guides are of the box type, made of cast iron with equal working face ahead and astern. The connecting rods are of forged steel. The crank pin bearings have a steel body lined with white metal, peened and bored, the bolt heads being doweled, and the nuts locked with set screws. The crank shaft is of forged mild steel, with flanges forged on, and the crank bearings are of brass, with roll out, water cooled bearings filled with white metal, planed and bored.

Other Features

The scavenging pumps are beam driven from the engine crosshead. Two pumps are furnished on the 250 and 400 S. H. P. engines. The discharge ends of each pump are independent and are connected to different cylinders.

The thrust bearing is of the horse-shoe type, and is watercooled.

The turning gear is composed of a worm and gear.

Size, Shaft Horse Power	250	400	600	1000
Speed, Revolutions per minute	230	185	185	165
Cylinders, Number	4	4	6	6
Diameter, inches	13½	16½	16½	21
Stroke, inches	18	22	22	28
Weight, Tons	16	25	40	55
Dimensions, Height above crank	9'0"	12'0"	12'0"	15'0"
Depth below crank	1'6"	1'8"	1'8"	2'1"
Overall Width	6'6"	8'0"	8'0"	10'0"
Overall Length	13'0"	16'0"	24'0"	30'0"
Center of Gravity—Height above center of crank shaft	—	—	3'16"	—
Distance aft of middle crank shaft coupling	—	—	1'6"	—

H. W. SUMNER COMPANY, SEATTLE, WASH.

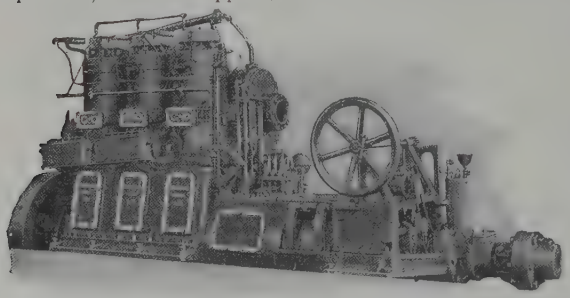
A CO-PARTNERSHIP: H. W. SUMNER, ALBERT E. PARKER

Marine Oil Engines

Products

The equipment manufactured by Fairbanks, Morse and Co. for shipyard and shipboard use covers a wide range of products and includes the following:

"C-O" Marine Oil Engines in sizes from 30 to 300 H.P. "Y" Stationary Oil Engines in sizes from 10 to 200 H.P. "Z" Kerosene and Gasoline Engines in sizes from 1½ to 20 H.P. Fairbanks Scales—all types. Electric Motors, Dynamos, Alternators, Light Plants, Starters, etc. Pumps—Centrifugal, Steam, and Power for every service. Coaling Stations and Coal Tipples, Water Systems, Tanks, Towers and Standpipes, Motor Cars, Hoists, Air Compressors, General Supplies, etc.



75 H.P. "C-O" Marine Oil Engine

"C-O" Marine Oil Engines

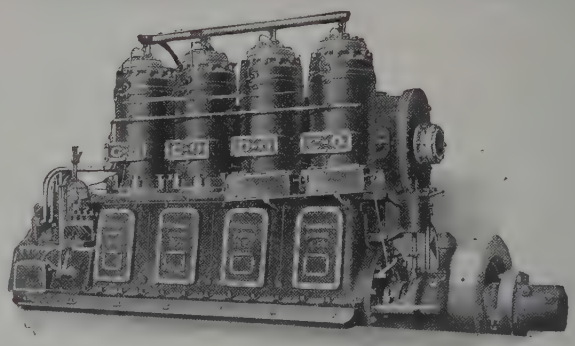
Fairbanks-Morse Type "C-O" Marine Oil Engines are made in sizes from 30 H.P. to 300 H.P. The smaller sizes have specially designed reverse gear, and sizes from 150 H.P. to 300 H.P. are directly reversible. The larger sizes may be equipped with auxiliary sailing clutch and flexible coupling.

Installations of "C-O" Engines

"C-O" Marine Oil Engines are in successful service on workboats in all parts of the world. Auxiliary Schooners and Barkentines, Freighters, River and Harbor Tugs, Packet Boats, Fishing Smacks, Trawlers, Cannery Tenders, Kelp Harvesters, Ferry Boats, Coal and Sand Barges—all these and many other kinds of workcraft are efficiently powered by "C-O" engines operating on fuel and crude oils of low grade.

Two typical ships on which these engines are in use are shown here. The illustration in the opposite column is one of five auxiliary five masted barkentines—sister ships—the "City of Orleans," "City of Shreveport, "City of Waco," "City of Austin" and the "City of Galveston." Each of these boats is 282 feet long with a 45 foot 9 inch beam; loaded draft 25 feet 6 inches; depth of hold 22 feet; gross tonnage 2259; net tonnage 2060; dead-weight capacity 3600 tons. Twin 200 H.P. "C-O" engines provide the power. All of these boats have established records for low fuel and maintenance costs.

The "Alf," shown on the opposite page, is a fishing boat owned by the Southern Alaska Canning Company. This boat originally driven by a well known distillate engine was recently repowered with a 75 H.P. "C-O" engine. The Southern Alaska Canning Company knew



200 H.P. "C-O" Marine Oil Engine

that this change in power meant greater returns from the "Alf"—for they also own and operate the "Fanshaw," "Petrol," "Einer Bayer," "Shamrock II" and "Shamrock III"—all of which boats are "C-O" engine powered.

Advantages of "C-O" Engines

The "C-O" Marine Oil Engine, together with the other types manufactured by Fairbanks-Morse represents the result of considerable study and experience in internal combustion engine design as applied to marine service. This engine has several distinctive features with many special advantages including the following:

1. No water injection into the cylinders.
2. Cool operation—all parts of the cylinder—combustion chamber and exhaust manifold being water jacketed.
3. Special means for quick starting give great advantage for intermittent as well as steady work.
4. Effective automatic crank case seal prevents the oil from blowing out and this insures positive lubrication.
5. Close regulation to all loads and at any speed for which the speed control is set.
6. Low fuel cost, the consumption on any grade of the cheaper fuels being less than one-tenth gallon per horse power hour.
7. Low Maintenance cost is assured by the elimination of all intake and exhaust valves and their operating mechanism. The operating cost is low, attendance and supervision being very slight.

The Motor Vessel "City of New Orleans"

Marine Auxiliaries

The Motor Schooner "Alf"

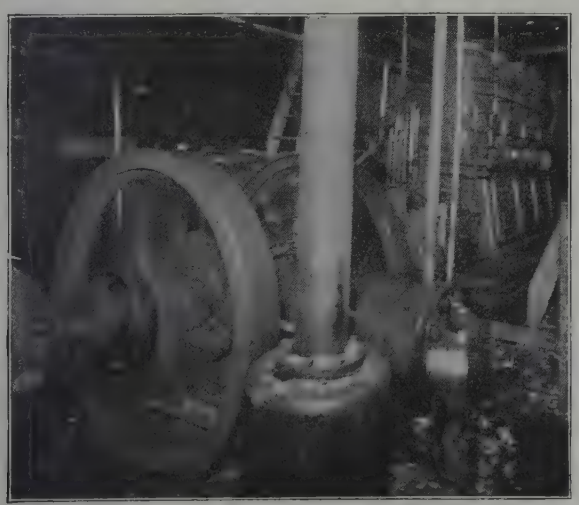
Auxiliary Equipment

We frequently furnish complete auxiliary power equipment for vessels in addition to the main power plant. This machinery includes stationary oil engines, motors, pumps, hoists, air compressors, light plants, Fairbanks Scales—all manufactured by Fairbanks-Morse and guaranteed by Fairbanks-Morse quality.

Some of this equipment is briefly described below to indicate the large range of sizes and types which can be furnished. Full details are covered by our catalogs which will be sent on request.

"Y" Oil Engines

This type of engine is furnished in sizes from 10 H.P. to 200 H.P. and is particularly adapted to furnished power for all purposes in the shipyard and on board ship. These units have been frequently installed for generating current, for hoisting, and for similar service. The photo below shows the 20 H.P. "Y" oil engine installed in the motor boat "John R. Bayliss."



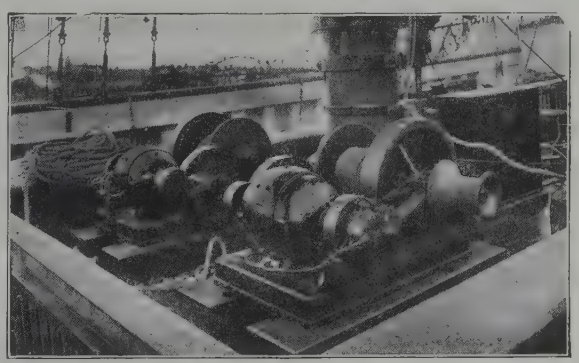
20 H.P. "Y" Oil Engine Direct Connected to Fairbanks-Morse Generator—Used for Light Plant on Boat John R. Bayliss

"Z" Kerosene and Gasoline Engines

This type of engine is furnished in sizes from 1½ to 20 H.P. and uses kerosene as well as gasoline. They are equipped with Bosch High Tension Oscillating Magneto and Throttling Governor. They are admirably adapted to such uses as hoisting, pumping, driving air compressors, generating current for lights, etc. A common use for the smaller "Z" Engines on boats off the east Canadian coast is for hoisting lobster pots. Their excellent service records at this and similar exacting jobs on board ship proves that their operation is not affected by bad weather, salt water or climatic conditions.

Motors

Fairbank-Morse Motors are built for both alternating and direct current and are in successful operation on hundreds of ships. They are built for standard voltages and in a wide range of sizes suitable for all purposes on shipboard and in the shipyard. Their excellence of construction makes them particularly resistant to the dampness, and salt air to which they are exposed in marine



Fairbanks-Morse Motor Driven Hoists on Motorship "Astoria"

work. The illustration above shows motor-driven hoists on the oil vessel "Astoria." On this vessel and seven sister ships the current is generated by a "Y" oil engine generator unit.

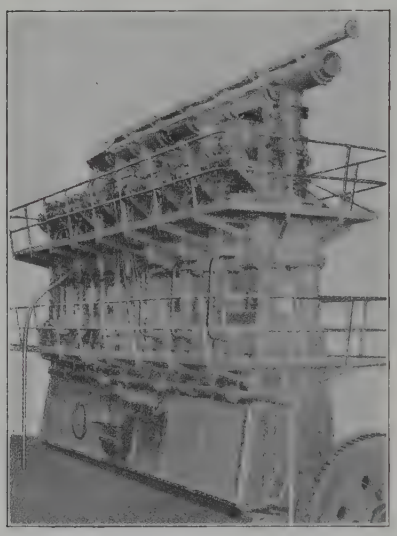
Hoists

A large range of sizes of hoists are furnished for all kinds of hoisting work on board ship and for hauling and hoisting work in the shipyard. Those machines are rugged in construction and are amply suited for the severe usage to which engines of this type are subjected. They can be fitted with "Z" Kerosene or "Y," oil engine or with either alternating or direct current motor, the entire unit being of Fairbanks-Morse manufacture.

Pumps

Centrifugal, Steam and Power Pumps can be furnished in sizes to meet every shipyard or shipboard need. All types are proving their worth through successful service on thousands of exacting jobs.

Diesel and Semi-Diesel Engines



Werkspoor Diesel Engine, 850 B.H.P.

Werkspoor Diesel Engines

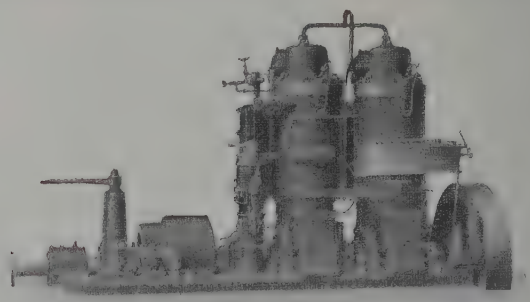
The Werkspoor Diesel Engines are built for marine and stationary purposes, for both main and auxiliary power, and are used in cargo vessels, schooners, tug boats, barges, fishing boats, etc. They are of the four cycle, single acting, vertical type and are built in the sizes listed in table below.

The larger engines are water cooled and equipped with crossheads, whereas the engines of 550 B. H. P. and under are air cooled and those of 300 B. H. P. and under are fitted with trunk pistons. All 6 cylinder engines are direct reversible.

Features

The reversible Werkspoor Diesel Marine Engines are ruggedly built throughout, with heavy crankshafts, bearings, etc. Cast iron columns carrying the cylinder block encase steel tie rods reaching from bottom of bedplate to top of cylinder block. The cylinder head and liner are combined in one casting to eliminate the heavy joint at the hottest part of cylinder thus greatly increasing the efficiency of water cooling. The piston can be inspected readily by lowering the lower part of the cylinder liner, and after removing the four bolts connecting it to the piston rod, it can be taken out without removing any valve gear or piping. A three stage compressor is placed at forward end of engine to allow greater accessibility.

Size B.H.P.	No. of Cylinders	Approx. Overall Dimen. Length	Width	Height Top Cyl. Above Shaft	Approx. Net Weight in Tons of 2000 lbs	Fuel Consumption per 24 hrs. in Barrels	R.P.M.
100	2	8′ 6″	4′ 4″	5′ 5″	8	3.5	250
150	3	10′ 9″	4′ 4″	5′ 5″	10	5.2	250
200	4	13′ 6″	4′ 4″	5′ 5″	12	6.9	250
300	6	18′ 0″	4′ 4″	5′ 5″	16	10.3	250
550	6	31′ 6″	6′ 10″	12′ 11″	80	19.	165
850	6	38′ 5″	7′ 4″	15′ 5″	120	28.	135
1100	6	42′ 6″	9′ 4″	17′ 9″	160	38.	115
1500	6	48′ 0″	10′ 6″	20′ 0″	230	51.	100
2000	8	52′ 6″	10′ 6″	20′ 0″	300	68.	100



Skandia Hot Bulb Oil Engine, 38 B.H.P.

Skandia Hot Bulb Oil Engines

The Skandia Hot Bulb Oil Engines are built for both marine and stationary purposes in the sizes listed in table below. They operate on heavy crude oil, and are of the two cycle type in which the combustion is created by the aid of a hot ball. This hot ball is kept sufficiently hot by the heat produced by the explosion and compression, thus necessitating the heating by means of a torch only when the engine is started cold. This torch is extinguished as soon as the engine is started and running under its own power.

Features

The 360 and 550 B. H. P. engines have open crank cases with scavenging pumps on the rear side, whereas all the other sizes of engines have enclosed crankcases. All one and two cylinder marine engines are equipped with reversing gear of the spur gear type, while the four and six cylinder engines are direct reversible.

All Skandia engines have a mechanically operated force feed lubricator with sights mounted on the top and with separate adjustment, so that the amount of oil furnished to each part of the engine is visible at all times and can be increased or decreased.

The two cylinder marine engines are equipped with a patented idling device which insures steady running for any length of time, with the clutch released. All two, four and six cylinder engines are equipped with automatic air starters.

Size B. H. P.	No. of Cylinders	Approx. Overall Dimensions Length	Width	Height Above Shaft	Approx. Net Weight in Tons of 2000 lbs.	R. P. M.
9	1	4′ 4″	1′ 8″	2′ 8″	.66	500
16	1	5′ 5″	2′ 1″	3′ 6″	1.38	400
24	1	6′ 2″	2′ 5″	4′ 0″	1.87	375
38	2	7′ 10″	2′ 3″	3′ 7″	2.73	375
55	2	9′ 7″	2′ 7″	4′ 0″	3.90	375
70	2	10′ 6″	2′ 10″	4′ 10″	4.63	325
100	2	11′ 0″	3′ 6″	5′ 10″	8.75	275
120	2	11′ 3″	3′ 4″	5′ 10″	8.75	300
140	4	11′ 5″	2′ 10″	4′ 6″	8.00	325
175	2	15′ 2″	3′ 11″	7′ 9″	12.75	250
200	4	13′ 3″	3′ 4″	5′ 10″	13.50	275
240	4	13′ 3″	3′ 5″	5′ 10″	13.50	300
360	4	15′ 11″	3′ 11″	7′ 9″	23.00	250
500	6	26′ 11″	3′ 11″	7′ 9″	35.00	225

H. S. JOHANNSEN, 25 WEST 43RD STREET, NEW YORK

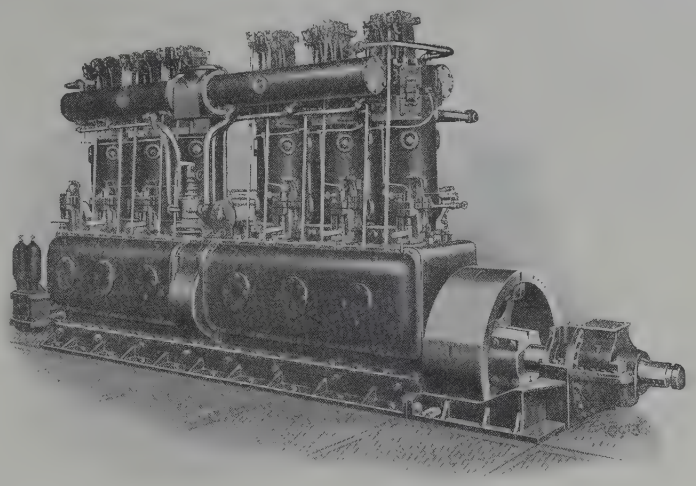
Eastern Agent—Skandia Pacific Oil Engine Co.

P–R Marine Oil Engine

Automatic Ignition at 200 Pounds Pressure

The Ingersoll-Rand Heavy-oil-Engine, Type P-R, uses the four-stroke cycle with low compression (about 200 pounds per square inch), with direct injection of fuel. It requires no hot bulb or any other means of ignition, except for a few seconds in starting, other than the temperature of compression.

By the ingenious method of direct fuel injection, so perfect is the atomization of fuel that two hundred pounds per square inch is sufficient to ignite the fuel automatically. Thus the Ingersoll-Rand Heavy-oil Engine has the high overall economy of the full Diesel type, yet demands no higher compression and no more complicated fuel injection system than the semi-Diesel.



Ingersoll-Rand Heavy-Oil Engine, Type P-R

Economy of Ingersoll-Rand Heavy-oil Engine

The distinctive design of the Ingersoll-Rand Heavy-oil Engine secures a high degree of operating economy, not only in fuel consumption but also in absence of wear. Three points of advantage in this design are especially noteworthy.

1. The mean effective pressure, which is proportional to the net work developed in the cylinder for the same brake horsepower of engine, need be only 85 per cent of that of the high compression cycle. This is due to the higher mechanical efficiency—there are no air compressors to be driven with the Ingersoll-Rand Engine and the friction losses are lower.

2. The mean pressure of compression, which is proportional to the work done in the engine cylinder during the compression stroke, is approximately half that of the high-compression cycle. The performing of the extra work by the piston, high-compression, and the return to the piston of an equal amount of excess work during the expansion stroke, represents more wear on piston, cylinder and bearings. For the same brake horsepower the low compression cycle subjects the engine to approximately 30 per cent less wear. With parts of equal dimensions they will wear considerably longer, and will require less attention.

3. The maximum pressures and temperatures in the cylinder are considerably lower, so that all the parts that are designed for strength, stiffness or temperature stresses may be constructed much more conservatively.

Description of the Cycle

Suction Stroke—The intake valve is opened mechanically and the piston moves downward on the suction stroke, drawing in a full charge of pure air.

Compression Stroke—The intake valve is closed by the valve spring and the piston returns, compressing the air from the cylinder into the combustion chamber to a pressure of approximately 200 pounds per square inch. Injection of the fuel starts near the end of the stroke and is completed before the piston has reached the end of its travel. The system of fuel injection is such that ignition is automatic and perfect combustion occurs.

Working Stroke—Combustion at constant volume occurs almost exactly at dead center and the pressure rises from 200 to approximately 400 pounds and the piston moves downward on the working stroke.

Exhaust Stroke—Near the end of the working stroke, the exhaust valve is opened mechanically, the pressure drops, and the piston returns expelling the burned charge.

Construction of Engine

Ample strength in every part, for durability and dependability, insures satisfactory operation of the Ingersoll-Rand Heavy-oil Engine. Particular attention has been paid to accessibility, large doors permitting easy inspection of the driving parts and of the side shafts, eccentrics, governor, etc.

Adjustments and repairs, though seldom required, can be made in the minimum of time, a feature which appeals to both the operating engineer and the owner.

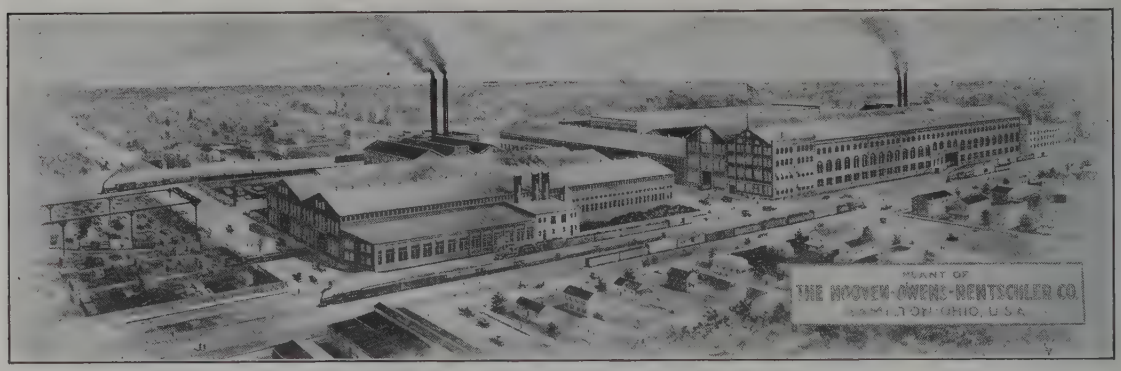
Perfect alignment of bearings can be easily maintained by adjustment of the wedges, the adjustment being made from the outside. In every detail the engine is built for the greatest convenience in operation.

Standard Sizes

The Ingersoll-Rand Heavy-oil Engine can be supplied in the following standard sizes:—Reversible Type, 220, 300, 500 and 1500 shaft horsepower. Also Non-Reversible Type, adapted for direct connection to generators for electric ship drive and for driving ship auxiliaries.

Specifications for engines and recommendations for any particular installation will be furnished on request.

Hamilton Marine Engines



Plant of the Hooven, Owens, Rentschler Co., Hamilton, Ohio

Experience

The Hooven, Owens, Rentschler Co. are furnishing complete triple expansion marine engines in units from 400 to 5400 H. P., and quadruple expansion marine engines up to 6500 H. P. During the last two years this company reached the unprecedented output of four complete 2800 H. P. marine engines per week. The Hooven, Owens, Rentschler Co. has built power equipment since 1845.

The company operates its own Foundry with a capacity of 100 tons per day. The equipment of the Machine Shop is complete, modern, and well-balanced; it includes probably the finest and largest outfit of heavy machine tools in the United States.

The Engineering department is thoroughly organized. Hamilton Engineers are in the front rank—each one a specialist of established reputation in his chosen field.

The company recognizing that there is a wide difference in the Marine and stationary engine practice, have designed and built the Marine engines with the help and advice of high-class Marine engineers, both designing and operating, and are constantly studying the design and operation of Marine Engines in this country and Europe. The engines themselves are heavy and substantial in every way with large bearing surfaces and are made of the best materials. They are made to suit the best standard Marine practice with the correct clearances and oiling arrangements, and are erected under the supervision of experienced operating Marine engineers. There has been no attempt to depart from standard American or British Marine practice, or to embody any stationary practice in these engines.

Hamilton Marine engines have proved and are proving themselves by actual performance. They are built to withstand the greatest strains. They are reliable.

Foundry Facilities

In its foundry, the Hooven, Owens, Rentschler Co., through long experience, is thoroughly familiar with molding large castings. This was shown in the foundry turning out six complete sets of cylinder castings for the 2800 H. P. size a week. A few years ago, six weeks was thought to be a short time in which to mold and cast the intermediate cylinder alone. Nor was quality impaired. The demands of rapid production were adequately met by devising improved methods in shop practice.

Each step and factor in foundry production is characterized by the most modern practice and ingenious and distinctive features. In all the operations of molding, spraying, drying, assembling cores, pouring, cleaning, and testing castings, new standards have been set at the Hooven, Owen, Rentschler plant in foundry methods making for improvement in the quality of the castings as well as enormous savings in time and labor.

Machine Shop Facilities

The machine shop of the Hooven, Owens, Rentschler Co. is fully equipped with jigs and special tools for quantity production of various parts. The engineering department maintains a particularly close co-operation with the shops. Complete sets of drilling jigs and various milling, assembling and planing fixtures are being used. These special tools promote a high degree of efficiency in the machine shop, resulting in an output of four complete 2800 H. P. engines a week during the war.

Even greater care is used in conducting the various machining operations than in assuring the delivery of none but sound castings to the machine shop, as otherwise castings that represent a considerable outlay in time and material might be rendered valueless. Each step in setting up, rough machining, finish machining and checking and testing is done by experienced men

Hamilton Marine Engines

S. S. Edmore, Driven by Hamilton Engines

and carried out by methods that have been developed to meet the requirements of quantity production as well as to obtain the extreme accuracy demanded by this class of work. In every possible case, work is expedited materially through machining a large number of parts at one time.

Hamilton Engine Installations

Hamilton marine engines have been installed and are in successful operation on large numbers of merchant ships, tugboats, and other types of vessels. To date the plant has built more than 225 marine engines.

Factors Assuring Satisfactory Operation

Hamilton engines are giving satisfactory service because of the correctness of their design, the skillful machining of all parts, and particularly because of the care exercised to assure proper fitting of parts and correct assembly.

The Hooven, Owens, Rentschler Co. recognizes that on the correct assembly and proper testing of a marine engine depends its smooth running. Perfect alignment is secured before any engine is permitted to be dismantled for shipment, and no chances are taken that bearing surfaces such as eccentrics, main bearings, crosshead slippers, or crank pin brasses may develop undue heating from any cause connected with initial fitting. Skilled mechanics of long training who are experienced in assembling heavy machinery are entrusted with the erection of all machines, and each step is carefully checked.

All valve gear and other adjustments are properly made before shipment and are plainly indicated for the engineer's future guidance in subsequent overhaulings. Both the clearance and striking points at the upper and lower ends of each cylinder are marked on the crosshead guides, and several thin liners are interposed between the lower end of the connecting rod and the crankpin boxes to permit adjustment as necessary for the property clearance.

General Construction of Engine

The Hamilton Marine Engine is of the vertical, inverted direct-acting type.

The handling station is at the starboard side, with the throttle and reversing gear in the larger sizes of engines on the front high pressure housing. The turning engine, furnished with all engines when required, actuates through worm gear on the crank shaft.

Lubrication is from a distribution box placed on each main cylinder so as to be easily reached from the engine room grating. The main bearings, crank pins, eccentrics, horseshoe type thrust bearing, and shaft bearings are cooled by water service from the sea, the water service in the guides being part of the sanitary system if required.

The valves are actuated through a Stephenson link motion, the link used being of the double bar type. The valve gear is equipped with linking up screws for the purpose of altering the cutoff of any cylinder independent of the others. Balance pistons and cylinders are provided for counterbalancing the weight and inertia of the valves and valve gear when conditions require.

The following instruments are mounted on gage boards:—Eight-day clock, main steam gage, receiver gages, vacuum gage, and a revolution counter.

Designing Facilities

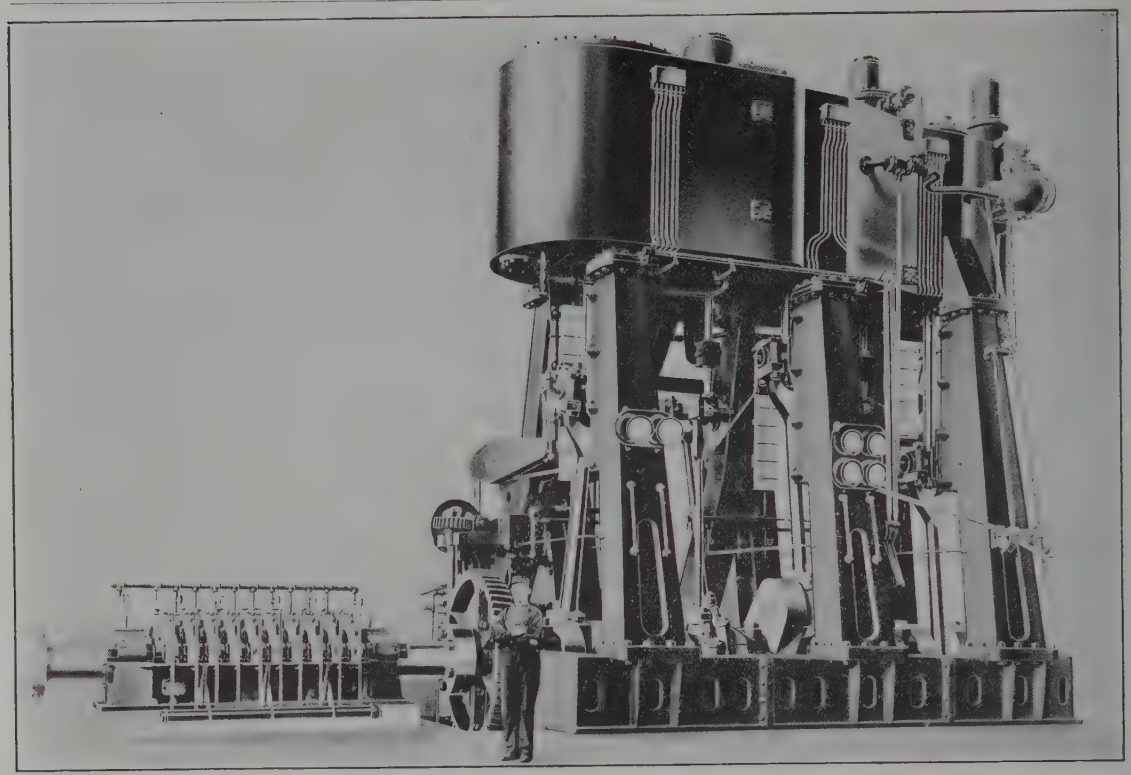
The standard designs of Hamilton Marine Engines meet practically all ordinary requirements for marine propulsion. For any unusual conditions, or for installations where variations in design may be desirable, complete designs can be developed to meet individual requirements.

The Hooven, Owens, Rentschler Company is also fully equipped to build steam reciprocating engines, of any type, from designs prepared outside. Inquiries will receive prompt attention. Our Engineering Department will cooperate with you in solving your engine problems.

THE HOOVEN, OWENS, RENTSCHLER CO.

HAMILTON, OHIO

Hamilton Marine Engines



2800 H.P. Triple Expansion Engine

Ease of Replacements

Throughout the entire process of machining, jigs and fixtures are used wherever possible. Many machine shops correct errors in the machining of bearing surfaces by means of shims used in the assembling operations. It is the practice of the Hooven, Owens, Rentschler Co., however, to depend for satisfactory assembly on the care and accuracy of the previous machining operations. The manufacturing method insures interchangeability of all parts and the utmost possible ease of repairs and replacements.

Quick Repair Part Shipments

Because of the constant, multiple production of Hamilton engines and their parts, a large stock of parts is maintained at all times, permitting prompt shipment. The central location of the plant and its proximity to important trunk lines insure quick shipments to all coast and lake ports and enable delivery of repair parts to be made in the shortest possible time.

Special Repair Part Bulletins for Hamilton Engines

For convenience in ordering repair parts for the standard Hamilton engines, special bulletins have been published. These bulletins contain complete parts lists of these engines with order references, and detailed and descriptive drawings of engine parts, together with complete instructions for ordering repairs as shown below. Every operator of ships with Hamilton, reciprocating engines should have a copy. Repair parts bulletins sent free on request.

Instructions for Ordering Marine Engine Repair Parts

In order that any customer may secure the proper part, it is necessary in ordering to give full information in connection therewith.

Consequently, the attention of the customer is directed to the fact that on each engine is supplied a name-plate, giving name of manufacturer — also when built for U. S. Shipping Board, their Engine Number.

In addition to the figure number of cut as shown in the bulletin — to aid in securing the correct piece, where a customer is ordering a new cylinder, cylinder liner, or a new valve—gauges of the bore, into which other parts must fit, should be supplied, as well as length of piston rod, when same is desired. The various pieces in detail are shown in the illustration herein, and we have further printed a list of pieces and piece numbers referring to parts as shown in the illustrations.

We suggest in the interest of prompt service and to avoid mistakes, that your order should be made out as follows:

For any Marine Engine of ..... Horsepower capacity.

Order Blank

Name of Purchaser.....

Address of Purchaser.....

Ship to .....

Destination .....

Ship How..... Piece Number..... Name of Piece .....

Number of Pieces Required..... Figure Number in Bulletin ..... Page No .....

State Whether High, Intermediate or Low Pressure .....

Size of Engine Cylinder, H. P..... M. P..... L. P .....

Stroke of Engine .....

..... Number.....

Name of Manufacturer on Name-plate.....

In the figure illustrations, it will be noted that some bolts, pins, keys and the like, do not have any separate piece number.

If these parts are wanted, purchaser should plainly state this fact in his order so that these small pieces may be included complete.

INDICATED HORSE POWER FOR HAMILTON TRIPLE MARINE ENGINES

For Most Economical Operation at Various Steam Pressures and Revolutions

Size Engine	Boiler Steam Pressure	Revolutions Per Minute															
		65	70	75	80	85	90	95	100	105	110	115	120	125	130	135	140
12¾–21½–36	170	..	..	..	..	..	..	..	413	434	455	476	496	517	537	558	578
	180	..	..	..	..	..	..	..	439	462	483	505	527	550	571	593	615
27	190	..	..	..	..	..	..	..	466	489	512	536	558	582	605	629	651
	200	..	..	..	..	..	..	..	492	517	541	566	590	615	639	664	688
15½–26–44	170	..	..	..	..	..	..	..	682	716	750	784	818	852	886	921	955
	180	..	..	..	..	..	..	..	725	761	797	834	870	906	942	978	1014
30	190	..	..	..	..	..	..	..	768	807	845	884	922	960	999	1036	1075
	200	..	..	..	..	..	..	..	812	852	892	932	973	1014	1055	1095	1135
18–30½–52	180	..	..	..	873	919	973	1026	1080	1134	1188	1242	1295	..	..	..	..
	190	..	..	..	926	976	1033	1090	1146	1205	1262	1320	1376	..	..	..	..
33	200	..	..	..	977	1029	1089	1152	1210	1272	1331	1392	1451	..	..	..	..
	210	..	..	..	1030	1086	1149	1214	1275	1344	1405	1470	1532	..	..	..	..
19–32–56	180	..	929	995	1060	1126	1194	1260	1326	1391	1458	..	..	..	..	..	..
	190	..	984	1054	1124	1194	1264	1335	1405	1475	1545	..	..	..	..	..	..
36	200	..	1041	1115	1190	1264	1338	1414	1488	1562	1635	..	..	..	..	..	..
	210	..	1097	1175	1254	1334	1410	1490	1568	1645	1725	..	..	..	..	..	..
20½–35–60	180	..	1255	1345	1434	1522	1613	1702	1792	1882	1972	..	..	..	..	..	..
	190	..	1334	1427	1523	1616	1712	1807	1904	1998	2095	..	..	..	..	..	..
42	200	..	1407	1506	1607	1707	1807	1908	2018	2110	2210	..	..	..	..	..	..
	210	..	1484	1589	1695	1800	1905	2012	2120	2225	2334	..	..	..	..	..	..
23–39–66	180	..	1569	1680	1794	1905	2015	2135	2240								
	190	..	1660	1780	1900	2020	2135	2260	2375								
42	200	..	1758	1880	2010	2135	2260	2390	2510								
	210	..	1850	1984	2117	2246	2380	2514	2645								
23–39–66	180	..	1680	1800	1920	2040	2160	2285	2400								
	190	..	1780	1910	2032	2162	2290	2420	2540								
45	200	..	1884	2020	2150	2290	2420	2560	2690								
	210	..	1984	2128	2265	2412	2550	2695	2832								
24½–41½–72	180	..	2052	2200	2350	2495	2640	2788	2935								
	190	..	2180	2335	2490	2645	2800	2960	3110								
48	200	..	2300	2468	2630	2795	2960	3125	3290								
	210	..	2425	2600	2775	2945	3120	3295	3470								
27½–46–78	190	2510	2700	2895	3090	3280	3475	..	..								
	200	2650	2850	3055	3260	3465	3665	..	..								
48	210	2790	3010	3220	3442	3655	3860	..	..								
	220	2935	3160	3384	3614	3845	4060	..	..								
27½–46–78	190	2670	2870	3080	3280	3490	3690	..	..								
	200	2820	3030	3250	3465	3585	3900	..	..								
51	210	2970	3195	3425	3655	3885	4110	..	..								
	220	3120	3355	3595	3840	4080	4310	..	..								
27½–46–78	190	2820	3040	3258	3475	3690	3920	..	..								
	200	2980	3210	3440	3670	3900	4130	..	..								
54	210	3140	3380	3625	3865	4110	4350	..	..								
	220	3300	3560	3810	4065	4320	4575	..	..								
30–51–86	190	3195	3435	3685	3925	4175	4415	..	..								
	200	3370	3635	3885	4145	4400	4660	..	..								
51	210	3560	3830	4110	4380	4660	4930	..	..								
	220	3740	4020	4310	4600	4885	5170	..	..								
30–51–86	190	3380	3640	3900	4160	4415	4680	..	..								
	200	3565	3840	4110	4390	4660	4935	..	..								
54	210	3770	4060	4350	4640	4925	5220	..	..								
	220	3955	4260	4565	4870	5170	5480	..	..								

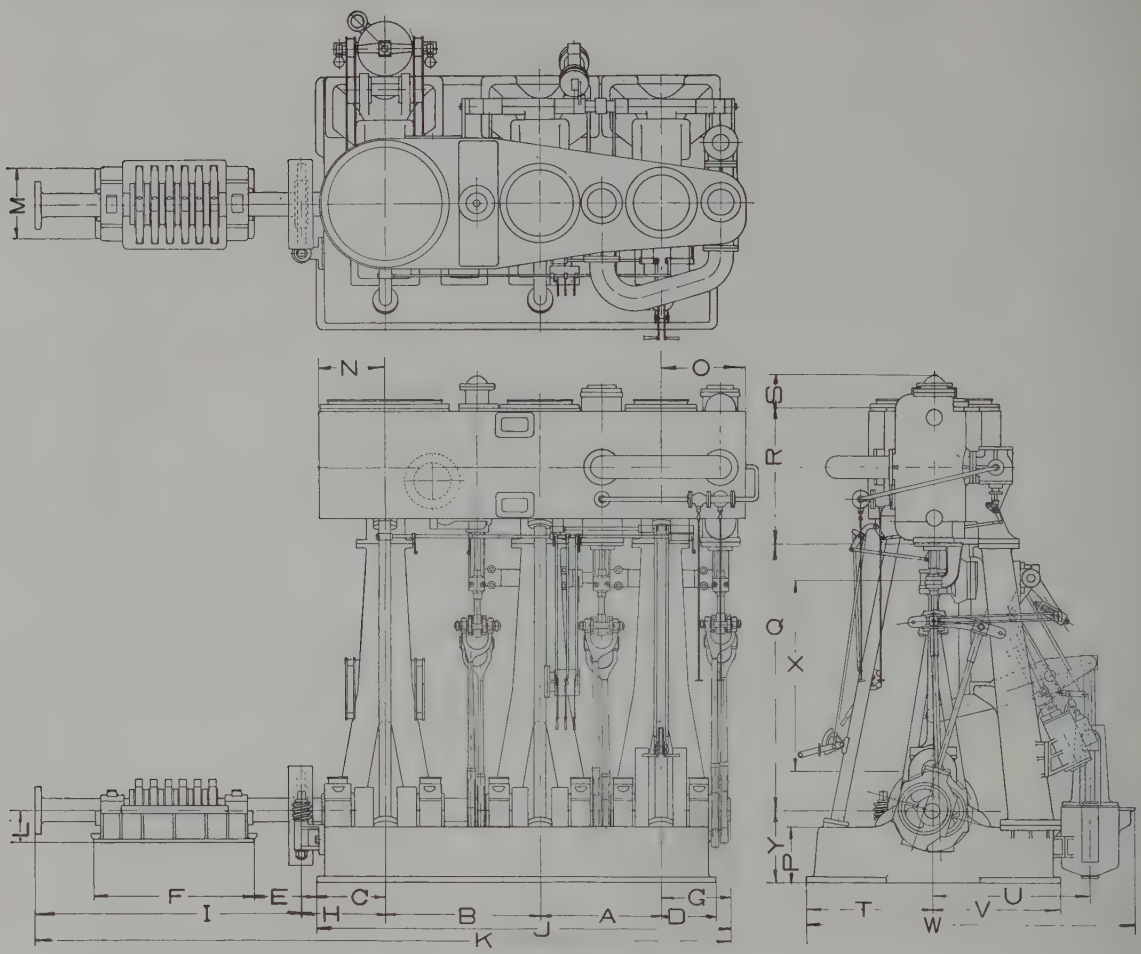
INDICATED HORSE POWER FOR HAMILTON QUADRUPLE MARINE ENGINES

For Most Economical Operation at Various Steam Pressures and Revolutions

Size Engines	Boiler Steam Pressure	Revolutions Per Minute					
		65	70	75	80	85	90
24½–36–53–78	200	2364	2545	2728	2910	3095	3270
	210	2480	2670	2860	3050	3245	3435
51	220	2620	2820	3020	3220	3430	3630
	230	2745	2955	3167	3375	3590	3800
24½–36–53–78	200	2505	2695	2890	3080	3072	3465
	210	2625	2825	3030	3230	3440	3635
54	220	2772	2985	3200	3415	3630	3840
	230	2905	3130	3350	3575	3800	4022
27½–40–59–86	200	3120	3360	3600	3840	4075	4315
	210	3285	3540	3790	4040	4300	4550
54	220	3450	3715	3980	4250	4515	4780
	230	3620	3900	4180	4455	4735	5010
30-43½–64–93	200	3695	3980	4260	4550	4830	5120
	210	3890	4185	4485	4790	5080	5380
54	220	4095	4405	4720	5040	5350	5670
	230	4295	4620	4950	5280	5610	5940

Estimated Weights of Standard Engines

Size	Bare	With Att. Pumps	With Att. Pumps and Thrust	Center of Gravity Complete	
				Above center of shaft	Aft of center of H.P. cyl.
12¾–21½–36	40,000	42,500	45,000	41″	53″
27					
15½–26–44	67,500	71,000	75,000	45″	58″
30					
18–30½–52	88,500	92,500	100,000	50″	68″
33					
19–32–56	132,500	138,000	150,000	54″	73″
36					
20½–35–60	161,000	167,000	180,000	62″	83″
42					
23–39–66	187,500	195,000	210,000	63″	89″
42					
23–39–66	195,200	203,000	218,000	66″	89″
45					
24½–41½–72	258,000	267,000	287,000	71″	93″
48					
27½–46–78	319,000	330,000	353,000	69″	104″
48					
27½–46–78	327,500	339,000	362,000	73″	104″
51					
27½–46–78	336,000	348,000	371,000	77″	104″
54					
30–51–86	370,500	385,000	411,000	73″	114″
51					
30–51–86	381,000	396,000	422,000	77″	114″
54					
24½–36–53–78	398,500	410,000	434,000	73″	154″
51					
24½–36–53–78	411,000	423,000	447,000	77″	154″
54					
27½–40–59–86	482,000	497,000	523,000	77″	162″
54					
30–43½–64–93	544,000	561,000	589,000	77″	172″
54					



Small Engine

TABLE OF DIMENSIONS

Small Engines

Size Engine	12¾-21½-36x27	15½-26-44x30	18-30½-52x33
Dimension			
A	43½	45	53
B	52½	59	69½
C	22	23½	27
D	19	20½	23
E	20	21	21
F	56	61	68½
G	24½	25	29
H	26	27½	31½
I	80	88	92
J	137	148	172½
K	226½	244½	275
L	12	13	13½
M	25	26	31½
N	21½	25½	29¼
O	27½	29⅛	32⅛
P	14	16½	18½
Q	87	96	106
R	44½	47⅝	56
S	12½	12⅞	25
T	45	47½	52
U	45	61½	66
V	57	47½	52
W	117	120	130
X	61	67½	75
Y	24	27	30
Steam	4	5	6
Exhaust	12	15	16
Air Pump	15 x 10	18 x 12	18 x 15
Bilge Pump	3 x 10	3½ x 12	4 x 15

Small Triple Expansion Engines

The bedplate is of heavy construction with six girders for supporting the main bearings. The main bearings are babbitted, with flat bottom shoe and separate cap.

The crank shaft is a forging built up into one section.

The connecting rod is of forged steel and of the standard marine type.

The crosshead guide is of the bar type, and the crosshead is a steel forging with slippers of cast iron lined with bearing metal and bolted to it.

The piston rods are steel forgings and are interchangeable.

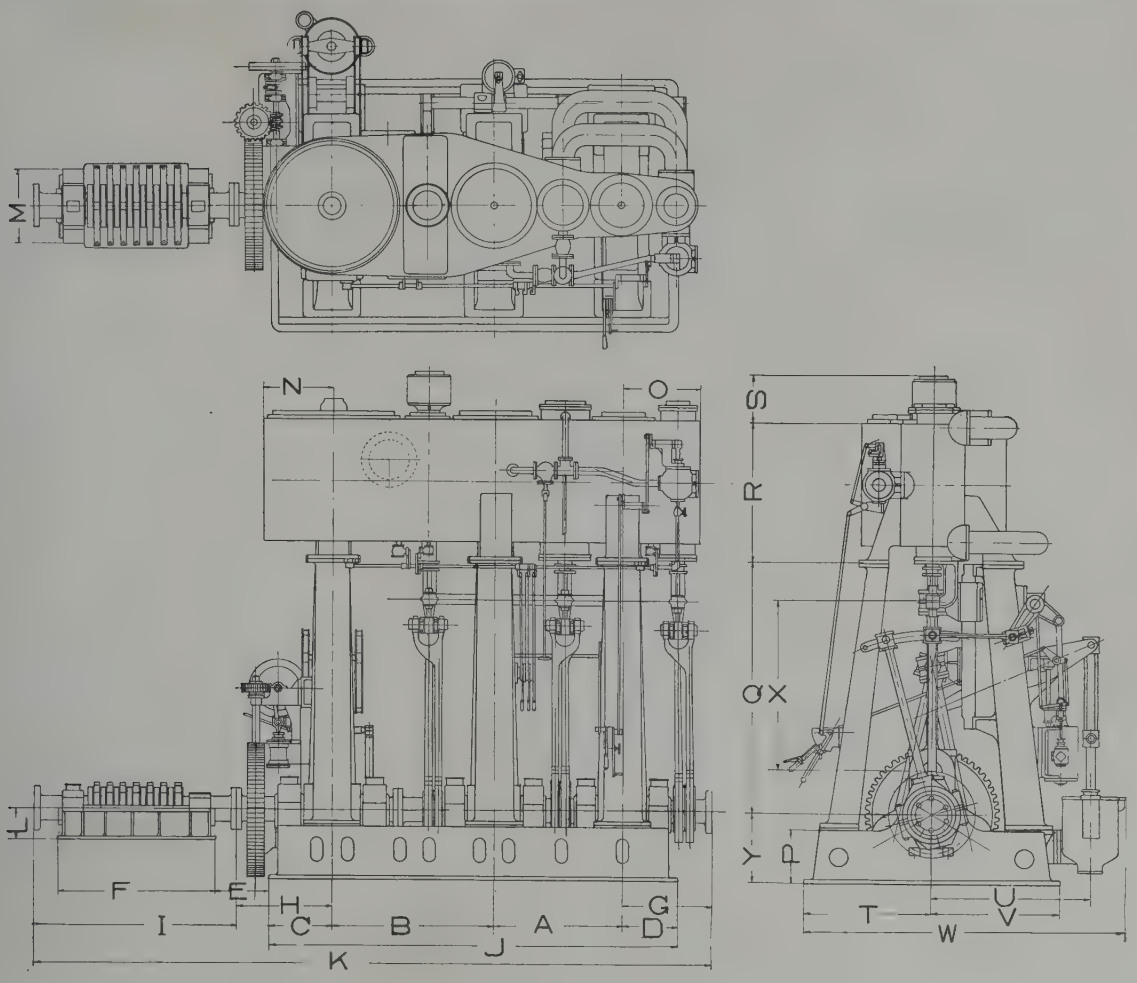
The eccentrics are cast iron, with cast iron eccentric straps lined with bearing metal and forged steel eccentric rods and valve stems.

The turning gear is operated by a ratchet.

The thrust shaft is of forged steel and the thrust bearing is of the horseshoe type.

Guards are fitted where required for protection.

By-pass and drain piping is fitted to cylinders and operated from the working platform.



Medium Engine

Medium Triple Expansion Engines

The bedplate is of heavy construction with six girders for supporting the main bearings. The main bearings are babbitted, with flat bottom shoes and separate caps. The lower shoes are fitted with removable half round shell.

The crank shaft is a forging built up in three interchangeable sections.

The connecting rod is of forged steel and of the standard marine type.

The crosshead guides for the smaller size engines are of the bar type. The larger engines either have single slipper type or double slipper type according to size of engine.

The throttle valve is of the poppet type. Larger engines are also fitted with butterfly valve and both valves are operated from the starting platform.

The thrust shaft is of forged steel and the thrust bearing is of the horseshoe type.

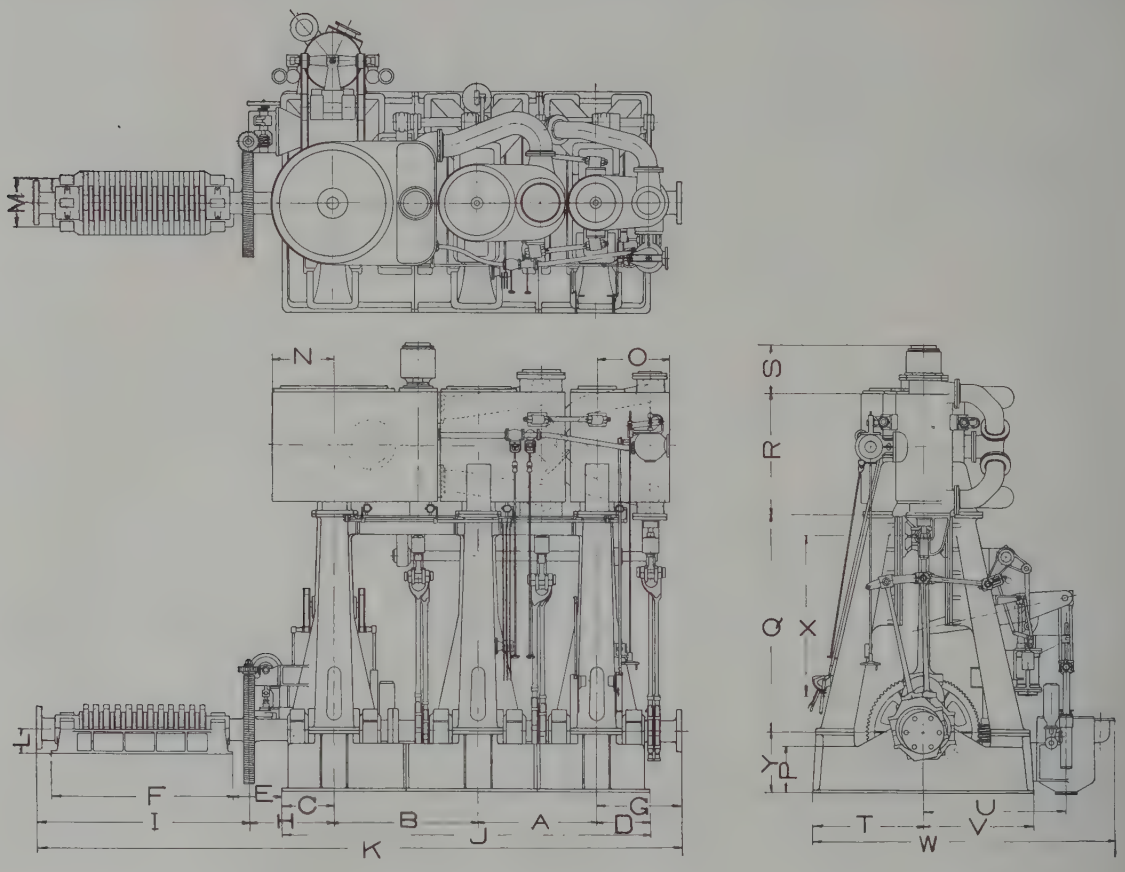
Guards are fitted where required for protection.

By-pass and drain piping is fitted to cylinders and is operated from the working platform.

TABLE OF DIMENSIONS

Medium Engines

Size of Engine		19-32-56 x 36	20½-35-60 x 42	23-39 66 x 42	23-39 66 x 45	24½-41½ 72 x 48
Dimension	A	58¼	67	72¾	72¾	74¾
"	B	73½	82	89	89	93
"	C	28¼	29⅛	30½	30½	34⅜
"	D	25½	29⅛	30½	30½	31⅝
"	E	29⅛	30½	31⅞	31⅞	37¾
"	F	68½	85	88	88	110½
"	G	44⅜	48½	52⅝	52⅝	55⅝
"	H	44⅜	48½	52⅝	52⅝	55⅝
"	I	92	102	107	107	143½
"	J	185½	207¼	222¾	222¾	233½
"	K	312½	348	374	374	412½
"	L	13½	14½	15¼	15¼	16
"	M	31½	32	33½	33½	34¼
"	N	31¼	34¾	38¾	38¾	40¾
"	O	34⅜	39	42¼	42¼	41
"	P	24½	24	24	24	26¾
"	Q	114¼	131	133	138½	149
"	R	63	71½	72¾	75¾	80½
"	S	25⅞	28¾	29⅝	29⅜	27
"	T	58¾	60½	62½	62½	65½
"	U	72	77	80	80	85¼
"	V	58¾	60½	62½	62¾	65½
"	W	148¾	158½	164	164	171½
"	X	81	96	96	100	108
"	Y	32	37	38½	38½	41
Size						
Steam Inlet		6	7	7	7	8
Exhaust		18	20	22	22	23
Air Pump		22 x 16	22 x 18	24 x 18	24 x 19¼	26 x 21
Bilge Pump		4 x 16	4 x 18	5 x 18	5 x 19¼	5 x 21



Large Engine

TABLE OF DIMENSIONS

Large Engines

Steam Engine		27½-46-78 x 48	27½-46-78 x 51	27½-46-78 x 54	30-51-86 x 51	30-51-86 x 54
Dimension	A	84	84	84	95	95
"	B	102	102	102	110	110
"	C	37⅜	37⅜	37⅜	40½	40½
"	D	37⅜	37⅜	37⅜	40½	40½
"	E	33⅜	33⅜	33⅜	50⅝	50⅝
"	F	130	130	130	134	134
"	G	60	60	60	62½	62½
"	H	60	60	60	62½	62½
"	I	152	152	152	178½	178½
"	J	260¾	260¾	260¾	286	286
"	K	458	458	458	508	508
"	L	17¼	17¼	17¼	18½	18½
"	M	35½	35½	35½	38	38
"	N	44¼	44¼	44¼	48¼	48¼
"	O	51½	51½	51½	53¾	53¾
"	P	35	35	35	36	36
"	Q	146½	154	161½	155½	163
"	R	83¾	86¾	89¾	86¾	89¾
"	S	33⅜	33⅜	33⅜	34	34
"	T	77½	77½	77½	77½	77½
"	U	101½	101½	101½	101½	101½
"	V	77½	77½	77½	77½	77½
"	W	213	213	213	214	214
"	X	108	114	120	114	120
"	Y	45	45	45	48	48
Steam		9	9	9	10	10
Exhaust		27	27	27	30	30
Air Pump		28 x 22½	28 x 24	28 x 25½	30½ x 24	30½x25½
Bilge Pump		5 x 22½	5 x 24	5 x 25½	6 x 24	6 x 25½

Large Triple Expansion Engines

The bedplate is of heavy construction with six girders for supporting the main bearings.

The main bearings are babbitted, with flat bottom shoes and separate caps, the lower shoes being fitted with removable half round shells.

The crank shaft is a forging built up in three interchangeable sections.

The connecting rod is of forged steel and of the standard marine type.

The crosshead guide is of the double slipper type, and the crosshead is a steel forging with slippers of cast iron lined with bearing metal and bolted to it.

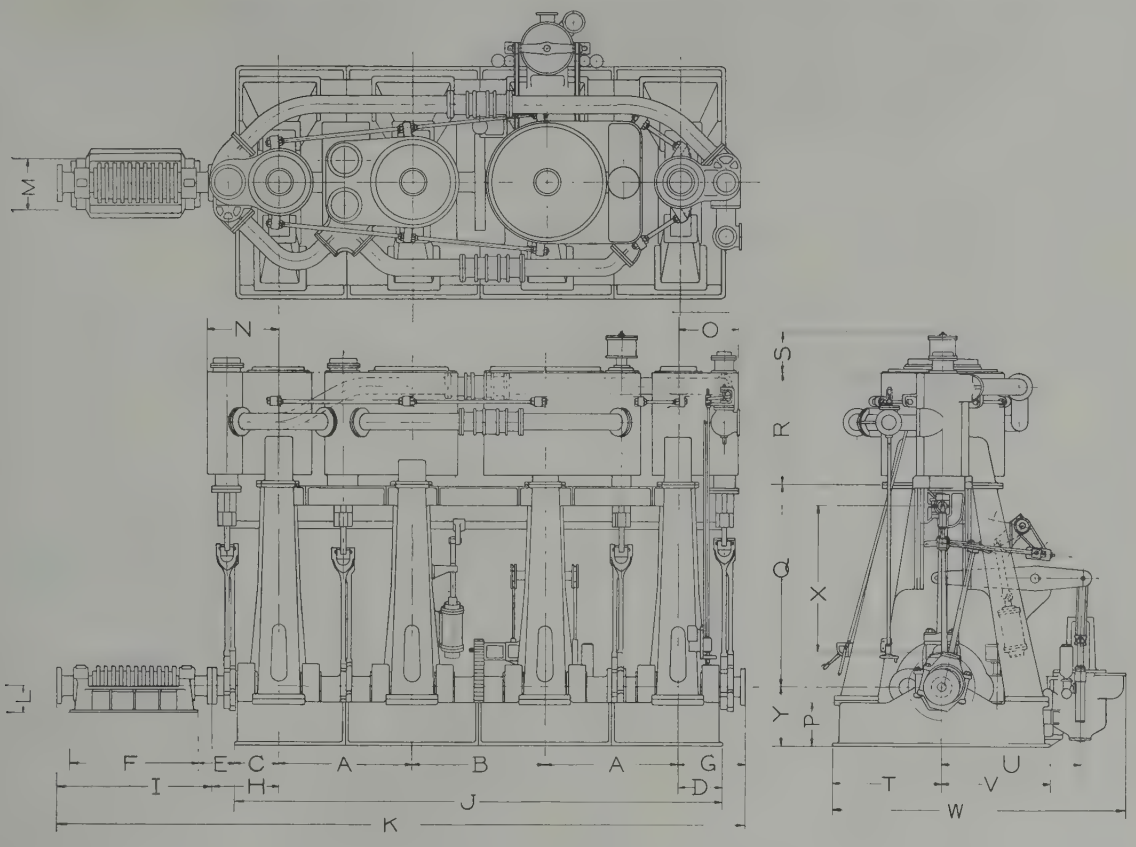
The piston rods are steel forgings and are interchangeable.

The throttle valve is of the poppet type and fitted with butterfly valve, both being operated from the starting platform.

The thrust shaft is of forged steel, and the thrust bearing is of the horseshoe type.

Guards are fitted where required for protection.

By-pass and drain piping is fitted to cylinders and operated from working platform.



Quadruple Engine

Quadruple Expansion Engines

The bedplate is of heavy construction with eight cross girders for supporting the main bearings.

The main bearings are babbitted, with flat bottom shoes and separate caps. The lower shoes are fitted with removable half round shells.

The crank shaft is a forging built up in four interchangeable sections.

The crosshead guide is of the double slipper type and the crosshead is a steel forging with slippers of cast iron lined with bearing metal and bolted to it.

The piston rods are steel forgings and are interchangeable.

The connecting rods are of forged steel and are of the standard marine type.

The throttle valve is of the poppet type and fitted with butterfly valve, both being operated from the starting platform.

The thrust shaft is of forged steel, and the thrust bearing is of the horseshoe type.

Guards are fitted where required for protection.

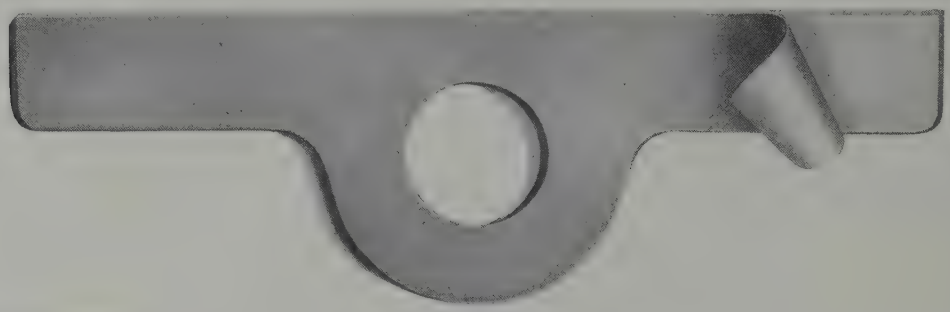
By-pass and drain piping is fitted to cylinders and operated from the working platform.

TABLE OF DIMENSIONS

Quadruple Engines

Size of Engine		24½–36–53–78x51	24½–36–53–78x54	27½–40–59–86x54	30–43½–64–93x54
Dimension	A	96¾	96¾	102	113
"	B	81	81	85½	93
"	C	35	35	37⅝	39½
"	D	35	35	37⅝	39½
"	E	38⅛	38⅛	38⅜	48
"	F	130	130	138½	145
"	G	56¼	56¼	59¼	68½
"	H	56¼	56¼	59¼	68½
"	I	163	163	172½	178½
"	J	334½	334½	363½	404
"	K	550	550	574½	638½
"	L	17¼	17¼	18½	19
"	M	35½	35½	37	38
"	N	56⅜	56⅜	59¾	63
"	O	48¾	48¾	52½	54
"	P	35	35	36	36
"	Q	154	161½	163	165
"	R	86¾	89¾	89¾	89¾
"	S	33⅜	33⅜	34	34
"	T	75	75	76	76
"	U	95	95	98¾	99½
"	V	74	74	76	76
"	W	201½	201½	209	211
"	X	114	120	120	120
"	Y	45	45	48	48
Size Steam Inlet		8	8	9	10
Exhaust		27	27	30	34
Air Pump		28 x 24	28 x 25½	30½x25½	33 x 25½
Bilge Pump		5 x 24	5 x 25½	6 x25½	6 x 25½

Laminated Shims



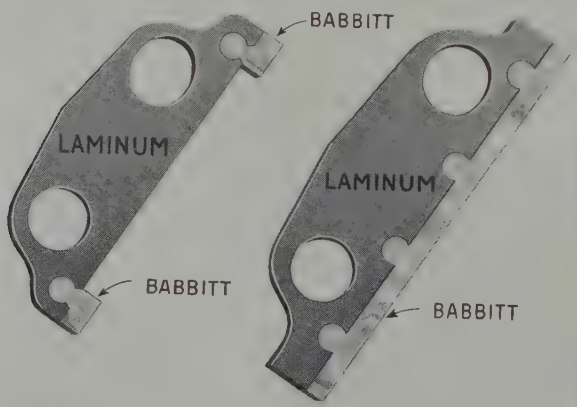
Choice of Shims

In selecting Shims for the adjustment of bearings, choice must be made from the three existing types, i. e., solid, loose-leaf or Laminum. The solid shim requires time for filing and scraping. The work must be done by an expert mechanic and there is always the opportunity for inaccuracy in thickness and the lack of an even surface.

The Laminated Shim

The Laminated shim is without doubt or question the most efficient shim obtainable. This is borne out by the fact that leading engineers in all industries have adopted the Laminated shim. Laminum, as the name implies, is composed of innumerable thin layers of hard brass, held together by a metal binder. These layers are made in two thicknesses, .002″ and .003″.

The surface of a Laminated shim is as smooth as glass. There is a perfect adjustment always. Costly time and labor are quickly conserved and a much better job results. Laminated shims are endorsed by



leading marine-engine builders, marine engineers and ship builders generally because no other shim is so well adapted for the purposes required. During the war Laminated shims were extensively used by the Allied Governments.

Laminum may also be obtained with Babbitt facing. Where there is an all-Babbitt bearing required, Babbitt-faced Laminum immediately becomes the shim to use.

Other Types Waste Time

The process of making a true solid shim is expensive and wasteful of both time and labor. The loose-leaf shim likewise has its disadvantages. Dirt and grease seep in the layers and work out under pressure, often resulting in a loose bearing. Besides, the loose-leaf shim necessitates time for assembling.

Laminum A Time Saver

By peeling off successive layers, a perfectly smooth, solid, uniform and accurate shim is quickly obtained and at an exact thickness.

Laminated shims can be made as easily as lifting a sheet of paper from a pad.

Branch Office and Agencies

Samples of and information concerning Laminum may be obtained by applying direct to the manufacturer or to the branch office and agencies listed below:

Detroit, Mich.: Dime Bank Bldg.
St. Louis, Mo.: Mazura Mfg. Co.
England: R. A. Rothermel, 24-26 Maddox St., Regent St., London, W. I.

LAMINATED SHIM COMPANY

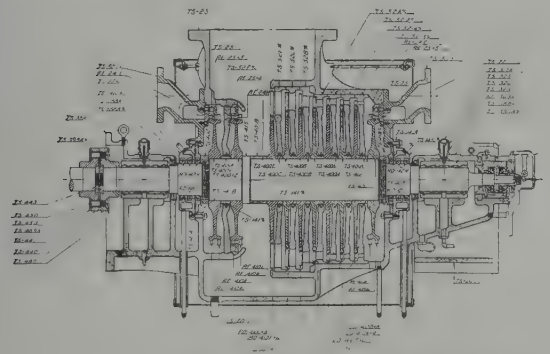
533 CANAL ST., NEW YORK, N. Y.

De Laval Marine Steam Turbines and Gears

De Laval Turbines and Gears

The De Laval Turbines and Gears have been developed and standardized through a period of 25 years. The De Laval Marine Steam Turbine is of the multi-stage type and consists of a series of impulse wheels, each running in a separate compartment. The expansion of the steam is accomplished entirely in the nozzles. Since the steam pressure is the same on both sides of each wheel, theoretically no axial thrust is transmitted to the shaft. Likewise there is no leakage over the tips of the buckets or vanes, making close clearances unnecessary. The lubrication is automatic. All parts are accessible upon lifting the casing cover.

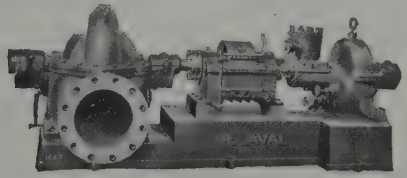
De Laval Marine Steam Turbine with Double-Reduction Gears; 1,500 H.P.; 90 R.P.M.



De Laval Marine Turbine. Each Part Is Made to Limit Gages and Is Stamped with an Identifying Symbol, as Indicated

De Laval Speed Reducing Gear

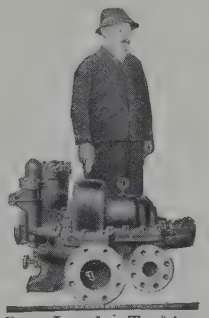
The first De Laval Double-helical Speed-reducing Gear was introduced in 1889. Since that time many hundreds of gears have been produced which are now in successful operation. Correct design, coupled with specially developed methods and a high degree of accuracy in cutting the teeth, insures their satisfactory mechanical operation and silent running. The almost entire absence of wear is proof of their high efficiency in transmitting power.



De Laval Geared Turbine-Driven Centrifugal Condenser Circulating Pump

De Laval Geared Turbines

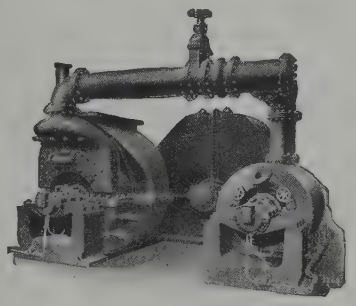
Any requirements in power and speed can be met with De Laval Geared Turbines. Where the conditions demand a ratio of reduction not over 1 to 24, a single reduction is supplied. There may be either one or two pinions. With two pinions, the turbine is divided into high and low pressure sections; both sections can operate on high pressure steam, if necessary, giving a duplicate power plant.



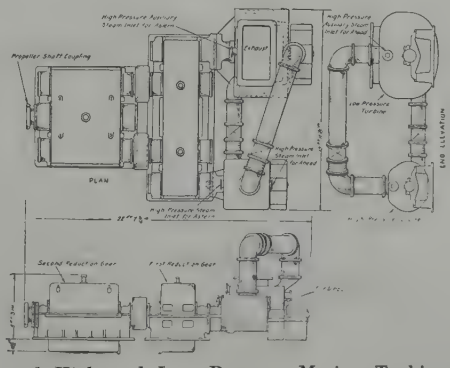
De Laval Turbine-Driven Boiler Feed Pump—Capacity 3,000 H.P.

Other De Laval Products

Steam-turbine-driven auxiliaries are manufactured by the De Laval Steam Turbine Co., as follows: Condenser Circulating Pumps, Centrifugal Boiler Feed Pumps, Bilge and Cargo Pumps, Fire Pumps and Turbo-Generators. Ask for Catalog M-88.



De Laval High and Low Pressure Compound Single-Geared Unit; 2,500 H.P.; 110 R.P.M.



De Laval High and Low Pressure Marine Turbine with Double-Reduction Gear Having Two Intermediate Pinions; 3,000 H.P.; 90 R.P.M.

DE LAVAL STEAM TURBINE CO.

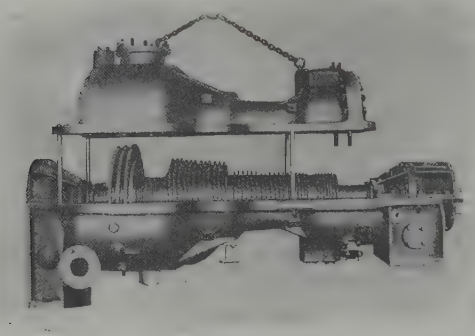
TRENTON, N. J.

Propelling Turbines

Marine Cross-Compound Steam Turbine

The High Pressure and Low Pressure Units of the Cross-Compound 2800 Shaft Horse-power Parsons Turbine shown on this page and the opposite page are manufactured by the Hallidie Company, under license from the Parsons Marine Steam Turbine Company of England.

This Cross-Compound Turbine is of the double reduction gear type, with a turbine speed of 3200 RPM and a propeller shaft speed of 90 RPM.



High Pressure Unit Parsons 2800 S. H. P. Turbine Built by The Hallidie Company

The High Pressure Unit shown in the cut and drawing on this page operates under a steam pressure of 195 pounds. The Low Pressure Unit shown on opposite page takes the steam at 18 pounds pressure absolute after it has passed through the High Pressure Unit, and exhausts into the condenser.

With this Cross-Compound type of Turbine there are two separate turbines each complete in itself and either one or both may be used. These turbines which develop 2800 shaft horsepower have been built to give 11 knots for a 9400 ton steel freighter on the mile trial run, but an average speed of over 12 knots in actual service has been secured in some of the vessels in which these turbines have been installed; and with one turbine only of the pair operating for purpose of test to see what speed could be secured with one unit only, results have been over 8 knots.

Advantages of Turbines for Ship Propulsion

The advantages secured in using Turbines for ship propulsion are as follows:

Saving in space and weight—important items in the design of vessels.

Saving in the cost of installation.

Economy in operation due to the fact that the water rate or steam consumption is only 11½ pounds per horsepower hour.

Requires smaller boilers.

Great saving in fuel.

High Pressure Unit

The cut on this page shows the top half of the casing of the High Pressure Unit raised exposing the rotor with the blading in place.

The Ahead Turbine is the long section of the rotor on the right-hand side of the cut and is of the Parsons standard reaction type.

The Astern Turbine which is on the same shaft and in the same case is shown on the left-hand side of the cut and is of the Parsons standard impulse type.

The Rotor is a solid forging with the impulse Astern Wheel shrunk on.

The Blading is of special rolled bronze cut from the bar.

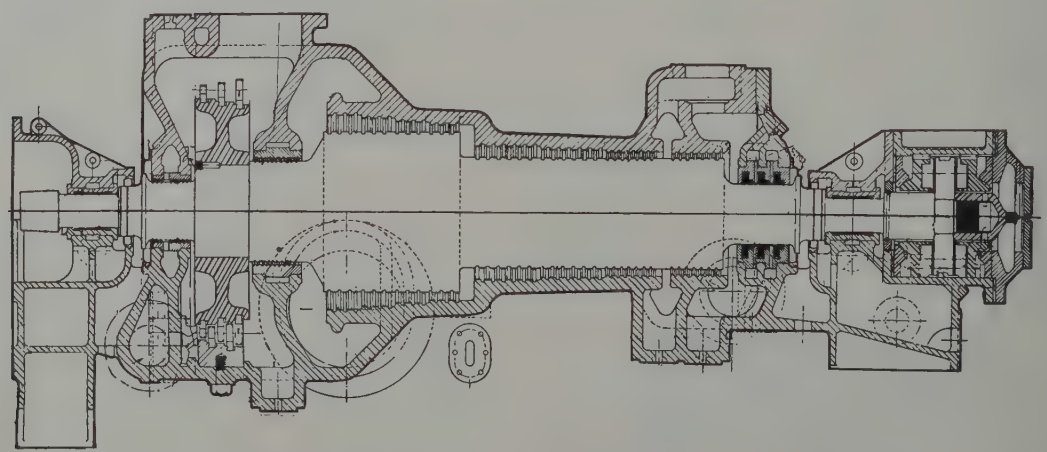
The Cylinders or Casings are of cast iron.

Net weight—14,800 pounds.

Length Overall—10 feet.

Width Overall—4 feet.

Height Overall—4½ feet.



General Arrangement of the High Pressure Unit of the Cross-Compound 2800 Shaft Horse-Power Parsons Turbine

HALLIDIE COMPANY, SPOKANE, WASHINGTON

Propelling Turbines

The General Arrangement Drawing on this page gives the details and shows the compact arrangement and the sturdy construction of the Low Pressure Unit of the Cross-Compound 2800 Shaft Horsepower Parsons Turbine.

Low Pressure Unit

The cut on this page shows the top half of the casing of the Low Pressure Unit raised exposing the rotor with the blading in place.

The right-hand end of the rotor is the Ahead Turbine with the Parsons standard reaction type blading and the left-hand end is the Astern Turbine with the Parsons standard impulse type blading.

The Rotor is a solid forging with the impulse Astern Wheel shrunk on.

The Blading is of special rolled bronze cut from the bar.

The Cylinders or Casings are of cast iron.

Net weight—15,800 pounds.

Length Overall—7 feet.

Width Overall—5½ feet.

Height Overall—4½ feet.

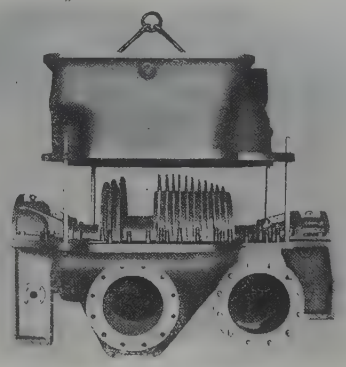
The General Arrangement Drawing shown below gives the detail dimensions, and shows the compact arrangement and sturdy construction of the Low Pressure Unit 2800 Shaft Horsepower Parsons Turbine.

Turbine Building Facilities

The Parsons Turbine is, of course, well known and no argument is necessary as to design, and in the matter of construction we can refer you to a number of very successful installations of our manufacture now in service and giving best of satisfaction.

Our excellent designing staff, well equipped Turbine shop and trained and experienced mechanics insure the maintaining of the high standard of production produced in the past.

We have other designs of turbines and we are prepared to build them in almost any size.

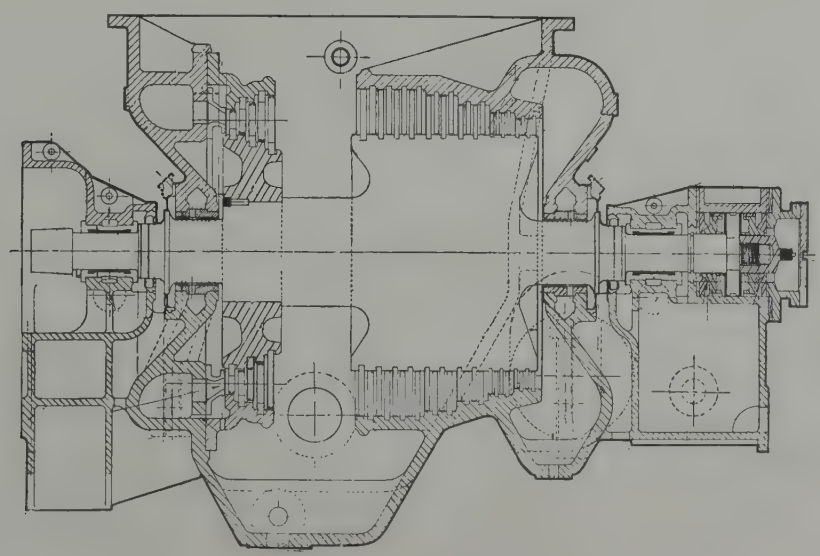


Low Pressure Unit—Parsons 2800 S. H. P. Turbine Built by The Hallidie Company

Other Products

We also build Marine Reciprocating Engines including Compound, Triple and Quadruple and in all the principal sizes.

Also deck machinery including Winches and Anchor Windlasses.



General Arrangement of the Low Pressure Unit of the Cross-Compound 2800 Shaft Horse-Power Parsons Turbine

Westinghouse Facilities

Westinghouse Electric & Manufacturing Co., South Philadelphia Works

Westinghouse—The Institution

George Westinghouse in 1881 founded at East Pittsburgh, Pa., the Westinghouse Machine Company, followed by the Westinghouse Electric Company in 1886, the two developing in parallel in the fields of prime movers and applied electricity until their merger in 1916 under the name of "Westinghouse Electric & Manufacturing Company", an organization whose influence is felt in every line of electrical and prime mover endeavor.

To Westinghouse belongs the credit for having placed electric lighting on a commercial basis, for having made possible the cheap and efficient long distance transmission of power by the development of the alternating current system and the induction motor, the first high speed compound engines and the first gas engines of commercial size for lighting and power generation.

In 1896, Westinghouse secured patent rights on Parsons turbines and in 1899 built the first commercial installation in this country, in 1900 taking the world lead in turbine production by building a successful installation at least twice as large as any that had been built anywhere up to that time.

This was followed by the development of the Westinghouse Combination Turbine, involving the best points of both Curtis and Parsons types. The latest accomplishment is the installation of a 70,000 KW turbo-generator set with a water rate of 10.75 lbs. per KW hour, probably the largest and most efficient generating unit ever built.

To Westinghouse must also go the credit for visioning the possibility of the marine turbine with reduction gear, and for having done a great part in the work of development and application of this idea: for having produced the apparatus which made possible the harnessing of Niagara Falls; for having given to the world the first induction watthour meter; for having helped largely to bring electric railroading to its position of commanding importance, and for having done countless other acts and made countless other contributions effecting man's well being through the mechanical and electrical sciences.

The Westinghouse Plants

An idea of the size and scope of this institution may be suggested by a few figures:

To traverse the entire East Pittsburgh Works requires a walk of over ten miles.

This plant employs over 30,000 people, consumes over 400 tons of coal per day, has a total floor space exceeding 91 acres, a power house with a capacity of 20,000 H. P., a payroll averaging over $2,500,000 monthly, monthly shipments exceeding 1,000 carloads and uses a total of 108 electric traveling cranes in capacities of 1 to 100 tons.

In addition to the Works at East Pittsburgh, the Company owns a plant at South Philadelphia, Pa., covering 500 acres of ground along the Delaware River, and employing 3,500 persons, where marine propelling equipment and auxiliaries are made. This plant is being constantly enlarged to care for a rapidly growing marine business, part of which is still handled by the East Pittsburgh Works.

The Westinghouse Company also operates eleven other manufacturing plants, with an additional operating force of approximately 10,000 employees.

The Westinghouse Company is equipped to supply, in any quantity, almost any form of electrical apparatus from electric lights to propelling equipment or power plant installations for shipboard or ship yard work, and the best type of steam power apparatus.

Research and Experimental Work

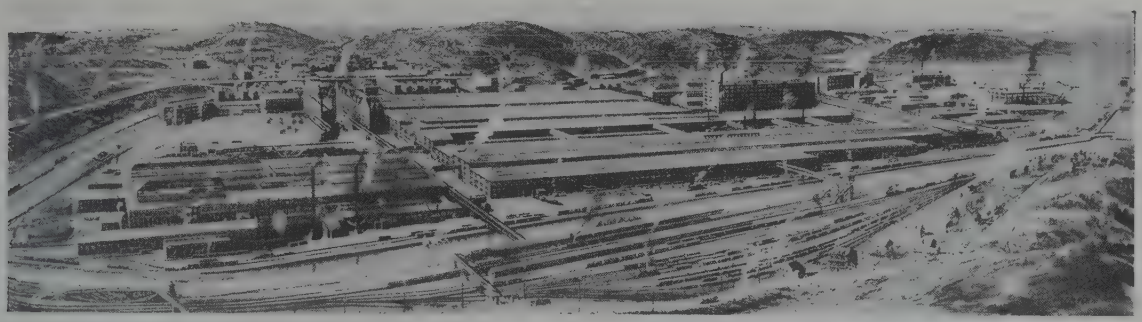
Comprising one of the largest manufacturing organizations in the world, the Westinghouse Company employs a large force of research and experimental engineers, insuring not only that the best apparatus can be turned out in large quantities, but that the possibility and characteristics of the apparatus will be fully understood; that not only will the equipment give the best service, but that customers will have the advantage of the latest discoveries and inventions in the field of electric and power development, in which field Westinghouse is constantly a pioneer.

WESTINGHOUSE ELECTRIC & MFG. CO.

EAST PITTSBURGH, PA.

Address nearest office. For list of offices see opposite page.

Westinghouse Classes of Apparatus



Westinghouse Electric & Manufacturing Co., East Pittsburgh Works

Classes of Apparatus

The Westinghouse Company manufactures complete lines of steam and electrical apparatus for shipboard and for shipyard installations. A condensed list of equipment and materials follows.

District Offices

The Company maintains district offices in the following cities. Marine divisions have been established in certain offices as indicated by an asterisk. The nearest district office should be addressed.

CONDENSED LIST OF EQUIPMENT

Air Ejectors
Battery Charging Outfits
Brakes, Electric
Circuit Breakers
Condensers, Steam
Condenser Auxiliaries
Connectors, Frankel Solderless
Controllers, Motor
Gears, Bakelite Micarta
Generators, Electric
Heaters, Electric
Insulating Materials, Electrical
Insulators Porcelain, Glass and Moulded
Lamps, Arc
Lightning Arresters
Lighting Systems
Motor Generator Sets
Rectifiers, Mercury Arc
Reduction Gears
Rotary Converters
Steam Turbines
Stokers
Switchboards
Switches, Knife, Oil and Krantz Safety
Transformers
Engine Generator Sets
Fans
Fuses
Locomotives, Electric
Meters, Electric
Motors, Electric
Turbine Generator Units
Tools, Portable Electric
Ventilating Sets, Motor Driven
Welders, Electric

DISTRICT OFFICES

Atlanta, Ga.
Birmingham, Ala.
Charlotte, N. C.
Chattanooga, Tenn.
New Orleans, La.
*Boston, Mass.
Buffalo, N. Y.
Rochester, N. Y.
Syracuse, N. Y.
Chicago, Ill.
Milwaukee, Wis.
Minneapolis, Minn.
Cincinnati, Ohio.
Dayton, Ohio.
Indianapolis, Ind.
Louisville, Ky.
Dallas, Texas.
Denver, Colo.
Salt Lake City, Utah.
Detroit, Mich.
Toledo, Ohio.
*Los Angeles, Cal.
El Paso, Texas.
Tucson, Ariz.
*New York, N. Y.
*Philadelphia, Pa.
Baltimore, Md.
Bluefield, W. Va.
Charleston, W. Va.
Wilkes-Barre, Pa.
Pittsburgh, Pa.
*Cleveland, Ohio.
Columbus, Ohio.
St. Louis, Mo.
Joplin, Mo.
Kansas City, Mo.
Memphis, Tenn.
*San Francisco, Cal.
*Seattle, Wash.
Butte, Mont.
Portland, Oregon.
*Washington, D. C.

In addition, Hunt, Mirk & Co., Inc., with offices at San Francisco, Seattle and Los Angeles are special representatives on the Pacific Coast.

*Has a Marine Division.

WESTINGHOUSE ELECTRIC & MFG. CO.

EAST PITTSBURGH, PA.

Address nearest office. For list of offices see above

Westinghouse Marine Propelling Turbines

Cargo Carrier "New Windsor" Equipped with Westinghouse Geared Turbines

Marine Propelling Turbines

The steam turbine has replaced the reciprocating engine in land service. The greater economy, tremendous saving in space and weight for units of equal power, simplicity and small number of moving parts, and the few repairs needed, has won the most conservative engineers to specify turbines for all new installations.

The Westinghouse Company was one of the first manufacturers of turbines in this country, and has produced turbines that have given the highest economies of any steam turbine or engine ever built in commercial sizes.

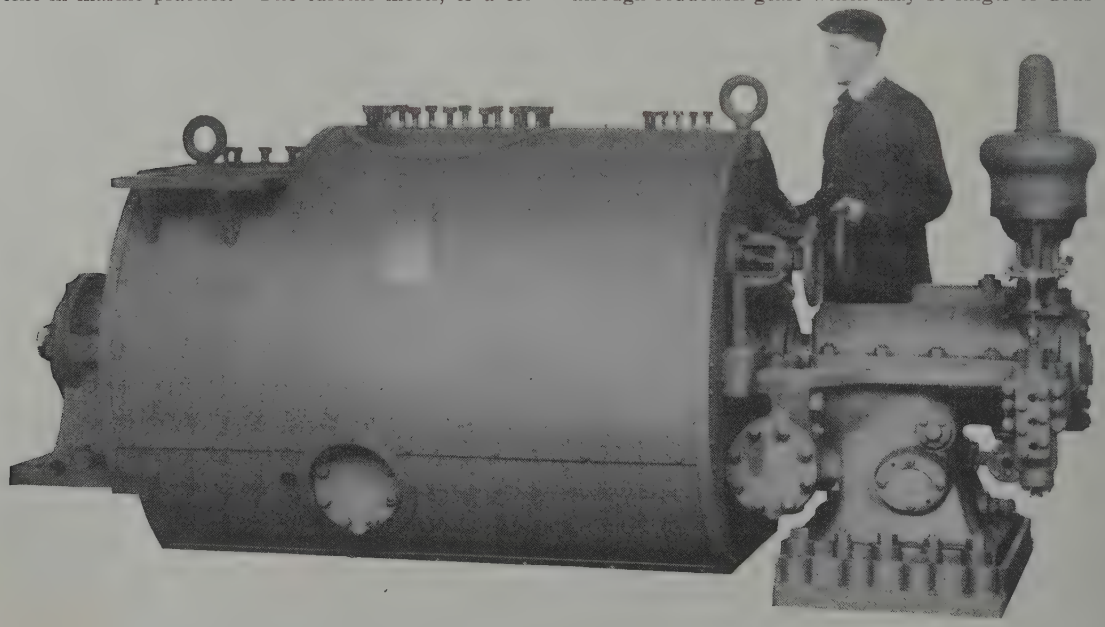
The same advantages apply to an even greater extent in marine practice. The turbine meets, to a certain extent, the same opposition from conservatives that it did on land, but is steadily making headway against it, so that all new naval vessels, and most modern steamers are using turbine drive.

Method of Application

Turbine power may be applied to drive propelling shafting in the following ways:

(a) Direct Drive. Turbine connected directly to propeller shaft. This requires a large slow speed turbine, which speed gives such poor efficiency for both turbine and propeller, as to be prohibitive except for high speed vessels.

(b) Gear Drive. Turbine operates at most efficient speed and reduces to most efficient propeller speed through reduction gears which may be single or double



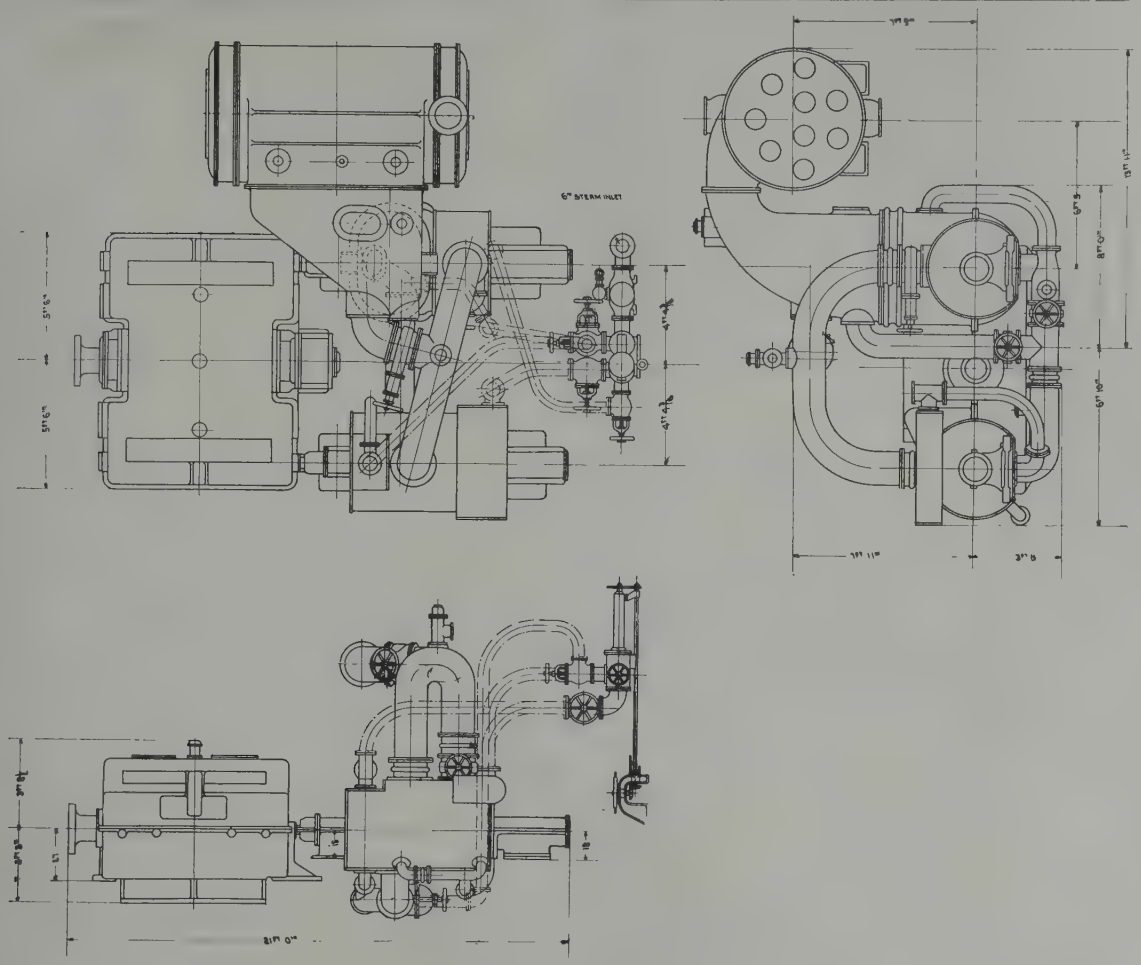
Westinghouse Propelling Turbine

WESTINGHOUSE ELECTRIC & MFG. CO.

EAST PITTSBURGH, PA.

Address nearest office. For list of offices see page 925

Westinghouse Marine Propelling Turbines



Cross Compound Layout
3,000 S.H.P. Unit

reduction, according to speed ratios between turbine and propellers.

(c) Turbine-Electric Drive. Propeller shafts are driven by direct connected motors at efficient speeds. Power is supplied by turbo-generator running at the efficient higher speed of the turbine, the reduction being electrical. Smaller electrical units may be employed by a reduction gear between motor and shaft for slow speed vessels.

Advantages of Turbine Drive

(a) Economy. The fuel cost, greatest item of operating expense, is directly proportional to water rate. Hence, turbine economy of from 18 to 25% better than that for reciprocating engines means a great direct saving in operating expenses. In addition, the decreased space required for fuel means greater available cargo carrying space.

(b) Light Weight and Compactness. The steam turbine is the lightest and most compact prime mover known. This is especially advantageous where displacement and cargo space are vital consideration.

(c) All motion in turbine machinery is rotative. There is complete absence of the vibration encountered, with the attendant stresses and strains that are always present with even the most carefully balanced reciprocating engines. The decrease in noise is also an advantage.

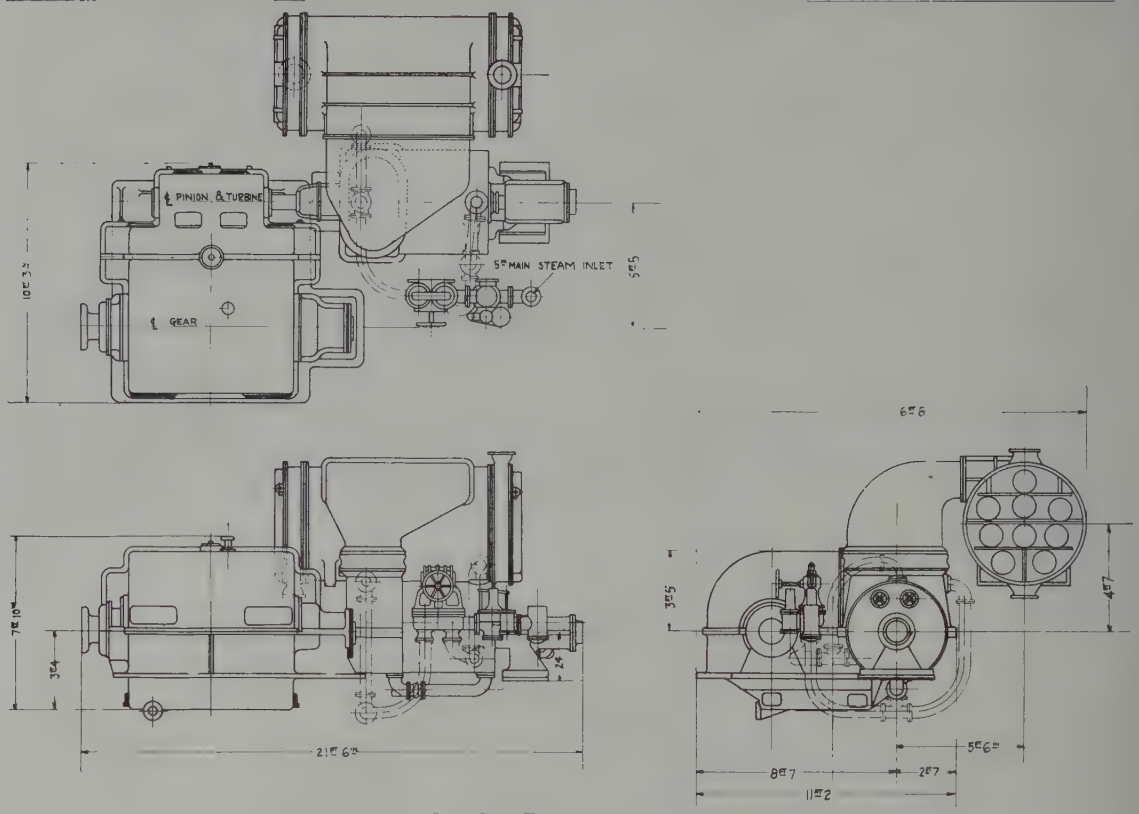
Types of Turbines and Their Advantages

(a) Cross compound turbines, consisting of a high and a low pressure turbine, operating through a 2-pinion gear, give the best steam economy, from 2 to 6% better than a complete expansion unit. An additional advantage is that one turbine may be completely cut out, and propeller operated by remaining turbine, insuring that a single screw vessel will not be helpless if one turbine is shut down for repairs or by accident, but can proceed at reduced speed.

(b) Complete Expansion. While the water rates are not quite so favorable, the floor space occupied is less and the turbine steam piping is much simplified. These are usually used on small power vessels or on electric generator drive.

(c) Double Flow, Divided Flow, and Special Combinations may be designed to suit special conditions of speed or space requirements.

Westinghouse Marine Propelling Turbines



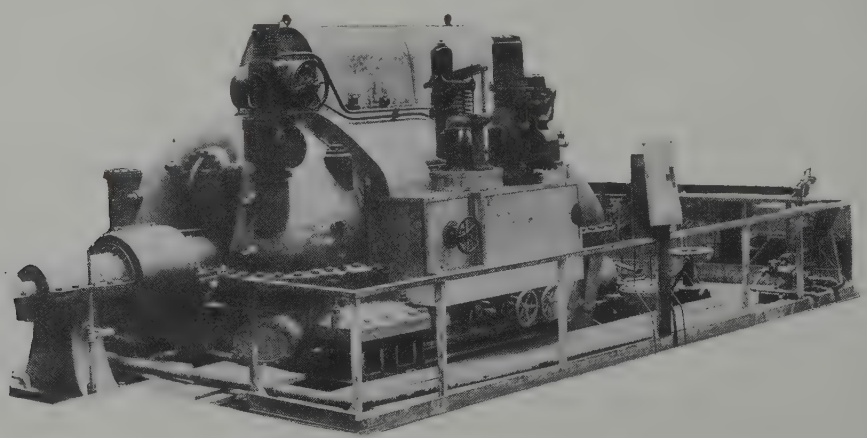
Complete Expansion Layout
1,800 S.H.P. Unit

Special Features and Advantages

(a) The Parsons or Reaction Type Blading is the most efficient, its chief disadvantage being the length of spindle required for the small high pressure blading in which blading also takes place the greatest steam leakage.

Curtis elements mean a much shorter turbine, although due to disc friction and other causes the efficiency is not so high.

The Westinghouse principle combines the advantages and eliminates much of the objections to the two. The small reaction blading of the first stages is replaced by a two row Curtis or impulse stage, cutting down the length by 25%, and making, if anything, better economy, at least in most turbines below 5000 H. P., for although the reaction turbine as a whole is the most efficient, it is the least efficient part of this blading that is replaced, the result being better than either a straight impulse or straight reaction type alone.



Turbine of U. S. Battleship "Tennessee" on Testing Floor

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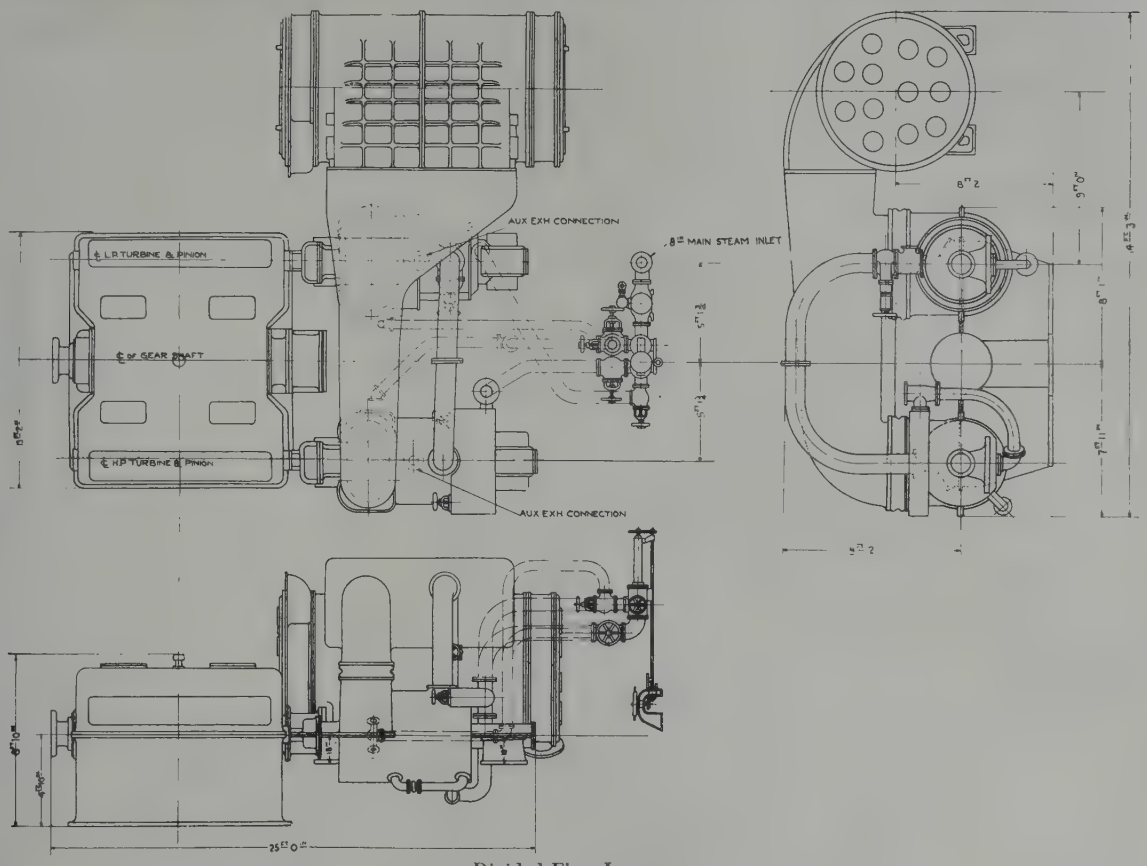
Westinghouse Marine Propelling Turbines



Divided Flow Layout
5,000-6,000 S.H.P. Equipment

The excellent water rates obtained by Westinghouse turbines, especially the cross compound type, makes them the most economical form of steam propelling machinery, the result showing up immediately in the fuel bill. The significance of this item is seen when it is found that a change of 1% in economy of our standard merchant type equipments amounts to an invested capital equal to approximately 10% of the cost of the equipment. In other words, a buyer could afford to pay up to 10% increase in cost price to save 1% in water rate.

Water rates obtained with Westinghouse turbines have varied from 8.95 lbs. per brake horse-power hour to 12.3 lbs. per brake horse-power hour, depending upon the steam and operating conditions of the unit.

(b) Governor Controlled Turbine. In addition to the usual safety overspeed stop Westinghouse Turbines are also equipped with a new oil pressure or steam pressure governor, which, while it allows hand regulation of speed, prevents normal overspeed or racing when propeller comes out of water, but without having to be reset after functioning. In other words, its action is continuous and automatic as a flyball governor, but only prevents overspeeding. Thus no operator is required constantly at the throttle during rough weather and screw speed is constant.

(c) Maneuvering Valve. By a patented interconnection, the movement of a single handwheel controls both ahead and astern movement, making convenient and rapid control.

(d) Drum Type Construction of Rotor. The blades are mounted on a hollow cylinder of large diameter which forms the shaft, descreasing the danger of critical speeds that exist when blades are mounted on separate rotors, which must in turn be mounted on an ordinary shaft of small diameter.

(e) Patented Blade Construction. The blades are assembled in a dove-tailed slot, thus making a positive joint. The blades are also reinforced at the roots, decreasing vibration in the steam currents.

(f) Water Glands for Packing. These are in the form of small centrifugal pumps, keeping a small body of water under continuous pressure to act as packing, and eliminating all rubbing contacts and steam leakage.

The Importance of propelling equipment usually make desirable such changes of design necessary to meet customer's peculiar conditions of steam and speed to give best economy. Thus no standard designs can be recommended to meet all conditions, but if customer outlines his requirements the company is able to bring to bear on this problem a broad experience and knowledge of turbine application, and submit recommendations, performance and outline drawings of the best design of equipment.

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Weights and Engineering Data

In the preceding pages are shown the outlines of some of our standard types of apparatus with dimensions of same. Below are given the weights of these units, and their water rates, at various conditions of steam and exhaust vacuum. The Naval Architect should note, however, that increases in power do not necessarily cause proportional increases in dimensions or weights, as efficiencies, steam conditions and manufacturing consideration influence size and type, and while the examples may do for preliminary layout, investigation by Westinghouse engineers may cause them to recommend a better, less expensive or more efficient type of apparatus of different design. It should also be borne in mind that water rates and economy improve as the capacity and size of unit increases.

WEIGHTS AND WATER RATES ON THREE STANDARD SIZES OF WESTINGHOUSE MARINE EQUIPMENT

COMPLETE EXPANSION TYPE 1,500-1,800 S. H. P.

For layout see page 928.

Weights		*Water Rates; Lbs. per S. H. P. per Hour.					
		Throttle Pressure, 200 lbs. per sq. in.			Throttle Pressure, 250 lbs. per sq. in.		
Apparatus	Pounds	Suph't	28 in. vac.	28½ in. vac.	Suph't	28 in. vac.	28½ in. vac.
Main Turbine	19,500						
Reduction Gear	65,000						
Piping, Valves, etc.	2,400						
Condenser	20,000	0°	12.8 lbs.	12.5 lbs.	0°	12.3 lbs.	12.0 lbs.
Condenser Pumps, etc.	6,500	50°	12.1 lbs.	11.9 lbs.	50°	11.7 lbs.	11.4 lbs.
		150°	10.8 lbs.	10.8 lbs.	150°	10.7 lbs.	10.4 lbs.

*Water Rates given include all gear losses, and are for main units only.

CROSS COMPOUND TYPE 2,500-3,000 S. H. P.

For layout see page 927.

Weights		*Water Rates; Lbs. per S. H. P. per Hour.					
		Throttle Pressure, 200 lbs. per sq. in.			Throttle Pressure, 250 lbs. per sq. in.		
Apparatus	Pounds	Suph't	28 in. vac.	28½ in. vac.	Suph't	28 in. vac.	28½ in. vac.
High Pressure Turbine	14,000						
Low Pressure Turbine	18,000						
Reduction Gear	85,000						
Piping, Valves, etc.	12,000	0°	12.7 lbs.	12.4 lbs.	0°	12.2 lbs.	11.9 lbs.
Condenser	28,000	50°	12.0 lbs.	11.8 lbs.	50°	11.6 lbs.	11.3 lbs.
Condenser Pumps, etc.	9,700	150°	10.9 lbs.	10.6 lbs.	150°	10.5 lbs.	10.3 lbs.

*Water Rates given include all gear losses, and are for main units only.

DIVIDED FLOW TYPE 5,000-6,000 S. H. P.

For layout see page 929.

Weights		*Water Rates; Lbs. per S. H. P. per Hour.					
		Throttle Pressure, 200 lbs. per sq. in.			Throttle Pressure, 250 lbs. per sq. in.		
Apparatus	Pounds	Suph't	28 in. vac.	28½ in. vac.	Suph't	28 in. vac.	28½ in. vac.
High Pressure Turbine	21,500						
Low Pressure Turbine	23,000						
Reduction Gear	105,000						
Piping, Valves, etc.	7,000	0°	11.8 lbs	11.4 lbs.	0°	11.3 lbs.	11.0 lbs.
Condenser	48,000	50°	11.2 lbs.	10.8 lbs.	50°	10.7 lbs.	10.4 lbs.
Condenser Pumps	14,000	150°	10.2 lbs.	9.9 lbs.	150°	9.7 lbs.	9.5 lbs.

*Water Rates given include all gear losses, and are for main units only.

WESTINGHOUSE ELECTRIC & MFG. CO.

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Westinghouse Marine Reduction Gears

Marine Reduction Gears

The helical reduction gear has long proved in land service to be the lightest, most efficient and compact apparatus for transmitting power and reducing speed from the turbine running at its high, most efficient speed, to the low speed at which pumps, certain types of generators, etc., find their best efficiency.

The efficient propeller speed is still lower, from 70 to 150 RPM., making speed reduction imperative for efficient operation. However, gears transmitting large powers at such speeds require exact alignment and perfect tooth bearing surfaces. The twisting of gear frame due to the torsion of the vessel and the propeller shaft, destroy this alignment with the best construction, concentrating pressure on local areas, resulting in broken or worn gear teeth.

This defect was not overcome until the invention of the floating frame pinion, by the late Rear Admiral Melville of the U. S. Navy, and John H. Macalpine of the Westinghouse Machine Company. In this design, the pinion is carried in a frame, which in turn is flexibly supported, allowing the pinion to adjust itself against the gear wheel so as to equalize bearing pressure.

Application

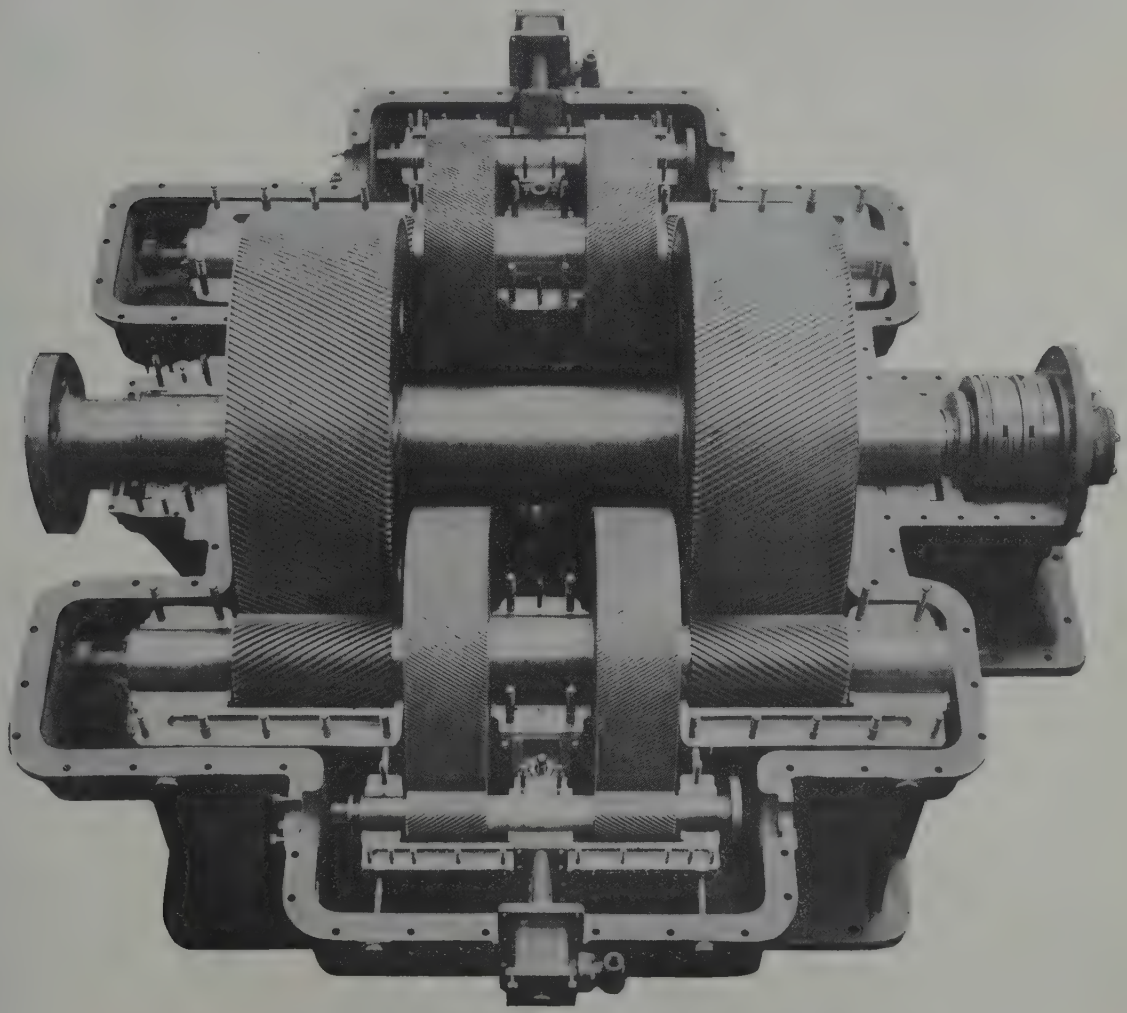
Double reduction, involving two speed reduction, is used on merchant vessels requiring slow propeller speeds. Single reduction gears are used if propeller speeds are high, such as in destroyers or passenger liners.

Advantages of Gear Drive

(a) That it transmits power from turbine to propeller, permitting each to operate at its most efficient speed, has already been mentioned.

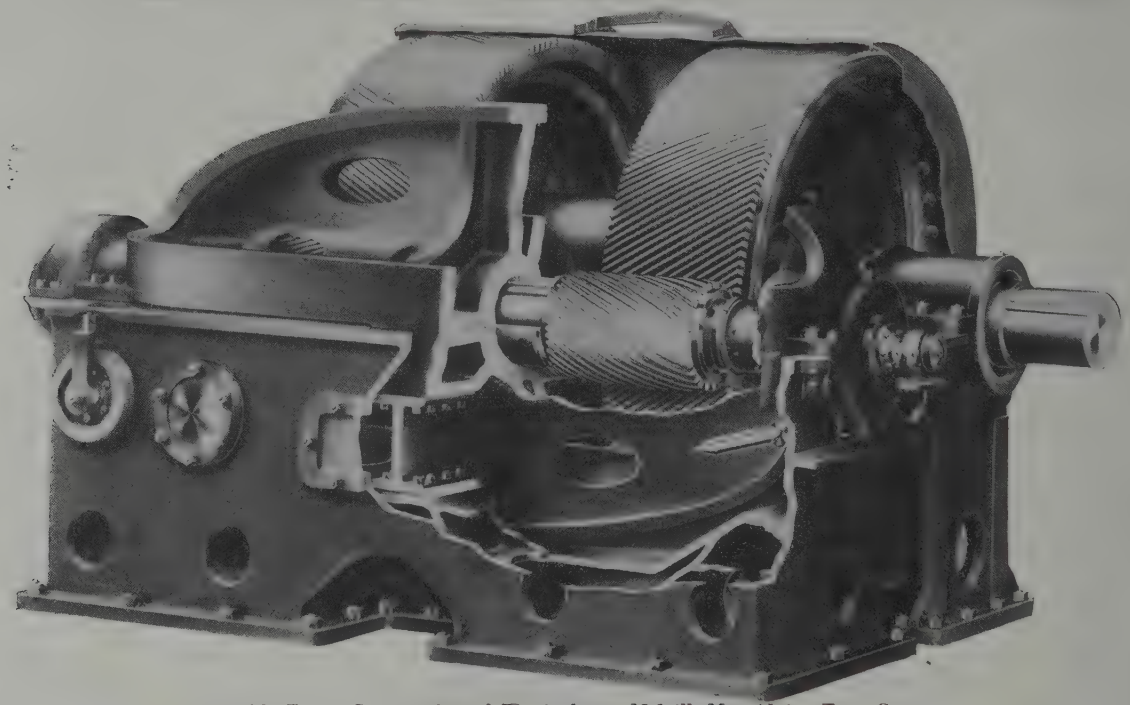
(b) The high turbine speed permitted by its use results in a much smaller, more reliable and economical turbine.

(c) It is the most efficient form of speed reducing transmission, the efficiency of Westinghouse gears being from two to five per cent higher than the best form of electric drive.



Double Reduction Marine Gear. Top View with Cover Removed.

Westinghouse Marine Reduction Gears



Flexible Frame Construction of Westinghouse Melville-Mac Alpine Type Gear

The Melville-Macalpine Floating Frame Gear

(a) Floating or Flexible Pinion Frame. Gear wheel bearings are mounted on solid frame. Pinion bearings carried in rigid frame which, however, is supported or floats either on oil pistons or a flexible I-beam. In case of torsion of gear housing causing uneven alignment, the pinion immediately aligns itself to make even bearing surfaces on teeth, the flexible frame permitting this movement. This equalizes tooth pressures and prevents breaking or undue wearing of teeth.

Quiet Operation. The pinion frame, being connected to main frame through but one flexible connection, or floating on oil, as well as the perfect contact made between pinion and gear, results in the elimination of much of the noise usually generated by gears, making the Westinghouse gear the quietest on the market.

(b) Dynamometer Feature. To know at any time the amount of power being transmitted to propeller is a necessity to any ship operator wishing to obtain data on operating cost. The pressure between pinion and gear teeth is a direct function of the power. With the floating frame supported by the oil pressure of the dynamometer, this pressure, transmitted to a calibrated gauge, shows the horsepower being transmitted at any time.

This feature is special and is not usually incorporated in standard merchant type gears.

(c) Flexible Shaft Connecting Turbine and Pinion. Besides the loose coupling on turbine-pinion connecting shaft to allow longitudinal distortion as vessel flexes, the pinion shaft is bored out and connecting shaft runs through the hollow cylinder thus formed and is connected to pinion shaft at far end, thus allowing a maximum length of flexible connecting metal to provide for lateral distortion without transmitting same to pinion, with most compact arrangement.

(d) Kingsbury Thrust Bearings incorporated with gear housing. This bearing, occupying but a fraction of the space taken by ordinary horseshoe collar thrust bearing, and capable of sustaining many times greater thrust, from 350 to 1000 lbs. per square inch pressure, normal, is usually built directly into gear casing, and attached to gear shaft, using the same oil system that supplies gear. This gives a very compact and convenient arrangement of the highest type of thrust bearing. Bearing is arranged so that it can be examined or repaired without lifting gear cover or dismantling gear in any way.

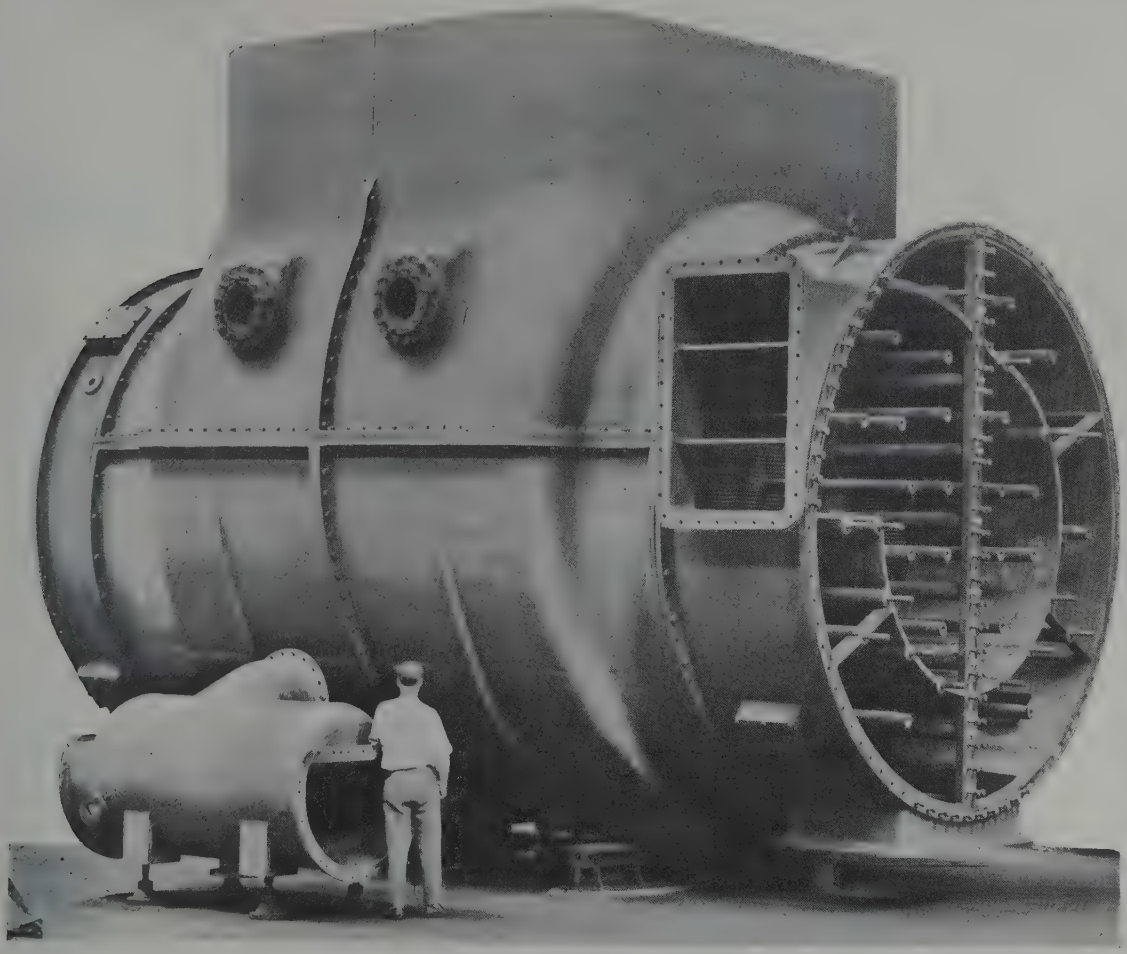
(e) Cast Iron Gear Case. Sheet steel housing with cast iron frame is sometimes used where weight is a matter of importance, but our usual practice is to use cast iron housing, which gives a rigid construction and greatly decreases noise.

(f) Arrangement of Gears. Gears may be arranged in single or in two cases as desired, though the single case is most compact. In tankers, where machinery is located far aft, the gears are often placed ahead of turbines, the longer propeller shaft thus allowed, passing back between the turbines.

Diesel Engine Gears

The same remarks that apply to turbines hold true, though in lesser degree, for Diesel engine drive, i.e., reducing the speed between engine and propeller gives more efficient results and allows a smaller Diesel engine to be used. We can supply gears for this service in any reduction ratio or any size.

Westinghouse Marine Condensers



Comparative View of 50,000 sq. ft. and 1,250 sq. ft. Condensers

Marine Condensing Equipment

Surface Condensers. Surface condenser design is so nearly standard and its proportion of total cost of engine room equipment so small that choice of apparatus becomes mainly a question of auxiliaries and facilities of production. Many shipbuilders desire to build their own condensers. The fact that the Westinghouse Company has had such wide experience in land and marine condensers of all sizes, that it has the best facilities for quantity production, and handling large apparatus, and that much trouble and delay is saved by having the complete engine room units built by one manufacturer, together with the excellent performance of their condensers, makes them a most advantageous proposition.

Design of Condenser. The usual type for marine work is the cylindrical shell, of cast iron or sheet steel, two or three pass, down flow condenser. The shells may be of special shape to fit ship structure.

In large sizes the Westinghouse Company uses a special radial flow design which produces a smaller temperature difference between incoming steam and condensate, the higher condensate temperature causing a distinct saving in feed heating.

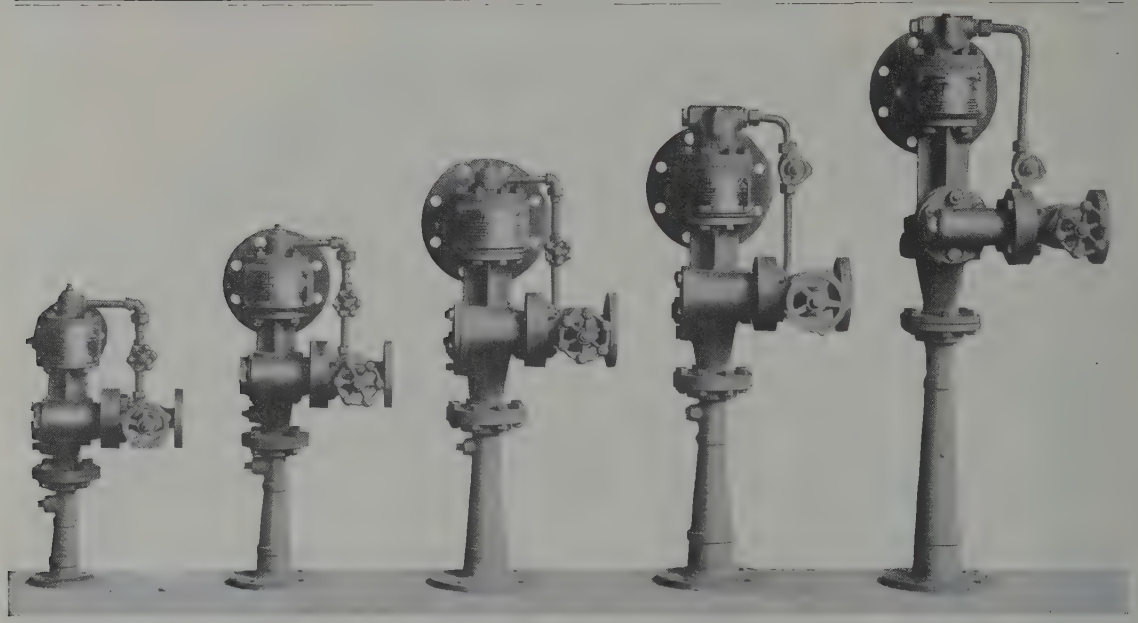
Jet Condensers

For Great Lake or fresh water trade where boiler feed water is drawn directly from the lake, the jet condenser is very practicable. The advantages are—less cost than a surface condenser, simpler apparatus and absence of tube cleaning and tube troubles with leaking or clogging tubes.

Auxiliary Apparatus

Circulating Pumps and Drives. For these the Westinghouse Company uses turbine driven centrifugal pumps of standard design, reducing from the high turbine which gives best efficiency to the lower most efficient pump speed through a reduction gear, the whole being built compactly as one unit. They are built in any capacity within the range of marine requirements.

Westinghouse Marine Ejectors



Range of Sizes of Westinghouse Le Blanc Air Ejectors

Condensate Pumps

These are direct, turbine driven, built in any capacity. The exhaust from the condensate and circular drives may be conducted either to the condensers or to feed water or other heaters.

Air Ejectors, Westinghouse Patent

This is an exclusive feature of Westinghouse equipment. It has high efficiency, and is the most compact air removing apparatus manufactured. There are no moving parts or valves to wear or to get out of order, and no complex system of intercooling.

For a 4,000 sq. ft. condenser, handling 33,500 lbs. of steam per hour, the two ejectors used to maintain 28½" of vacuum, have a total weight of only 216 lbs. One of these is usually sufficient, the other being used as a spare.

Ship Propulsion by Electricity

The Westinghouse Company can also furnish equipment for propelling ships by electricity. The Company on January 1, 1920, had contracts with the U. S. Navy for the following equipment:

3 Battleships	30,000 Horse Power Each.
4 Battleships	60,000 Horse Power Each.
2 Battle Cruisers	180,000 Horse Power Each.

a total of 690,000 horse power. These equipments are most elaborate and while having no close relation to the usual requirements of cargo ships, tugs, and harbor vessels, the statement will readily indicate that the commercial ship requirements present no difficulties from an engineering standpoint.

The usual method of drive is obtained by the use of a main power, usually a turbine drive generator, furnishing power to a reversible slow speed motor, direct connected to the propeller shaft. The following is a description of an electric equipment applicable to the cargo ship requiring around 3000 H.P. per shaft.

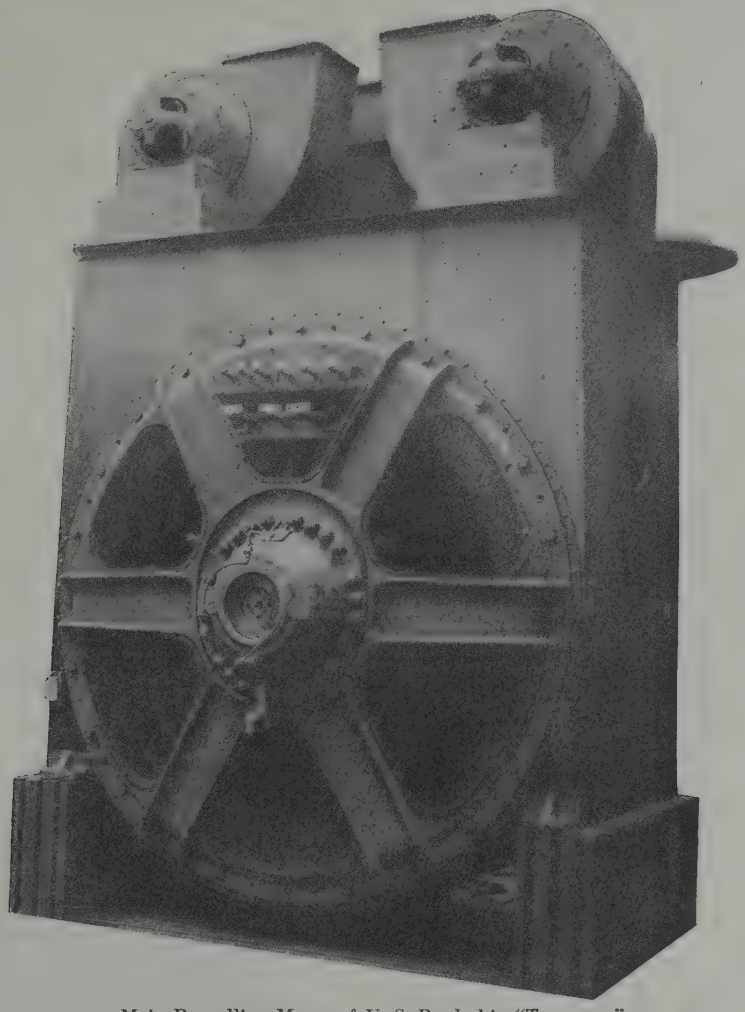
Turbo-Generator Units

The turbine design follows along the line of our usual practice, being of the combined impulse and reaction type, equipped with steam sealed and water sealed glands, automatic throttle valve, hydraulic control governor, and governor controlled valve and maneuvering valve. Automatic means are provided for shutting down the turbine at a pre-determined overspeed and means are also provided for tripping this device by hand.

The generator conforms to standard construction for turbo type generators, except that the windings are especially insulated and impregnated for marine service. The generator is coupled to the turbine by means of a suitable flexible coupling which is designed to take whatever end thrust is produced by the generator due to movements of the ship. This coupling also allows a small amount of misalignment between generator and turbine. The end thrust of the complete unit is taken by a suitable thrust bearing incorporated within the turbine.

Main Motor

The propelling motor, is usually of the wound secondary induction type, with marine type bearings designed to prevent oil from creeping along the shaft or leaking out, due to the movements of the ship. The windings are thoroughly insulated and impregnated before assembly, the insulation of the slot portion of the coil consisting principally of mica. The entire coil is thoroughly impregnated with moisture resisting compound during the



Main Propelling Motor of U. S. Battleship "Tennessee"

process of insulating and baked so as to give a finished product which is impervious to moisture.

In order to stop and reverse the motor quickly it is designed for "plugging" service, i.e., reversing the primary connections while the motors are operating at nearly full speed.

Excitation and Lighting

For exciting the main generator and also supplying power for the ship's lighting system, a small turbine driven generator is furnished. The turbine can exhaust in the main condenser while at sea, or into an auxiliary condenser when in port and the main machinery idle.

Switches and Control

The control stand, which may be located as desired, consists of three levers, one lever controlling the motor reversing switch, the second lever controlling the generator field excitation, and the third lever controlling the steam. These levers are interlocked with one another so that the proper sequency must be followed in starting and maneuvering. The reverser is designed to open the full power of the generator, but under normal conditions will never be opened or closed unless the generator is running at low speed without field.

Operation

In getting the ship under way, the turbine is brought up to slow speed, the reverser is then closed in the ahead direction and the field lever moved to the "on" position. This places power on the motor causing it to speed up. The secondary switches automatically close and short circuit the motor secondary windings, bringing the motor into step with the generator. At this point, a pilot light indicates that conditions are ready for bringing the equipment up to higher speeds which is done by operating the maneuvering valve. The turbine may then be adjusted to the desired running speed.

The same procedure holds true in the reverse direction of operation.

Westinghouse D. C. Turbo-Generators

The condenser equipment and its auxiliaries are no different from that used with the geared turbine propulsion equipment, which had previously been discussed.

Diesel Electric Drive

The Diesel engine electric drive is practically the same as the turbine electric, the Diesel engine replacing the turbine. This requires somewhat larger generators due to the slower engine speed. This method of drive is very adaptable where a multiplicity of direct-current generating units may be used which may be connected in series or multiple or a combination of both, furnishing power to the propelling motor. This affords a greater safety factor, as, in case of accident to any engine unit, operation may still be obtained at reduced capacity from the remaining units.

The electric propulsion of ships, while not completely overcoming the advantages of geared turbine propulsion, present certain advantages, particularly adaptable to certain types of ships and service. We mention the most important points:

The motor may be located in the most adaptable part of the ship regardless of the location of the power plant, without any changes in piping or control equipment.

Full power can be obtained in either ahead or astern operation at practically the same economy.

The control of the electric equipment and its ease of operation is particularly adaptable in ship maneuvering, or service requiring frequent reversal, changes in speed, etc., such as is necessary in operating tugs, fire boats, ferry boats, and other types of harbor vessels.

Westinghouse D. C. Turbo-Generators

The Westinghouse Turbo-Generator has been specially developed for ship lighting plants. It is also suitable for supplying power and light in shipyards and for furnishing current to locomotive crane magnets.

It is designed with the same engineering skill, built with the same care and of the same high grade materials as the large Westinghouse Turbines, which are recognized throughout the world for their excellence.

Simplicity

The Westinghouse Turbo-Generator is a unit of simple, rugged construction, with a minimum of moving parts which in emergency can readily be repaired or replaced locally. It can operate for long periods with minimum attention and few repairs. These features make it particularly adaptable for marine work and for use on locomotive cranes.

The entire set can be taken apart and assembled with ordinary tools.

By removing the cylinder head, the turbine rotor, nozzle, governor mechanism and valve are readily accessible. The upper half of the cylinder may be removed without disturbing the alignment. Ample space in commutator bracket is provided for examination and handling of the brushes.

Switchboard

A switchboard has been designed especially for use with these units. It consists of the necessary switches, fuses, meters, etc., and is especially compact and simple.

This unit has been built to secure maximum reliability and continuity of operation.

Every refinement tending to eliminate operating difficulties developed during many years of experience has been incorporated in the design.

Throughout the design and construction there has been kept constantly in mind the fact that the smaller the unit the less tendency there is to give it the care and attention shown larger pieces of apparatus. As a result, this Turbo-Generator is thoroughly reliable and as fool-proof as it is possible to make a machine of this kind.

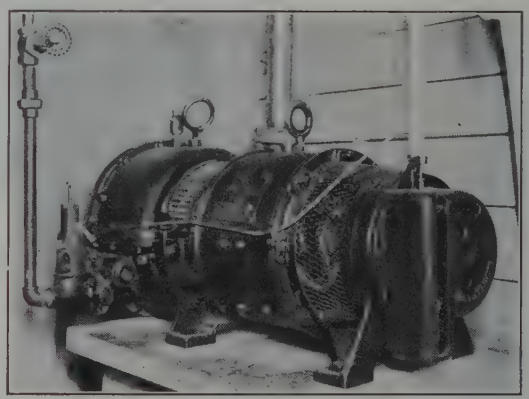
Cylinder. Split horizontally and has a cylinder head similar to that of a reciprocating engine.

Rotor. A single wheel with a single row of blades.

Governor. Direct-driven centrifugal to regulate between no load and full load within 3%.

Armature, Open slots, form wound coils, thoroughly ventilated by fan mounted on shaft.

Reading. Continuous full load with a temperature rise of 50 degrees C. in accordance with A. I. E. E. new rules.



Westinghouse Turbo-Generator Mounted in Engine Room of 88 ft. U. S. Navy Tug

Armature. Open slots, form wound coils, thoroughly ventilated by fan mounted on shaft.

Rating. Continuous full load with a temperature rise of 50 degrees C. in accordance with A. I. E. E. new rules.

Approved by U. S. Government

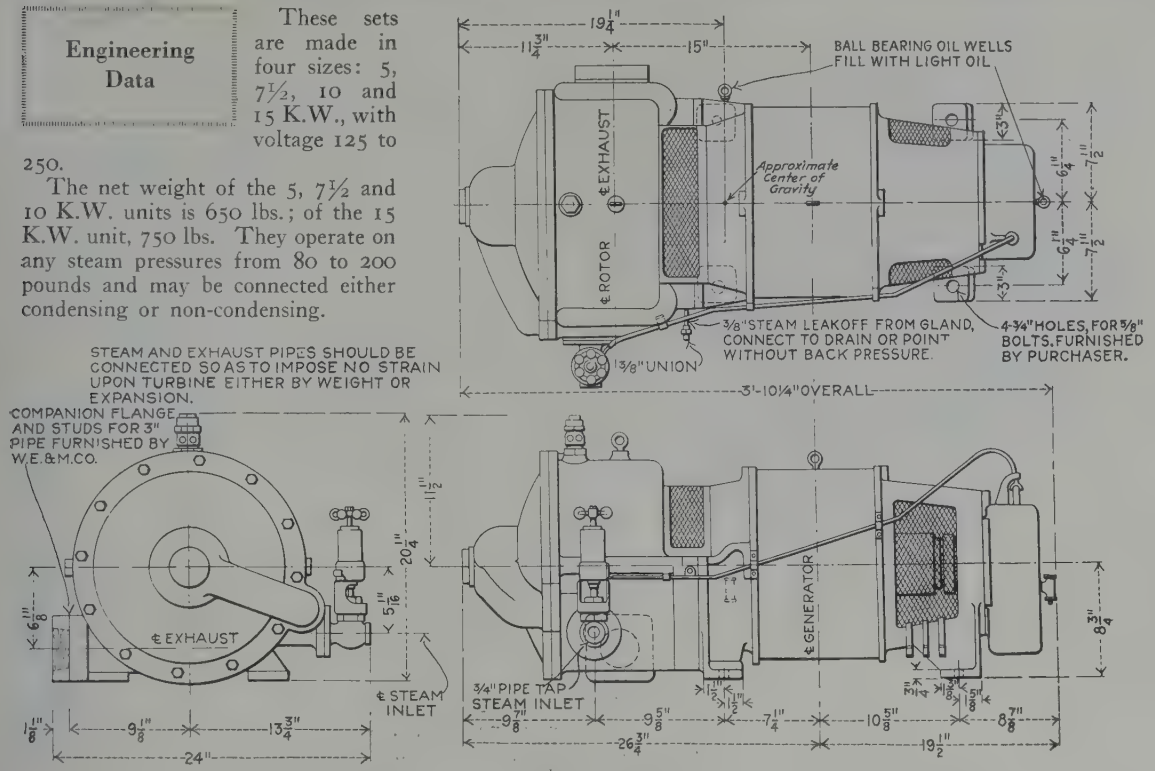
A large number of these units has been purchased and installed by the U. S. Navy Department and by the U. S. Shipping Board.

Large numbers have also been purchased by the Merchants Shipbuilding Co., Chester Shipbuilding Co., Todd Dry Dock and Construction Co., Toledo Shipbuilding Co., etc.

Engineering Data

These sets are made in four sizes: 5, 7½, 10 and 15 K.W., with voltage 125 to 250.

The net weight of the 5, 7½ and 10 K.W. units is 650 lbs.; of the 15 K.W. unit, 750 lbs. They operate on any steam pressures from 80 to 200 pounds and may be connected either condensing or non-condensing.

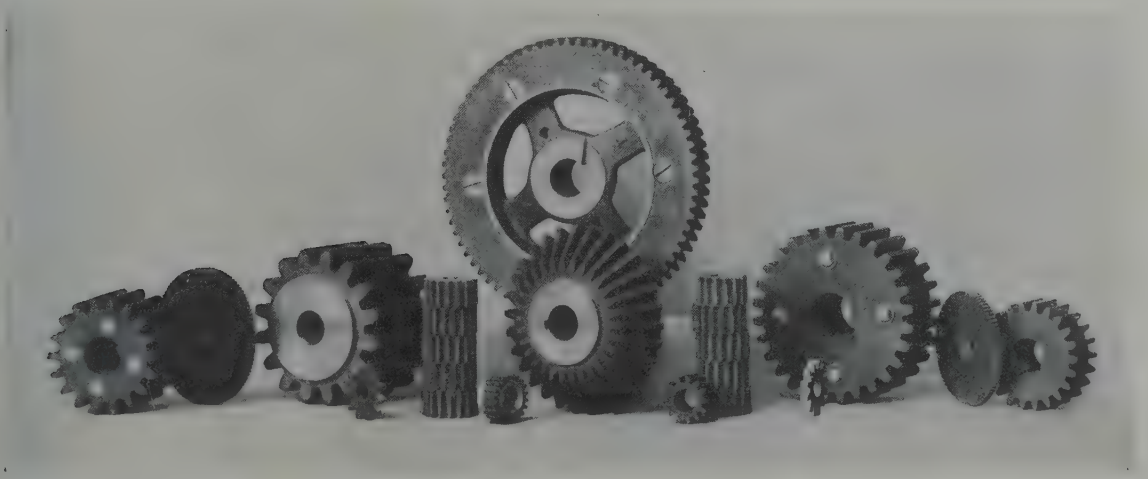


Outline Drawing of 5, 7½ and 10 K. W. Westinghouse Turbo-Generator

The dimension plan above gives overall dimensions, bolt hole spacing and center of gravity.

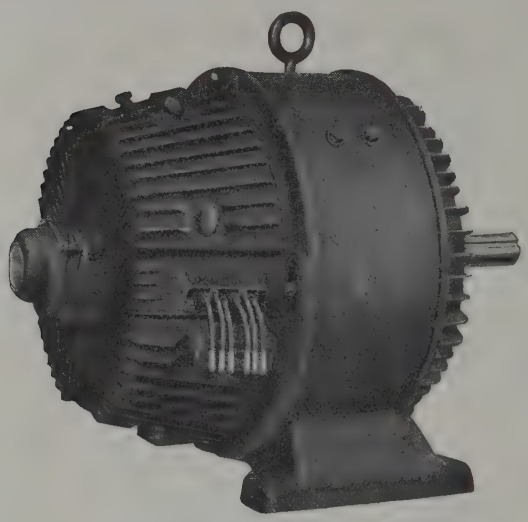
Bakelite Micarta Gears

Bakelite Micarta as a material is particularly applicable to the manufacture of gears and pinions. Its structural and wearing qualities make it preferable to raw hide and other non-metallic materials which are used where, because of noise, the use of metal gears or pinions is undesirable. The mechanical strength of certain grades is such that in most cases no metal shrouds or bushings are required. It is very tough and fibrous, and will withstand impact test equal to steel. Bakelite Micarta gears and pinions are regularly manufactured in various tooth forms and in sizes up to 36 inches in diameter.



Bakelite Micarta Gears

Westinghouse Motors for Shipyards and Shipboard

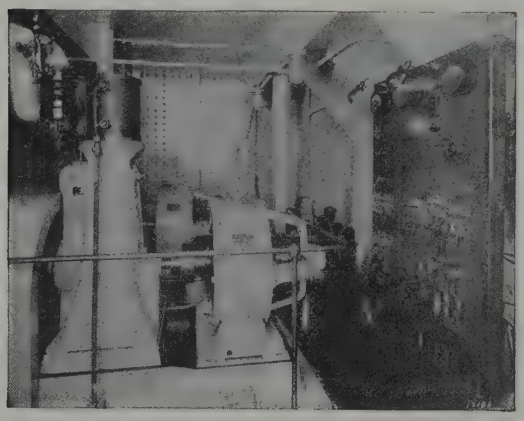


Totally Enclosed Direct Current Motor

Alternating Current Motor

Engine Generator Sets

The Westinghouse Company are in a position to supply complete engine-generator sets for lighting and power service. The set is a compact unit consisting of the Westinghouse type SK commutating pole generator driven by and mounted on common base with a vertical single cylinder engine of prominent manufacture. By selecting simple, rugged engines of moderate speed, and generators having strong construction, good commutation, and high efficiency, an enviable line of lighting sets has been established covering all capacities from 5 to 50 K. W. These sets are furnished for any steam pressure, condensing or non-condensing, and are complete with lubricator, throttle valve, wrenches and field rheostat. Where desired, a switchboard can be supplied on which is mounted main switch, voltmeter, etc., and any number of feeder switches.



Engine Driven Generator Set

In The Shipyard

The Westinghouse type SK motor fulfills the Shipyard need for general constant speed and adjustable speed motors where direct-current is the power supply. The SK line includes a design for a wide variety of applications, including all machine tools, i. e., reversing planers, etc. The type SK is a motor of remarkably simple construction with few parts, all of which are readily accessible. The successful operation of thousands of these motors in every conceivable industry has established a reputation that makes the SK motor universally known for its reliability and excellent operating characteristics.

Send for Catalog No. 30.

The Westinghouse alternating current motors, both squirrel cage (Type CS) and wound rotor induction motors (Type CW), incorporate the best features of design and construction that could be found after thirty years' experience in the design, manufacture and applying of induction motors. Either motor can be furnished in all horsepowers and speeds, horizontal, vertical, back geared, open, enclosed, etc.

Send for Catalog No. 33.

On the Ship

For Shipboard service, involving drive of various auxiliaries such as pumps, winches, windlass, etc., the Westinghouse Company have a motor incorporating all of the desirable features described above, including the light weight forged steel frame construction and in addition necessary marine features. The latter include especially impregnated windings for resistance to moisture and salt atmosphere, guarding against possibility of breakdown from this source. Non-leakable bearings and non-corrosive parts throughout are also features of Westinghouse Marine motors.

Appropriate control of all descriptions including hand operated automatic, water-tight, etc., has been designed to meet the Shipbuilders' requirements.

WESTINGHOUSE ELECTRIC & MFG. CO.

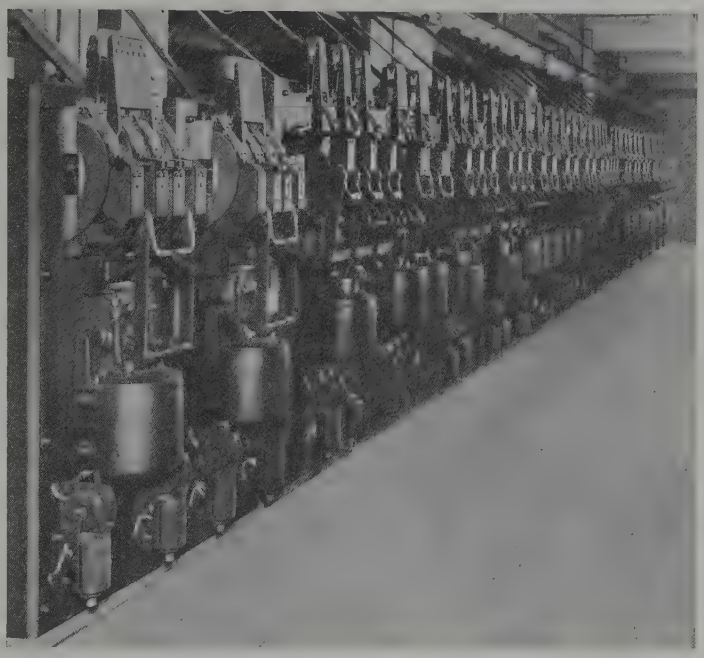
EAST PITTSBURGH, PA.

Address nearest office. For list of offices see page 925

Westinghouse Switchboards—Arc Welding Sets

Switchboards

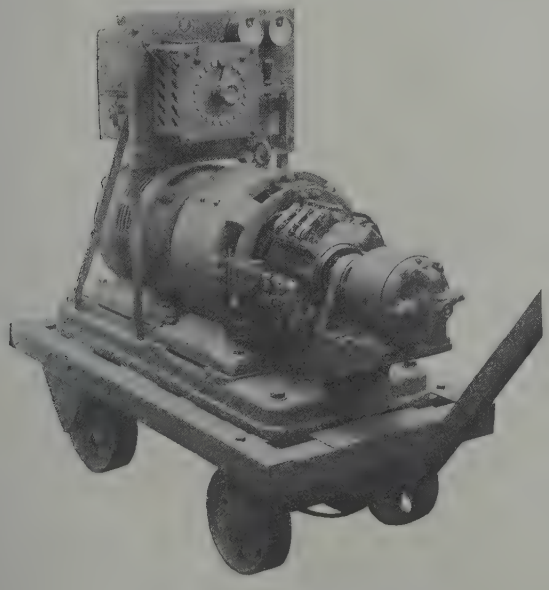
Westinghouse switchboards can be obtained to meet any possible demand that may arise in the control and application of alternating or direct current for shipboard or shipyard service. The selection of suitable switchboard apparatus for certain requirements is naturally governed by several conditions. In some cases first cost is the determining feature. In most cases continuity of service is of considerable importance. In all cases, the maximum degree of safety to life and property that can be obtained should be the goal. These and other considerations, such as space available, voltage, and capacity of plant, govern the proper selection of a switchboard equipment. All such essential factors are considered in connection with the design and manufacture of Westinghouse switchboards.



Westinghouse Switchboard in Shipyard

Westinghouse Arc Welding Set

The Westinghouse Single Operator Arc Welder has been especially designed to provide a small compact light weight unit for one welder and meets a wide demand for shipyard work. The motor-generator and its simple, small control panel is also supplied for portable service as per illustration. The truck is a fabricated steel structure only two feet wide, four feet long and fourteen inches high. The generator is a short arc, constant-current machine capable of operation over a range of 75 to 200 amperes. The current can be set for various values within this range by simply adjusting the field rheostat. The equipment is of high electrical efficiency for welding work since no energy absorbing resistance is used in series with the arc. These equipments are particularly adapted to service where a readily portable apparatus is required owing to welding jobs being scattered over considerable area, also for installations requiring the service of only one welder. The apparatus is primarily designed for metal electrode work. However, carbon electrode work may be done within the capacity of the unit.



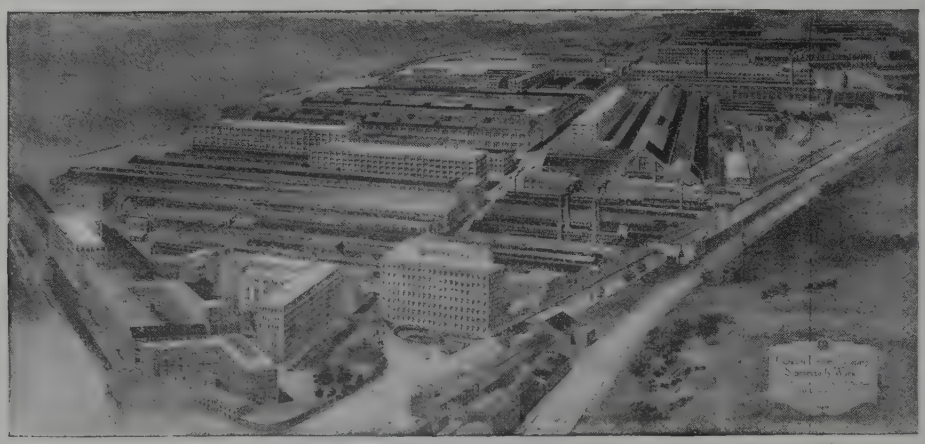
Westinghouse Arc Welding Set

For installations requiring the services of two or more welders where the work is not scattered over too great a territory, multiple operator motor-generators are available in capacities of 300, 500, 750 and 1000 amperes. To control the generator and various welding circuits, panels are supplied.

Electrode holders are supplied with the apparatus. For the protection of the operator's head and eyes a hood is supplied with the equipment.

Single operator equipments can be provided with motor for 110, 220, 440, or 550 volts, DC, or AC, 2 or 3 phase, 60 cycle. Multiple operator equipments can be supplied with motors for any commercial circuits, AC or DC.

Sales Offices of General Electric Company



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Uruguay: General Electric (S. A.), Montevideo.
Venezuela: Wesselhoeft & Poor, Caracas.

Unified Responsibility

The products of the General Electric Company comprise practically every kind of apparatus and machinery used in the generation, transmission, distribution and utilization of electrical energy.

In the electrical equipment of ships, yards or docks, it is possible to standardize almost completely with G-E equipment. By this procedure a single organization is responsible for the proper inter-relation of all phases of the electrical equipment.

Co-operative Service

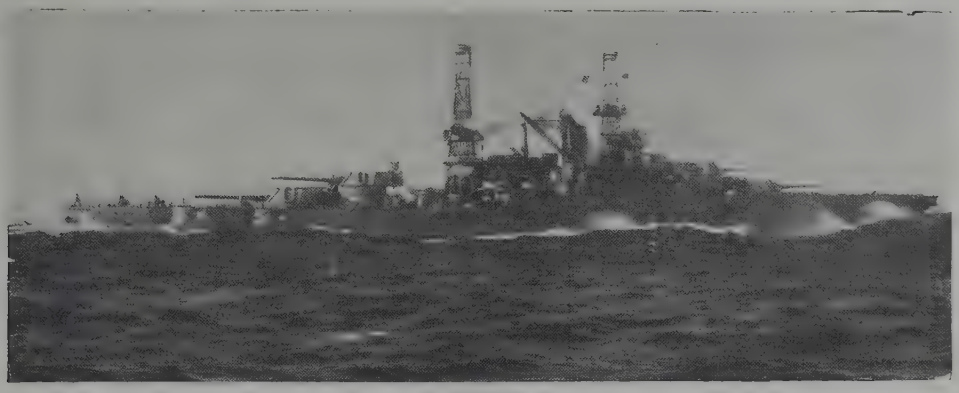
The engineering and sales departments are prepared to co-operate fully in the planning and selection of the apparatus and equipment best suited for specific requirements. At the service of these departments are the practically unlimited resources of the General Electric Company in factory, engineering and laboratory equipment.

To insure correspondence against avoidable delay, all communications should be addressed to the G-E office nearest the writer.

GENERAL ELECTRIC COMPANY, SCHENECTADY, N. Y.

Address nearest office. For list of offices see above.

The Electric Ship



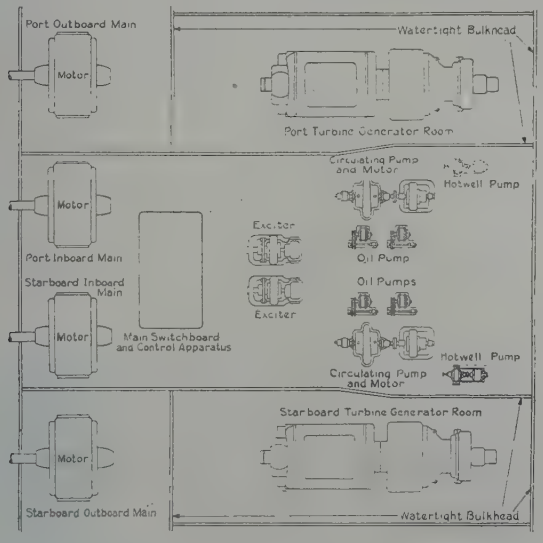
U. S. S. New Mexico at 21 Knots Driven by Four 7,000 H. P. G-E Motors

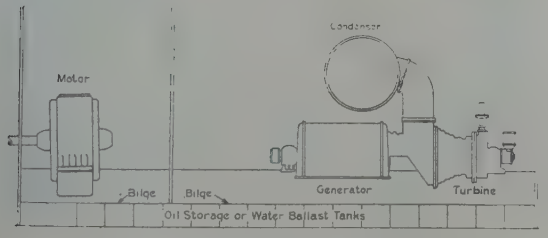
The Electric Ship

Electric drive for large vessels became a fact with the successful trials of the U. S. S. New Mexico, flagship of the Pacific Fleet.

This battleship has a displacement of 32,000 tons and a speed of 21 knots. Each of the four propellers is driven by a direct-connected 7,000 H. P. G-E Motor, receiving current, through a central control station, from two G-E Curtis Marine Turbine-Generators.

Six auxiliary Turbine-Generators of 300 Kilowatt capacity generate current for the electric apparatus and equipment throughout the vessel. With electricity used not alone for propelling the ship, but for driving all auxiliaries and even for cooking and washing, the New Mexico is indeed an Electric Ship.





Plan and Elevation of Engine Room Arrangement of the New Mexico

Electrically Equipped Throughout

Not only for propulsion but for many other purposes aboard ship, electrical equipment has marked advantages. The list of equipment below, showing electrical loads for various purposes, suggests how completely electrical is the New Mexico.

PARTIAL LIST OF ELECTRICAL EQUIPMENT OF THE NEW MEXICO

2	main turbine-generators	31,000 h.p.
4	motors for propelling	28,000 h.p.
6	auxiliary turbine-generators	2,400 h.p.
6	air compressors	300 h.p.
2	steering gear motors	250 h.p.
20	motor generator sets totaling about	100 h.p.
4	boat crane motors	200 h.p.
2	windlass motors	350 h.p.
4	winch motors	200 h.p.
1	capstan motor	50 h.p.
20	turret motors	500 h.p.
10	ammunition hoists	50 h.p.
2	refrigerator motors	40 h.p.
8	motors in kitchens	15 h.p.
6	motors in carpenter shop	20 h.p.
15	motors in machine shop	30 h.p.
6	motors in laundry (5 machines use electric heat)	10 h.p.
5	motors in printing shop	6 h.p.
14	water pumps	140 h.p.
4	oil pumps	8 h.p.
50	electric air heaters	150 h.p.
12	searchlights	200 h.p.
160	fans, 60 blowers, 6 electric toasters, 1 electric percolator, 15 electric irons, 104 loud speaking telephones, 176 ship service telephones, 170 fire control telephones, 2 electric gyroscopic compasses.	
7	portable electric drills, 2 electric glue pots, 6 electric soldering irons.	

Operation of Electric Drive

Six-Year Test of Electric Drive

More than six years ago electric drive was installed on the collier Jupiter, which is in most features a ship of the merchant type. At the same time one of her sister ships was equipped with geared steam turbine drive and another with direct-connected reciprocating engines.

The results proved the unquestionable superiority of electric drive. Rear Admiral Dyson says, regarding the operation of the Jupiter: "It is hard to imagine any installation of machinery which could have been more satisfactory than that on board the Jupiter. Her repair bills are practically nil; we never receive any adverse reports or criticisms from her, and so far as appeals for navy yard assistance are concerned, we do not know that the ship is in existence. In my opinion, electric propelling machinery is on its way as the peer of all propelling machinery, and I expect to see a wide spread in its use in the near future."

Method of Operation of the New Mexico

As shown in the engine room arrangement, each of the two main turbines is connected to an A. C. generator, having two poles. The four propelling motors are of the synchronous type and are so wound that by suitable changes of connections, effected by switches on the control board, the windings can be arranged for either 24 or 36 poles. Two ratios of speed reduction between the turbine-generator and the propeller, approximately 12:1 and 18:1, are thus provided.

Each turbine is equipped with a special governor, operated from a lever on the control board, to hold the speed at any desired point within the range.

For all conditions of steady running up to about 15 knots, only one turbine-generator is used and the propelling motors are connected for 36 poles, giving a speed reduction of 18:1. By changing the pole connections to 24, giving a speed reduction of 12:1, a speed of about 17 knots can be obtained with one generating unit. For speeds above 17 knots, both generating units are used.

Operating Advantages of Electric Drive

This flexibility of operation permits the main turbine-generators to be run at practically their maximum efficiency over a wide range of speed variation. At the varying speeds required for naval maneuver electric drive is more economical than any other type of propulsion.

As compared with the U. S. S. Pennsylvania, driven by direct connected turbines, the New Mexico uses from 20 to 30 percent less fuel at speeds above 15 knots.

With electric drive, each unit of the propelling equipment can be isolated in its own watertight compartment. Any unit might therefore be destroyed in battle and the ship could still go on at a reduced speed.

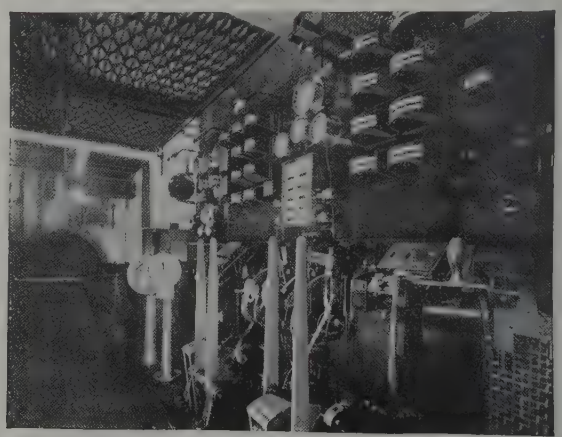
The New Mexico is the first of thirteen new dreadnaughts and six battle cruisers, all to be electrically propelled.

Reliability of Electric Drive

Electric propelling machinery has no motion other than simple rotation. This gives a maximum of mechanical simplicity—a minimum of wear and of interruption of service. Experience has shown the extreme reliability of electrical apparatus and that the parts liable to damage can be quickly and easily replaced or temporarily connected so as to be operative. Automatic means can be provided which, by interrupting excitation, guard against any possibility of serious damage through possible accidents.

Morever, even with the main generating unit or units entirely out of service, by delivering the power of auxiliary generating units through a motor-generator set to the main motor, the vessel could proceed at about half-speed.

A Propulsion Motor Showing the Direct Connection to the Propeller Shaft



The Main Control Station Showing Levers for Reversing and Changing Speed

Merchant Ship Propulsion

Simplicity of Operation

While the assumption is often made that the operation of electrical apparatus requires a high degree of skill and expert knowledge, long experience has amply demonstrated that this is not the case. The conditions in electrical apparatus make the reasons obvious.

Electrical machinery is simply a combination of electrical circuits with motion of rotation. No reciprocating parts or involved mechanisms are used. The connections are easily shown by diagrams and little mechanical skill is required to make them. Furthermore, the reliability of electrical apparatus is such that troubles which might involve any difficulty of repair, even by inexperienced operators, are improbable.

In many respects the machinery used to propel a ship is simpler than that commonly used for lighting and for driving auxiliaries. Electric drive simplifies the work of the operating force and makes ships less dependent on the skill and resourcefulness of crews.

Fuel Economy

Electric drive secures the efficiency of the high-speed turbine operating at a high degree of superheat and at high vacuum. In the average cargo vessel a saving in steam consumption of at least 30 percent can be effected over the reciprocating engine operating without superheat. Even if superheat is used with the reciprocating engine equipment the gain would still be over 20 percent.

Pioneer Work in Ship Propulsion

The General Electric Company was the first to produce high speed marine propelling turbines, with double reduction gearing.

The relatively low-speed turbine, with single reduction gear showed by comparative tests a reduction in steam consumption of 19 percent, as compared with the reciprocating engine. A further reduction of 14 per cent was accomplished by the use of high-speed turbines with double reduction gearing.

The next forward step in ship propulsion is the electric drive, as evidenced by the successful operation of G-E electric propelling equipment on the U. S. collier Jupiter, and the U. S. S. New Mexico.

Increase of Cargo Space

Since the electrical power is transmitted through cables from the engine room amidships to the motor compartment in the extreme stern, the shaft and shaft alley are entirely eliminated. The lessening of the space required for the engine room over a reciprocating engine installation still further increases cargo space.

Proposals for Electric Drive

At the service of shipbuilders and ship operators is the same engineering and designing staff which, in co-operation with the Navy Department, developed the equipment of the New Mexico. Complete plans and proposals for electric drive in merchant ships can be submitted for any contemplated vessel.

Proposals for Internal Combustion Engine Electric Drive

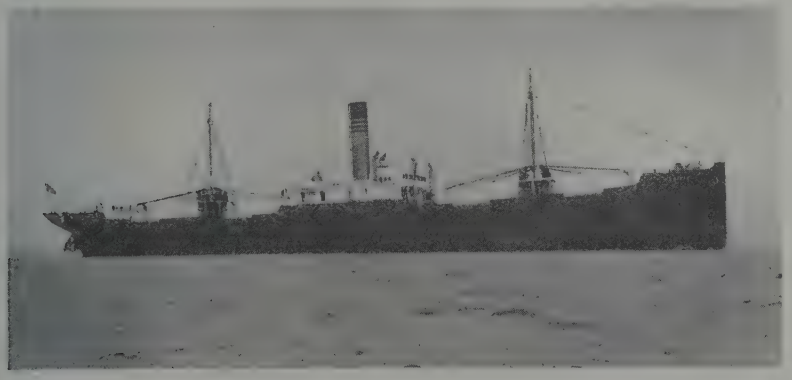
The General Electric Company is in a position to supply electric generators for direct connection to internal combustion engines for the propulsion of vessels by the electric system, as well as electric motors for use with all types of auxiliaries used aboard boats so propelled.

G-E Co-operative Service

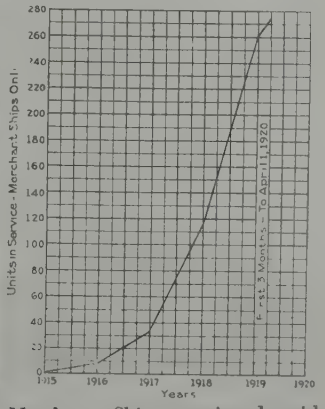
The General Electric Company maintains a corps of Marine Inspectors, and these as well as skilled Construction Foremen are promptly available upon request. The Company is also in a position to co-operate with shipyards in the replacement of older types of propulsion machinery by more modern apparatus.

Motor-Driven Auxiliaries

Because of dependability and ease of control, motor drive is rapidly being adopted for many auxiliaries. The General Electric Company is fully equipped to co-operate with shipbuilders in the selection of motors and of starting and control apparatus and to supply the equipment best suited to any specific installation.



S.S. "Pacific" Propelled by 2,500 H.P. G-E Marine Geared Turbine, in successful service since Dec., 1915



Merchant Ships equipped with G-E Marine Geared Turbines

GENERAL ELECTRIC COMPANY, SCHENECTADY, N. Y.

Address nearest office. For list of offices see page 940

Steam Engine-Driven Generating Sets

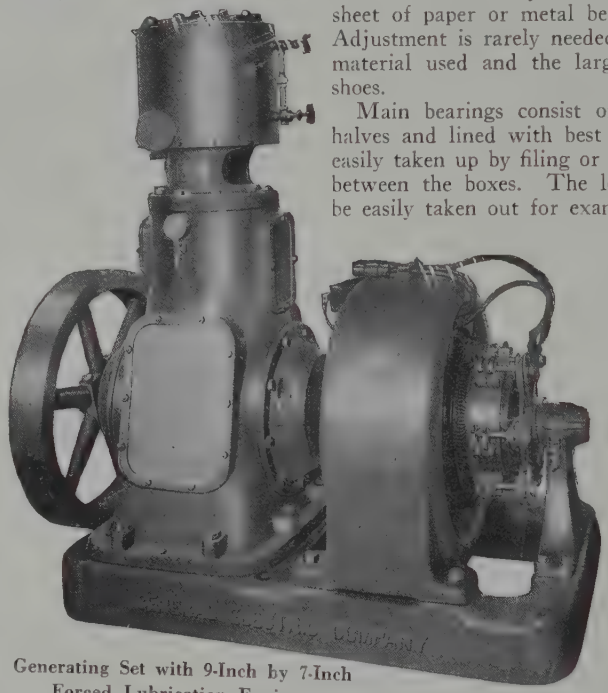
Purpose and Features of Design

The line of small direct connected generating sets manufactured by the General Electric Company was designed to meet the severe conditions of marine work, which demand light, compact and durable sets of close regulation and quiet operation. They are also adapted for both power and lighting in shipyards.

In addition to their many specific points of superiority, these sets have the great advantage of being manufactured complete at one factory, which insures perfect fit, uniformity of finish and a thorough test of the combined unit before shipment is made.

Similar parts of each size of machine are built to templets and gauges and are interchangeable, thus insuring exact fit of spare parts or replacements.

In material and workmanship these sets are similar to those built for the United States Navy, for which a large number have been furnished by the General Electric Company. Bulletin No. 42300.



Generating Set with 9-Inch by 7-Inch Forced Lubrication Engine

In the smaller sizes the design is simplified by casting the column and bedplate integral.

The connecting rod is of the best machine steel, forged in one piece. Removable liners provide for taking up wear and the boxes may easily be rebabbitted when necessary.

The crosshead is a mild steel forging. Wear on the crosshead shoes may be taken up by placing a thin sheet of paper or metal between crosshead and shoe. Adjustment is rarely needed, however, because of the material used and the large wearing surface of the shoes.

Main bearings consist of cast iron shells split in halves and lined with best quality babbitt. Wear is easily taken up by filing or machining the metal liners between the boxes. The lower half of the box can be easily taken out for examination or repair without removing the shaft.

The automatic governor has practically no parts that can give trouble or wear out, thus insuring its dependability and eliminating any necessity of frequent attention. The governor should, however, be taken apart occasionally and the various parts cleaned.

Automatic relief valves, as well as separate hand-operated valves, are fitted to each end of the cylinder.

Standard Sizes

These sets are made in standard sizes ranging from 2½ kw. to 60 kw. as follows: 2½ to 5 kw. single cylinder, gravity lubrication engines, direct connected to D. C. generators. 7 to 60 kw. single cylinder, forced lubrication engines, direct connected to D. C. generators. 25 to 60 kw. single cylinder, forced lubrication engines, direct connected to A. C. generators, with or without direct connected exciters mounted on base extension, or with shaft extension for pulley when using belt driven exciters.

Durability and Stability

Perfect alignment, balance, smoothness of operation and ability for long running periods without continued attention, ease of interchangeability and adjustment for wear are insured by the accurate construction of all parts.

The bedplate is carried out to the full width of the generator frame, making an ample base surface for foundation without increasing the floor space required.

The base is not designed to be self-supporting and foundation must be so constructed as to prevent deflection.

Simplicity and Compactness

On these single cylinder engines only one valve is used. By the adoption of a short stroke for the engines and special windings for the generators, the height and length of the sets have been reduced without detracting from their efficiency or accessibility.

Generators

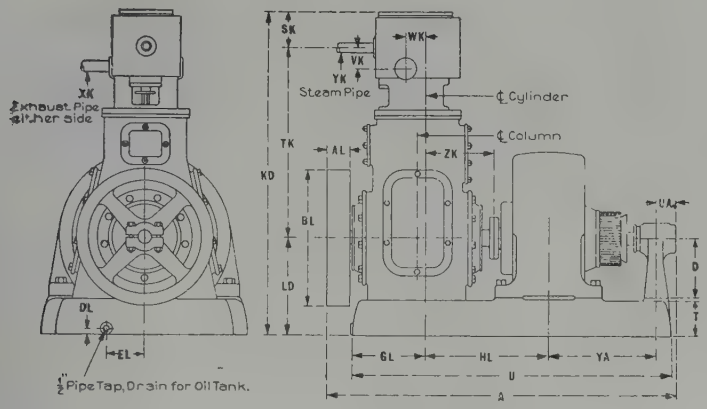
The generators are regularly wound for line voltages between 110 and 125 volts and may be flat compounded or over compounded for any line voltage between these limits. Generators for other voltages can be furnished on special order.

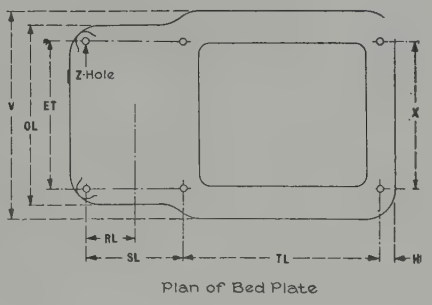
They will operate continuously under full load with a temperature not exceeding 40 degrees C on any part of the machine with the exception of the commutator which will not exceed 45 degrees C. On a one-hour overload the temperature rise will not exceed 55 degrees C. An overload of 50 per cent may be carried momentarily without injurious heating.

Where required three-wire generators can be supplied for all ratings listed in the table on opposite page.

Information regarding the standard single-cylinder engines with alternating current generators will be supplied on request.

Steam Engine-Driven Generating Sets





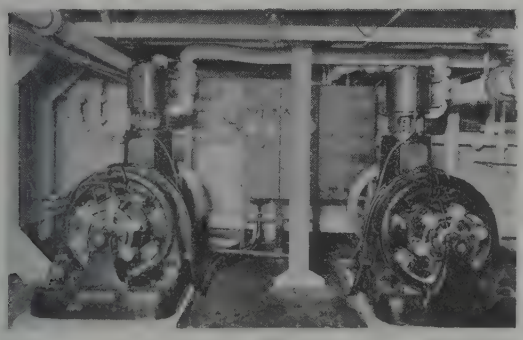
Plan of Bed Plate

DATA ON SINGLE CYLINDER STEAM ENGINE GENERATING SETS

Kw.	R.P.M.	Cylinder		Steam Pressure	Net Weight
		Dia.	Stroke		
7	550	5	4½	80	2500
8½	550	5	4½	100	2600
10	475	6½	5	80	3100
12½	475	6½	5	100	3200
15	425	8	6	80	4800
17½	425	8	6	100	4900
20	400	9	7	80	6450
25	400	9	7	100	6450
30	305	11	8	80	9800
35	305	11	8	100	9800
40	305	11	8	125	9900
50	280	12	11	100	13000
60	280	12	11	125	14400

Engine Lubrication

The engines employ the forced system of lubrication. The base of the engine forms an oil tank of large capacity and radiating surface. A single-acting plunger pump driven by an eccentric bolted to the crank shaft forces the oil to the various bearings of the engine.



Two 15 Kw. Standard G-E Steam Engine Generating Sets Installed on Steamer "War Baron," Formerly the "Ellen Kloster."

DIMENSIONS IN INCHES OF STEAM ENGINE-DRIVEN GENERATING SETS, HAVING SINGLE CYLINDER FORCED LUBRICATION TYPE ENGINES.

Note: While all figures are approximately correct, they should not be used for construction unless endorsed by a G-E office.

	DIMENSIONS IN INCHES					
Kw.	7	10	15	20	30	50-60
A	55 15/32	57⅞	66½	68 3/16	82⅛	91 11/16
AL	4	4	5½	5	8	9
BL	21	26	34	36	42	51
D	9	9	12	15	15	15
DL	1	1¼	1⅜			3
EL	6	7	6			
ET	23¼	24¾	30	34	39⅛	46½
GL	11 7/16	12¼	15 7/16	16¾	15⅛	16⅜
HF	2¼	3⅝	2¾	2⅞	10¼	4⅜
HL	19¾	21 13/32	24¼	25 7/16	29¾	34 11/16
KD	50½	57⅛	67⅞	77	82½	96⅞
LD	15⅛	15¾	19¾	22½	26½	26⅝
OL	27¾	28⅜	35⅝	39¼	44½	52½
RL	9⅜	10 11/32	12 7/16	14⅛	13¾	12
SL	16½	19¾	23½	25½	27½	24
SK	5⅜	6⅝	7¾	8⅞	9⅞	12
T	5½	5⅝	7	7	7⅜	7¾
TK	30	34¾	40¾	45⅝	46⅛	58¼
TL	29⅝	27½	30¼	31¼	30½	45 7/16
U	50 7/16	52 7/16	60 7/16	62 7/16	69½	77 13/16
UA	3¼	3¼	3¼	3¼	3¾	4⅜
V	32½	32	37¼	39¼	44½	49¼
VK	3⅜	4¾	5⅜	6	5 13/16	7½
WK	2⅞	3½	4 3/16	3	7½	8¼
X	23¼	24¾	30	34	39⅛	39½
XK	1½	2	2½	3	3½	4
YA	17	16	18	17½	20½	23¼
YK	1¼	1½	2	2½	3	3½
Z	1	1	1	1⅛	1⅛	1⅜
ZK	11¼	13 7/16	15¼	15 13/16	18½	22 7/16

Customers should provide proper foundation and a base frame should be used if necessary to prevent springing of the bed plate.

Drains for oil tanks of 20 and 30 kw. engines are located above base between engine and generator.

Drain for oil tank of 50 kw. engine is located in base between engine and generator.

G-E Searchlights

The General Electric Company manufactures a complete line of searchlights, which meet fully the demand for durable, efficient and reliable projectors. There are two types: an 18-in. incandescent lamp, 1000-watt, 110-volt, searchlight, and the Arc Lamp type described below. Rheostats are provided with each arc projector to adjust current to its proper value. Bulletin 43856A.

Standard Sizes and Control

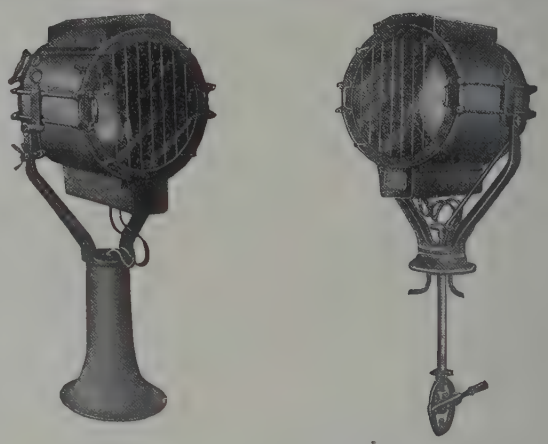
The standard commercial sizes of Arc Lamp Searchlights are 9, 13, 18 and 24 inches in diameter, but larger projectors of 30, 36, 48, 60 and 80 inches in diameter are manufactured and can be supplied on special request.

Projectors arranged for hand and pilot-house control are regularly kept in stock for immediate shipment. Projectors arranged for shaft control, rope control and electric control, can be provided, when desired.

Hand and Pilot House Control

In the hand control projectors the beam of light can be trained vertically or horizontally by means of handles on the sides of the barrel, and a star wheel mounted on the trunnion acts as a locking device by means of which the barrel of the projector may be held at any desired angle.

This form of control is intended for use where the projector is located directly on the deck or within convenient reach of the operator.



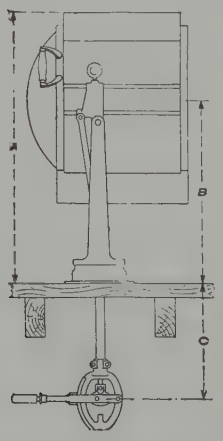
18-Inch Hand and Pilot House Control Searchlights

For dimensions of the 9, 13, 18 and 24 inch hand control projectors see table below.

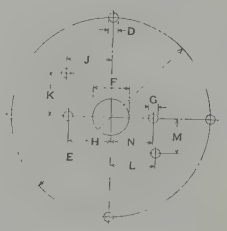
Where the projector is installed on top of the pilot-house, an arrangement from within is provided by which the beam can be moved either horizontally or vertically, by a single lever, within easy reach of the pilot.

The projector may be locked at any desired angle by simply turning the handle of the lever until it binds against the quadrant.

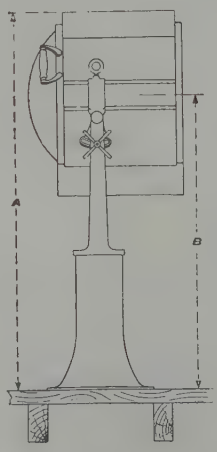
For dimensions of the 9, 13, 18 and 24 inch pilot-house control projectors, see table below.



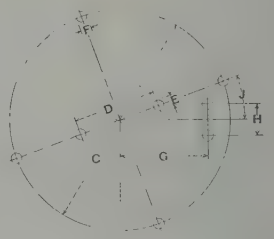
Pilot House Control Type



Outline of Base



Hand Control Type



Outline of Base

DIMENSIONS IN INCHES FOR PILOT HOUSE CONTROL														*
Class in In.	A	B	C	D	E	F	G	H	J	K	L	M	N	Net Wt.
9	23	16½	22	5/8	7	1¼	To suit diameter of cable bushings	1¾	1⅞	1¾	1⅞	1 3/16	1⅜	100
13	33	24 7/16	22	13/16	8¼	1½			1⅞	1¾	1⅞			175
18	41	27⅞	22	13/16	8¼	1½								285
24	59	41¾	22	1 1/16	22¼	2⅛		5 1/16					6 1/16	550

DIMENSIONS IN INCHES FOR HAND CONTROL									*
Class in In.	A	B	C	D	E	F	G	H	J	Net Wt.
9	54	47½	10¾	4	To suit diameter of cable bushings	1 1/16				140
†13	52¼	43¾	14¾	4¾		1 3/16				200
†18	60¼	47¾	14¾	4¾		1 5/16				300
24	63¾	46⅝	23½			1 7/16	7	5	20°	580

* Standard equipment including tool box, rheostat and 25 pairs of carbons.

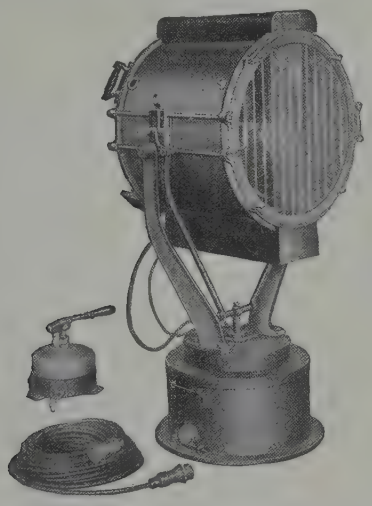
† Dimensions of 13- and 18-inch projectors are based on standard pedestal 22¾ in. high. Pedestals 26¾ in. and 30¾ in. high can be supplied on special order.

Hand control projectors can be supplied with low pilot house type of base on special order.

Pilot house control projectors can be supplied with hand control type of base on special order.

Electric Control

A more expensive, but more satisfactory, form of distance control is provided in the electric control projector, in which the training is accomplished by two motors mounted in the base and electrically connected to a small controller, which



24-Inch Electrically Controlled Searchlight

is so wired that the searchlight beam follows the movement of its handle in any direction.

This system requires less attention and is easier to operate than the rope control and has the great advantage over the latter that the controller wiring may be run by the most convenient route without regard to obstructions or changes of direction, which may form serious difficulties in the other systems.

Current and Voltage

The accompanying table shows the ranges in current and line voltage for which these searchlights can be adapted.

For the same current it is recommended that the larger searchlight be selected, as the strength of illumination in the beam will be greater with the larger diameter of mirror.

For example, it is preferable when the available current is limited to 10 amperes, to install a 13-inch searchlight operating at 10 amperes rather than a 9-inch with the same current.

Size in In.	CURRENT		VOLTAGE	
	Special Rating	Standard	Arc	Line
9	5- 7.5	10	43-46	65-125
13	10-15	20	45-48	70-125
18	20-27.5	35	47-50	75-125
24	35-42.5	50	48-50	80-125

Shaft Control Rope Control

Shaft control is by means of two shafts, one within the other, with suitable handwheels and gearing which gives complete control of the searchlight beam.

When placing order, the distance from the center of the searchlight to the outside of the control handwheel should be specified to enable the correct length of shaft and necessary bearings to be furnished.

In the rope control projectors the handle and quadrant of the pilot-house type are removed, and the rod, fitted with two pulleys, is rope connected to a simple controller mounted in the pilot-house or other desired location. The controller, by means of a single handle, gives full control of the beam in both directions. Short lengths of bronze tiller rope with turn-buckles are supplied with each equipment.

Novalux Lighting Units

The Novalux pendent units are designed for use with the efficient Mazda "C" lamp and embody the latest developments in light-directing devices. Extremely attractive in appearance, they are also built for long service.

Novalux Pendent Unit

These units are particularly adapted for the economical illumination of large interiors and exteriors. The different light-directing equipments available produce such a variety of illuminating characteristics that a selection can be made for any requirements.

The General Electric Company manufactures a complete line of lighting supplies, covered in Catalog G-E 18, No. 49902A.

Flood Lighting

G-E flood lighting projectors are of great value in facilitating night work and for protective lighting. They can be adjusted to illuminate any particular part of a yard, a shipway, railroad track, fences, sides of buildings, etc., and also to light vessels and piers for the handling of cargo.

The G-E flood lighting projector throws a beam of light having an enormous candle power. It can be located in any convenient place up to 500 feet away from the object or area to be illuminated. It is weatherproof, sturdily built and exceedingly economical to operate, since it burns only one 400-watt Mazda "C" lamp. Bulletin 43850-B.

G-E Flood Lighting Projector

Marine Switchboards

Switchboards for Merchant Ships

A line of G-E switchboards has been specially designed for controlling generators and distribution circuits aboard merchant vessels. The drawings and tables below offer a means of selecting a combination generator and feeder panel to suit all ordinary conditions.

These switchboards are designed and built by the same organization which produced the specialized control boards for the New Mexico and are of the same high quality throughout.

For any conditions which these designs will not meet, the General Electric Company is prepared to submit promptly designs and specifications exactly adapted for the work.

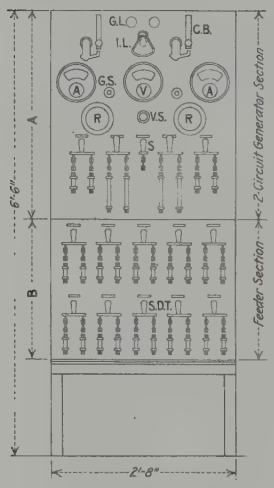


Fig. 1—Two-Circuit Generator and Feeder Panels

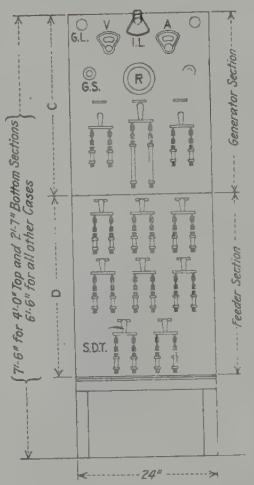


Fig. 2—Single-Circuit Generator and Feeder Panels

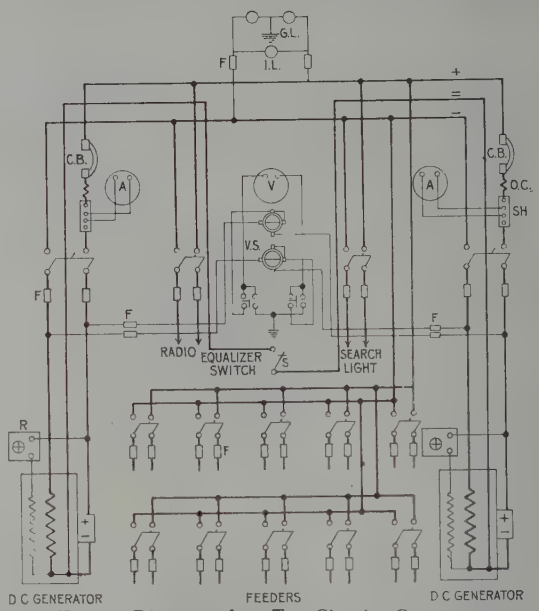
SWITCHBOARDS FOR TWO GENERATORS—FIG. 1

Two-Circuit Generator Section with Circuit Breakers (as shown in Fig. 1).	Feeder Section for Two-Circuit Generator Section (as shown in Fig. 1—may be used with either Generator Section above).
For 100 amp. switches, A=3′-0″. For 200-400 amp. switches, A=4′-0″	For 1 to 5 circuits, B—16″ For 6 to 10 circuits, B=24″
Two-Circuit Generator Section with Fuses (same general design as Fig. 1).	Note: "Searchlight" and "Radio" switches mounted on generator panel.
For 100-200 amp. switches, A=2′-7″ For 400 amp. switches, A=3′-0″	

SWITCHBOARDS FOR ONE GENERATOR—FIG. 2

Single-Circuit Generator Section with Fuses (as shown in Fig. 2).	Feeder Section for Single-Circuit Generator Section (as shown in Fig. 2—may be used with either Generator Section above).
For 60 and 100 amp. switches, C=2′-7″ For 200 and 400 amp. switches, C=3′-0″	For 1 to 3 circuits, D=16″ For 4 to 6 circuits, D=24″ For 7 to 9 circuits, D=2′-7″
Single-Circuit Generator Section with Circuit Breakers (same general design as Fig. 2).	Note: "Searchlight" and "Radio" switches mounted on generator panel.
For 60 and 100 amp. switches, C=3′-0″ For 200 and 400 amp. switches, C=4′-0″	

Note: Generator panels designed for controlling either one or two 125 volt machines in capacities up to 25 K. W.
All generator sections contain two switches, for controlling "Searchlight" and "Radio."
Instruments supplied in either round pattern (see Fig. 1) or G-E type D-12 pattern (see Fig. 2).



Wiring Diagram for Two-Circuit Generator Panel with Ten-Circuit Feeder Panel, with Circuit Breakers

SYMBOLS USED

A—Ammeter	SH.—Ammeter Shunt	S.—Single Throw Switch
V—Voltmeter	I. L.—Illuminating Lamp	S. D. T.—Double Throw Switch
R—Rheostat	G. L.—Ground Detector Lamp	G. S.—Ground Test Switch
F—Fuse	C. B.—Overload Circuit Breaker	V. S.—Voltmeter Switch

Construction and Equipment

The panels, of dull black marine finished slate, are of the sectional type, mounted on angle iron frame. Frame may be supplied by the shipyard, if desired. Rubber packing is placed between panel and frame.

The feeder switches are of 60 ampere capacity, for most rugged construction. Fuse clips are 30 ampere capacity, unless otherwise specified.

All instruments are manufactured by the General Electric Company and are of the highest quality throughout.

All panels meet requirements of Lloyd's rules, while those with circuit breakers meet the requirements of the American Bureau of Shipping.

Suggestions for Ordering

Inquiries addressed to the nearest office will receive prompt attention. To save time, the following data should be given in all inquiries:

Number, Kw. capacity and voltage of generators.

Number of Feeder Circuits; with approximate individual load, if over 30 amperes.

Markings for nameplates.

Whether shipyard will supply angle iron framework.

Number of fuses desired, including spares.

For G-E switchboards, adapted for the control and distribution of electric current for shore work, see following pages.

Switchboards for Shore Use

Switchboards for Every Purpose

The General Electric Company offers a complete line of switchboards for all systems of electrical distribution.

Engineers are invited to confer with switchboard specialists stationed in the principal branch offices of the company.

Sketches, detailed drawings and specifications of any such special boards, or the adaptation of standard unit panels, will be cheerfully and quickly furnished on request.

G-E Standard Unit Panels

The standard unit panel has been developed, classified and listed to meet certain conditions which have been found to occur repeatedly in connection with control and distribution of electric power. It has not been developed for voltage up to 1500 direct current or 3500 alternating current, although later it may be extended beyond these limits.

It is advisable whenever possible to use standard unit panels, for they are less expensive than the other classes, requiring less time to build and ship, though quality and workmanship are the same.

Standard unit panels may be ordered simply by one or more catalog numbers, taken from the General Electric Company's switchboard bulletins. Each bulletin is complete in itself and covers panels in a distinct class. They are shown in outline and the equipment is specified in every detail necessary to enable one to select just what is needed.

All equipments on these boards are made by a single company, thus centralizing responsibility for behavior of the entire switchboard.

Special Panels

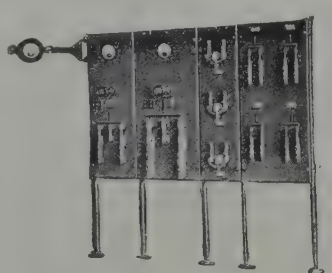
To meet unusual conditions of voltage, capacity, control, service, etc., special panels can be designed and constructed. The Panama Lock control boards serve as an extreme example.

G-E Direct Current Panels

For two-wire general power and lighting service, in small stations 125 and 250-volt D. C., G-E standard unit generator and feeder panels are built in a variety to meet practically every requirement. Feeder circuits on a single panel may be up to six in number and protected either by fuses or circuit breakers. Bulletin 47050A.

For two-wire D. C. service in large power stations, there have been standardized generator panels up to 6000 amps., feeder panels up to 4000 amps., at 125 and 250 volts, and up to 1200 amps. in 600 volts.

Bulletins 4995 and 47070.



Typical Standard Unit Panel D.C. Board for Use in Small Stations

For Edison three-wire service in small plants, there are built 125 and 250 volt D. C. combination generator and feeder panels up to 100 K.w., with 2, 4 or 6 feeder circuits. Bulletin A-4189.

For large capacity Edison three-wire systems, the standard unit panels include 125 and 250 volt D. C. three-wire generator panels up to 200 K.w. and feeder panels, for either two or three-wire service, up to 1200 amps. Bulletin 47070.

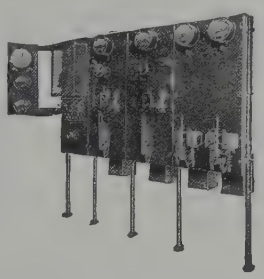
D. C. exciter panels are made in a variety of types to suit practically any operating conditions.

Bulletin A-4036.

G-E Alternating Current Switchboards

For alternating current plants where the ultimate capacity will not exceed 1500 Kv-a, both separate and combination generator and feeder panels are built. Sizes of generator panels, up to 5000 K.w. 480 volts and 680 K.w. 600 volts. Feeder panels up to 800 amps. Bulletin 47133.

For small alternating current plants where there is a possibility of later extensions, a line of panels is built which permits of adding units at any time. Both separate and combination generator and feeder panels. Generator panels up to 200 K.w. 240 volts and 400 K.w. 480 volts. Feeder panels, 2 to 9 circuit breakers. Bulletin 47131.



Typical G-E Standard Unit Panel A.C. Board for Use in Small Stations

For general power and lighting service up to 1800 Kv-a, voltages of 1150 and 2300 A. C., both separate and combination generator and feeder panels can be supplied. Generator panels up to 640 K.w. at 2300 volts, feeder panels up to 200 amps.

For controlling constant current transformers, series arc and incandescent panels in 1150 and 2300 volts A. C. can be furnished.

For starting and controlling squirrel cage, external or internal resistance, three-phase induction motors up to approximately 400 h. p., standard unit panels can be provided. Bulletin 47140.

For large plants operating at voltages up to 600 volts A. C., panels equipped with circuit breakers can be provided. Built for 240, 480, and 600 volts. Generator panels, single circuit. Feeder panels, single and double circuit. Voltage regulator and other panels.

Two types are built. For panels with oil circuit breakers mounted on pipe supports 5 inches back of panel, Bulletin 4901. For panels with oil circuit breakers mounted on pipe framework remote from switchboard, giving accessibility for cleaning, adjustment and repairs, Bulletin 47163-4.

For general lighting and power service, in the higher voltages up to 3500, a complete line of panels is built. All panels are so designed as to secure excellent service and a high degree of safety. By energizing instruments, relays and trip coils from the low tension side of transformers, there is no voltage higher than 110 volts on the front of the panels. Bulletin 47190.

Safety First Panels

The Truck Type Panels are especially adapted to group mounting and make a most desirable switchboard from the standpoint of safety to life, the elimination of fire risk and continuity of service.

Each complete unit consists of two elements—the truck or movable element carrying the panel, oil circuit breaker and instrument transformers; and the stationary or housing element enclosing the truck (when it is in an operative position), the buses and the terminal of the incoming and outgoing cables. All current carrying parts are completely enclosed when alive.

Bulletin 47100.

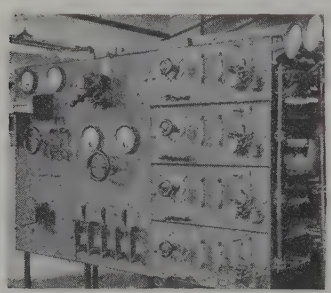
The Safety Enclosed Swing-Out Panel has a circuit breaker enclosed in a steel housing and so interlocked with the housing that the panel can be swung out only when the breaker is in the "off" position and the disconnecting device is therefore carrying no current.

Bulletin 67105.

Battery Charging Switchboards

Complete apparatus for charging storage batteries, for use either in electric trucks or locomotives, can be supplied by the General Electric Company.

The switchboard shown is expremely simple in operation designed to meet fully the needs of a yard having in use several storage battery locomotives or a large number of trucks. It is completely equipped with instruments, switches, rheostats, fuses, and automatic tripping devices, thus insuring safety and continuity in operation as well as guarding against overcharging of the batteries.



G-E Battery Charging Switchboard

Smaller charging outfits are available to meet requirements of lesser capacity.

G-E Switches and Circuit Breakers

The General Electric Company manufactures a complete line of lever switches, in either single or double throw, 1-, 2-, 3- or 4-pole and with straight or spade handle.

G-E circuit breakers are built with both air and oil break. The variety of types and sizes available permits the selection of a breaker exactly suited for any conditions of service.

G-E Electrical Instruments

The General Electric Company manufactures a complete line of indicating and recording instruments for all classes of electrical work.

For switchboard use, both round and horizontal edgewise types can be supplied in ammeters, voltmeters and wattmeters for either direct or alternating current.

G-E portable ammeters, voltmeters and wattmeters for direct or alternating current are well adapted for general testing purposes.

In curve drawing instruments, both ammeters and voltmeters can be furnished for either front or back connections.

For measuring power the General Electric Company manufactures the Thomson direct current astatic watthour meter.

Complete details regarding G-E instruments may be obtained by addressing the nearest office.

Flow Meters for Shore Use

The G-E Flow Meter provides a means of measuring accurately the total flow of steam, water, oil, air or gas through pipes or closed conduits and thus of securing information of great value in the economical operation of the power plant of a ship or shipyard.

Flow meters are built in several types for various classes of service, indicating, integrating and graphic recording. These three types have also been combined into one meter. Bulletin 46501C.

G-E Indicating Flow Meter

G-E Indicating, Recording and Integrating Flow Meter

Uses of Water Flow Meters

Water flow meters are used for measuring output of pumping plant, amount distributed to different sections, amount of feed water delivered to boilers, amount of water consumed in plants, etc., and for determining efficiency of pumps.

Uses of Air Flow Meters

Air flow meters are adapted for measuring the actual delivery of air compressors, for measuring the air consumption of any machine, group of machines or tools, etc. Thus they can be used for determining the efficiency of compressors, for discovering losses or leaks in air lines, for measuring the slip in pumps, etc.

Uses of Steam Flow Meters

Steam flow meters are adapted for measuring the amount of steam generated by a single boiler or battery of boilers; for measuring the steam used by any part of a plant for power, heating or manufacturing purposes; for measuring the steam consumed by turbines, etc. For equalizing load

on individual boilers of a battery, for checking the efficiency of any equipment generating or utilizing steam, for discovering losses caused by leaks, and for numerous other purposes, steam flow meters are invaluable.

Wire and Cable for All Purposes

The General Electric Company manufactures wires and cables with all standard types of insulation for all purposes.

Prompt co-operation in the selection of cable best suited for any specific conditions may be obtained by addressing the nearest branch office. Detailed information regarding G-E cables is given in Bulletin 49302.

Tests

All wires and cables are tested before shipment. A pressure test of at least two and one half times the working pressure is applied. After the pressure test, an insulation test is made with a 250-volt battery and delicate deflecting galvanometer.

Information for Ordering

In ordering, the following information should be given: size and number of conductors, current to be carried, voltage, type of insulation desired (rubber, paper, etc.), specific requirements as to insulation resistance, if any; finish desired (braided, leaded, armored, etc.), class of service, exact lengths in which each item is to be shipped.

Types of Insulation

Four grades of vulcanized rubber compound, the only practical waterproof insulation for electrical conductors, have been standardized and are made by the General Electric Company.

"Forty Per Cent" compound is particularly adapted for ship wiring, being used in U. S. Navy standard wire.

"Thirty Per Cent Hevea" is a very high-grade insulation, suitable for severe service and high voltages.

"Tricoat" insulation was designed for those desiring a high-grade wire but less expensive than the "Thirty Per Cent Hevea."

"Red Core" is an insulation suitable for house and building wiring and for all ordinary use. It is superior to the requirements of the National Board of Fire Underwriters.

In addition, special types and grades of rubber-insulated conductors to meet unusual conditions will be manufactured. Any of the standard finishes may be applied to rubber-insulated conductors.

Other types of standard insulations are weatherproof, flameproof, paper, varnished cambric and asbestos.

Braided Wires and Cables

Rubber-covered braided wires and cables are manufactured in a variety of types and sizes to meet practically any requirements. Included are lamp cords and flexibles, heater cord, deck cable, charging cables for electric vehicles, etc.

To facilitate pulling through conduits, braided wires and cables can be finished with a coating of talc, if so specified.

Cable with Braided Steel Armor

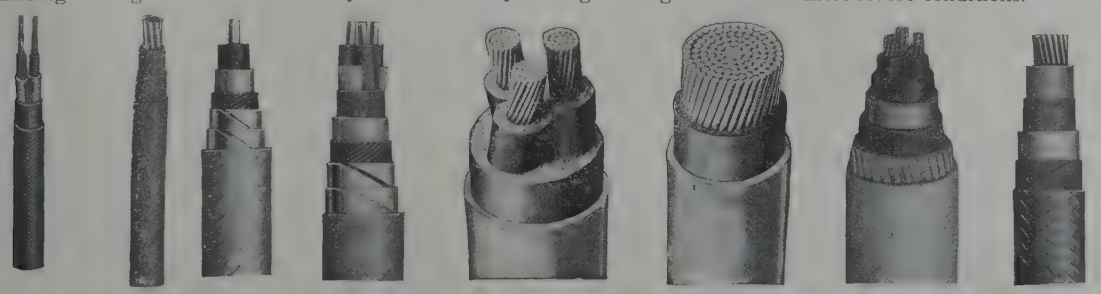
This type of cable is particularly adapted for use aboard ship, without conduit, and is the U. S. Navy standard. It consists of a basket weave of fine galvanized steel wires, applied over cables for mechanical protection.

Submarine and Dredge Cables

For use under water the General Electric Company manufactures cables to the following specifications: Conductors insulated with "Thirty Per cent Hevea" rubber compound and wrapped with varnished cambric; the insulated single conductors are stranded with jute fillers and jacket of varnished cambric placed over all; a lead sheath is next applied; then, between two layers of jute is applied a close helical winding of galvanized mild steel wires, the voids between wires being filled with asphalt compound.

For supplying power to electrically operated dredges, a cable similar to the above, except for the omission of the lead sheathing, is manufactured. This cable has the necessary flexibility to be supported on pontoons from the shore to the dredge.

Cables of these two types are giving good service at high voltages and under most severe conditions.



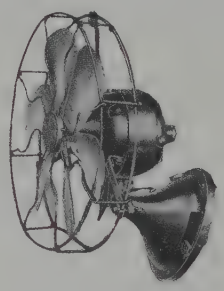
1 2 3 4 5 6 7 8

1. Deck cable; two-conductor, rubber-insulated, braided.
2. Single-conductor, stranded, cable; rubber-insulated.
3. Single-conductor, band steel armored cable.
4. Three-conductor, band steel armored cable.
5. Three-conductor, paper insulated cable.
6. Single-conductor, 2,000,000 C. M., cambric, leaded, cable.
7. Submarine cable, with steel wire, armor.
8. Navy standard cable with braided steel armor.

D.C. Electric Fans for Marine Service

G-E Direct Current Electric Fans for marine service are particularly adapted for use on board vessels. They are quiet in operation, light in weight, very efficient, and durable. The motors are enclosed, the iron base and motor cage are heavily enameled, and the fan blades and cage are of brass thoroughly lacquered, thus making the fans immune from the effects of exposure to dampness and salt air.

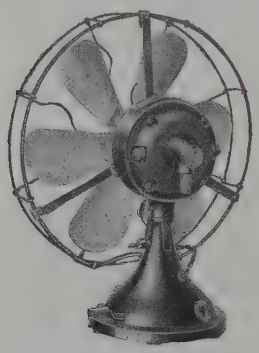
These fans may be readily converted from desk to bracket type as shown in the illustrations. They are arranged for three operating speeds, with "off" position. The control switch—which is mounted in the base—is of the improved lever design with notched guide insuring a positive setting for each speed.



Twelve-inch D.C. Marine Fan for Wall Mounting

These fans are furnished with six blades in non-oscillating types. They can be furnished for any popular voltage direct current and will operate over a range of 5 per cent above or below the normal voltage.

The power required at fast speed is 45 watts. Net weight 14 lbs.



Twelve-inch D.C. Marine Type Desk Fan

52-inch Direct Current Ceiling Type Fan

Standard AC and DC Electric Fans

G-E Standard Alternating and Direct Current Fans are made with four blades oscillating or non-oscillating in nine-inch, twelve-inch and sixteen-inch sizes. The twelve inch and sixteen-inch oscillating fans are also made with six blades.

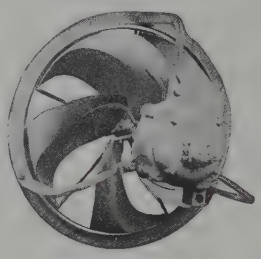
These fans are furnished to operate on either 110 or 220 volts alternating current with frequencies within the range of 25 to 60 cycles.

These fans are adapted for offices, shops, and wherever electric current is available.

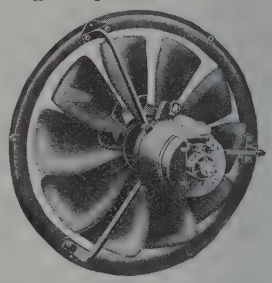
Ceiling fans are equipped with four blades in 32-inch and 52-inch sizes.

Motor Driven Exhaust Fans

These exhaust fan outfits are self-contained units, adapted for ventilating shops, factories, office buildings, etc., and for use where it is desirable to remove dust and smoke from buildings such as wood-working and forge shops.



Propeller Fan with Alternating Current Motor



Ventura Disk Fan with Direct Current Motor

They are also adapted for various ventilating purposes aboard ships. Fans of this type have been installed, with satisfactory results, in vent ducts from engine and boiler rooms, to insure proper circulation under all conditions. Bulletin 41801.

VENTURA EXHAUST FAN OUTFITS
Direct Current, with Type RT Motor

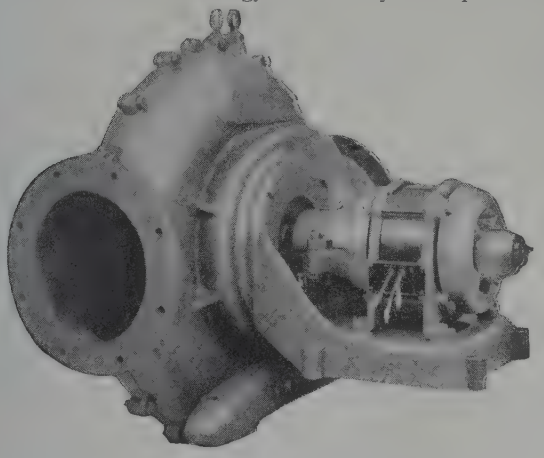
Fan No.	Dia. of Fan in In.	Air Delivery in Cu. Ft. per Min. (Approx.)	Ship Wt. in Lb. Outfit (Approx.)
2½	12½	850	45
3	16	1500	60
3½	18¾	2200	80
4	21¼	2900	125
5	26¾	4800	250
6	32	6900	300
7	37¼	9700	400
8	42¾	12500	575
9	48	16300	700
Alternating Current, 60 Cycles 1-, 2- and 3-Phase			
SINGLE-PHASE WITH TYPE SA MOTOR			
2½	12½	750	60
3	16	1580	90
3½	18¾	1860	130
SINGLE-PHASE WITH TYPE R MOTOR			
4	21¼	2900	190
5	26¾	4800	285
6	32	6500	375
7	37¼	9650	455
8	42¾	12500	585
9	48	17500	750
POLYPHASE WITH TYPE KT OR KQ MOTORS			
6	32	6500	390
7	37¼	9900	460
8	42¾	11300	620
9	48	17500	850

Centrifugal Blowers

The G-E centrifugal blower or centrifugal compressor is designed for large volumes and low pressures. It is particularly adapted for supplying air to oil or gas fired furnaces.

The blower or compressor is designed similarly to the well-known centrifugal pump. The drivers are either direct current motors, 60-cycle induction motors or steam turbines. The blower and driver are direct con-

nected, the complete unit requiring at most three bearings, and usually only two bearings. The blower differs from the ordinary fan blower in that it is provided with discharge or diffusion vanes which convert the otherwise lost energy of velocity into pressure



Centrifugal Blower Driven by Direct Connected 20 H. P., 60-Cycle Induction Motor

energy, resulting in high over all efficiency.

An inherent characteristic of the blower is its ability to deliver practically constant pressure over a wide range of loads. This is of particular advantage when the blower is supplying air to a battery of oil or gas fired furnaces, some of which may be shut down at times. The internal clearance of the blowers is very large, hence there is no internal rubbing, and no internal lubrication is required. The blower and driver being direct connected, means the minimum possible number of bearings, and eliminates countershafts and other fixtures inherent in belt or chain drive. It also eliminates much lubrication, otherwise necessary, for such fixtures. Gears, belts and chains being entirely absent, the expense incident to the protection of the operator therefrom to meet the requirements of state laws is eliminated. Bulletins 42800 and 48609.

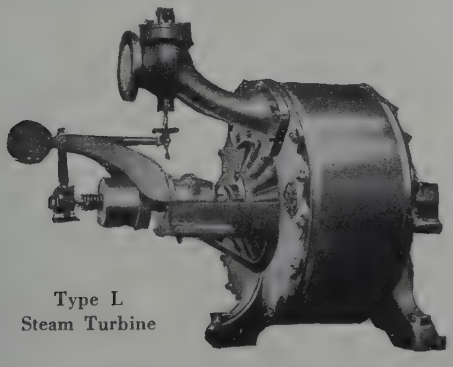
Turbines for Driving Pumps, Blowers, etc.

This turbine is especially adapted to driving centrifugal pumps, blowers, exhausters, generators and similar machines, and is furnished to operate exhausting to atmosphere or into a vacuum, or to operate against back pressure.

Turbines are built with one or more stages and with various sizes of steam and exhaust openings to suit specific requirements.

A governing device maintains a constant speed, and the speed may be changed while the turbine is in operation by simple hand wheel adjustment. Advantages in construction—split wheel casing, allowing ready inspection of bucket wheels; babbitted bearings with renewable linings; bronze buckets dovetailed into rim of wheel; packing gland readily accessible.

Descriptive leaflet 62010.



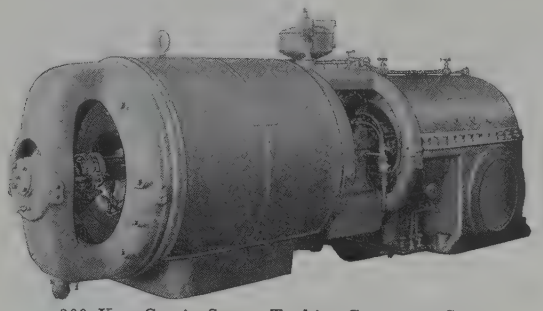
Type L
Steam Turbine

Generating Installations

The General Electric Company is in a position to supply complete equipment for the generation of electricity from steam, oil, gas or water power.

In addition to the direct current steam engine generating sets described on pages 944 and 945, Curtis Steam turbines can be supplied with A. C. generators up to 50,000 kv-a capacity and also with small D. C. generators.

Bulletins 42010, 42201A.

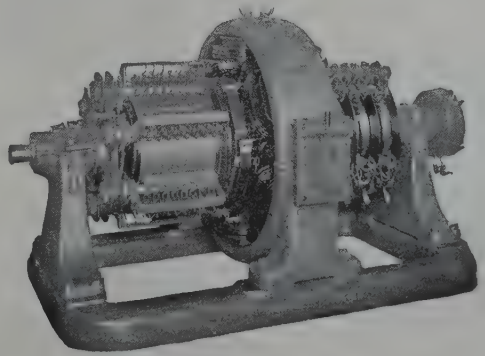


300 Kw. Curtis Steam Turbine-Generator Set

Synchronous Converters

G-E synchronous converters are well known through their extensive use by electric light and power plants, electric railways and industrial plants. They are made in sizes to meet practically any conditions of service.

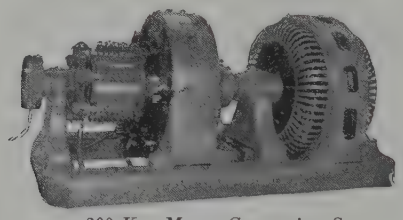
Where it is desirable to transform a small amount of power from alternating to direct current, G-E Type TC synchronous converter of the proper capacity may be specified. Bulletin 42500.



150 Kw. Compound Wound Synchronous Converter

Motor-Generator Sets

G-E motor-generator sets are built in sizes from .2 to 1500 kw. Small sets from .2 to 200 kw. are used for excitation purposes. A line of standard motor generators with single-phase, 60-cycle induction motor and shunt wound generators is used extensively for battery charging. Bulletin 42552A.

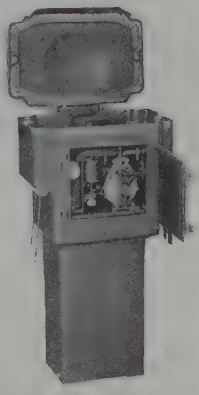


200 Kw. Motor Generating Sets

Voltage Regulators and Transformers

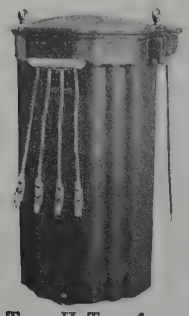
Constant voltage on a line may be provided by using G-E generator and feeder voltage regulators. A generator voltage regulator is usually installed in the main station to hold a constant busbar voltage. The feeder voltage regulators are installed at the main or substation and so adjusted that they will compensate for line drop to some predetermined center of distribution. The generator voltage regulators are designed to control alternating or direct current stations having a capacity as high as 200,000 kw.; while the feeder regulators are designed for operation on single or polyphase circuits of any standard voltage, frequency or current capacity.

Bulletins 45500A and 45402.



Pole Type Feeder Voltage Regulator

Smaller sizes of feeder regulators are also designed for outdoor installation to take care of unforeseen extensions in the line, industrial plants using both lighting and power service, as well as the regulation of lines tapping transmission lines for the purpose of supplying lighting service to small communities. Station type regulators either single-phase or polyphase may be adapted for outdoor service. Bulletin 45505.



Type H Transformer for Pole Mounting

For power service the General Electric Company is prepared to build transformers in all sizes. Detailed information should be obtained from the nearest G-E office.

For distribution service used in connection with light and power circuits the type H transformer for pole mounting is used. Bulletin 45110A.

G-E Electric Locomotives

The General Electric Company maintains a separate engineering organization specializing in electric locomotives. It has solved switching and haulage problems not alone in shipyards and on piers, but in many other industries.

The larger types are particularly adapted for switching cars. For lighter work electric locomotives as small as three tons can be supplied.

Advantages of Electric Locomotives

For switching and moving cars through the shipyards and on piers, the electric locomotive has many advantages over steam locomotives and other methods of haulage. motive. For the intermittent service required in a shipyard, the electric locomotive will save a large part of the costs of transporting material.

The electric locomotive has the following advantages: It consumes power only when in actual operation. Can be operated by one man of ordinary intelligence. Always ready for use. Has large momentary overload capacity. Possesses a simple and perfect system of control. Has comparatively few wearing parts and consequently low maintenance cost. Can be run inside buildings and in other places where the smoke and fire risk of a steam locomotive would forbid its use.

G-E Storage Battery Locomotive in Shipbuilding Plant

The storage battery type of electric locomotive has special advantages in shipyards where other operations do not allow necessary clearances for trolley wires.

Bulletin 64250 to 64257.

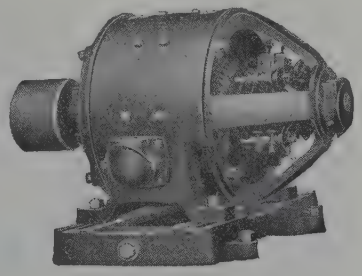
Locomotives can be furnished which operate from either a 250-volt trolley or a self-contained storage battery. The change from trolley to storage battery operation is made entirely automatic by a switch which makes the necessary connections without attention from the operator. This locomotive storage battery is automatically charged when locomotive is running from trolley wire.

Motors for Every Application

The General Electric Company manufactures a most extensive and varied line of electric motors, offering for every purpose or application a motor exactly adapted for the conditions of service. It is prepared to furnish complete information on the starting and control of any motor applied to any service, and to supply the motor and control suited to the conditions.

D. C. Constant Speed Motor

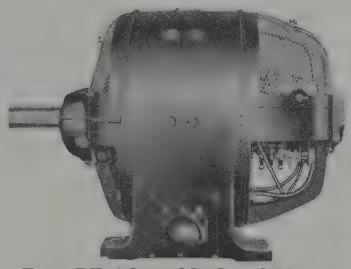
Type RC motor with commutating poles may be classed as the universal direct current motor as it is especially designed to meet the majority of conditions. Can be furnished shunt wound for close speed regulation, compound wound for heavy starting torque or where violent power fluctuations occur, or series wound where load either possesses fixed values or may be made subject to automatic or manual control. All RC motors are shipped for floor installations. May be readily arranged for wall or ceiling suspension. Bulletin 41013.



Type RC Motor with Pulley and Sliding Base

D. C. Adjustable Speed Motor

Type RF adjustable speed, commutating pole motors have been designed for machine tool and similar service where wide variation and adjustment of speed independent of load is required. Made for direct current only, in voltages of 230 and 550 and in ranges from 2 h.p. to 50 h.p. Speed adjustments 2 to 1, 3 to 1 or 4 to 1 to meet requirements. Bulletin 41021A.

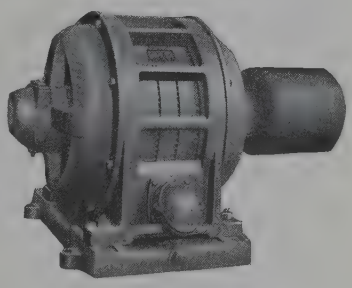


Type RF Adjustable Speed Motor

A. C. Polyphase Motors

Form KT Polyphase Induction Motors are built with either riveted or skeleton frame, from ¼ h.p. to 750 h.p., standard voltages. Adaptable for driving all classes of machines requiring constant speed. They are extremely simple, have great overload capacity and a high power factor.

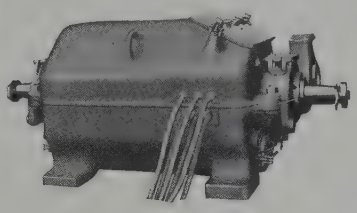
Form MT variable speed induction motors are adapted for service requiring frequent starting under load, or starting of loads with high inertia. High speed Form MT induction motors, ranging from 75 h.p. to 350 h.p., for direct connection can be furnished. Bulletin 41302A and 41519.



Constant Speed Induction Motor

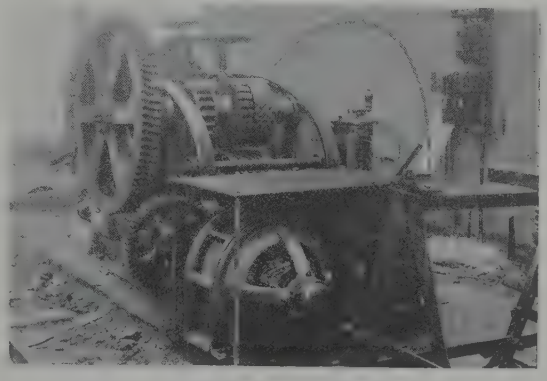
A. C. and D. C. Mill Type Motors

Type MI and MD mill type constant speed motors, for severe service, require special designs. In addition to cranes and reversing auxiliary machinery in steel plants, mill type motors can be applied with advantage to ore and coal bridges and unloaders, charging machines, heavy duty fabricating shop and erecting shop cranes, factory cranes, shears, small heavy duty hoists, etc.



Mill Type Motor

Furnished totally enclosed in sizes from 3 h.p. to 150 h.p. for 25-cycle, 220 and 440-volt A. C. and 230 and 550-volt D. C. Open type motors are furnished from 25 h.p. to 150 h.p. A. C. and 6 h.p. to 200 h.p. D. C. for continuous duty.



20 H.P. G-E Motor Driving Angle Iron Plane

Synchronous Motors

While the synchronous motor may be applied to most any industrial service, its greatest value is obtained when used on circuits which indicate a need for power factor correction as follows:

G-E Synchronous Motors Driving Air Compressors at the Sun Shipbuilding Company

1. When the power factor is low and greater generator, transformer or feeder capacity is required.

2. When power is purchased at a rate which is now, or shortly may be, dependent upon the power factor of the load.

3. When the voltage regulation is poor on account of an existing induction motor load and production falls off in consequence.

4. When continuity of operation is imperative and dirty operating conditions make a small motor air gap inadvisable.

The General Electric Company has designed complete lines of synchronous motors covering a wide range of speeds and capacities which are in extensive use throughout many industries driving rolls, compressors, pumps, grinders, crushers, blowers, fans, conveyors, etc.

For industrial drives these motors are furnished from 25 to 2,000 h. p. capacity with speeds from 80 to 1,800 r.p.m. and are designed to start any load met with in commercial practice without excessive current demands upon the power circuit.

Bulletin 41309. Our engineers will be pleased to supply additional information on request.

D. C. Crane and Hoist Motors

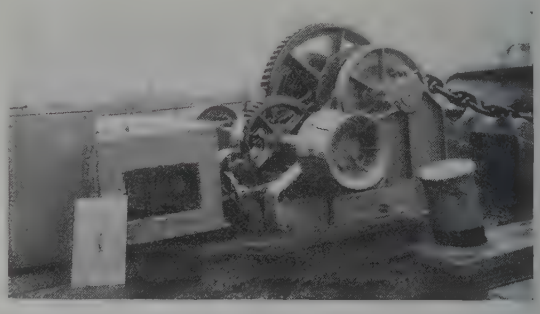
CO 1800 crane and hoist varying speed motors are designed for intermittent service requiring a maximum torque motor of ample overload capacity, enclosed, reversible and series wound. Suitable for floor, wall or ceiling mounting. Furnished with or without back gear.

Sizes range from 2 h.p. to 65 h.p., 115 and 230 volts, and to 50 h.p., 550 volts. Electric brakes of half or full torque capacity can be supplied to insure a quick sure stop. Bulletin 68100A.

Crane and Hoist Motor

Motor Starting and Control

An almost unlimited number of types and styles of motor controlling devices are manufactured by the General Electric Company. Among them are motor starting and speed regulating rheostats, starting compensators for A. C. motors, automatic starting devices, remote control switches, drum controllers, etc.

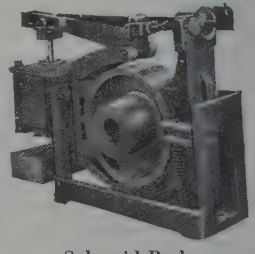


Windlass on S.S. "Bessemer," Driven by G-E Motor

Automatic Solenoid Brakes

G-E solenoid brakes, for both direct and alternating current, render excellent service for the automatic, quick stopping of rotating parts. As soon as the power is cut off the brake sets and applies a retarding force to the shaft.

G-E solenoid brakes are made for motors of 1 hp. and up, having equal braking torque in both directions of rotation. They are especially valuable for derricks, high speed hoists, etc. Bulletin 48900.



Solenoid Brake

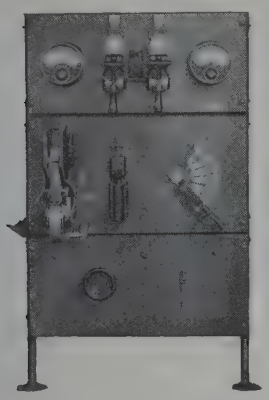
Uses and Advantages of Arc Welding

The use of welding apparatus in foundries, steel mills, shipyards and repair shops, is rapidly increasing, due to the economies effected, and this company has developed a complete line of electric arc welding equipment to meet all requirements. The principal advantages of the electric arc process is in concentration of heat (reducing expansion and contraction of metal worked upon) and high temperature.

Arc Welding Apparatus

Types of Arc Welding Apparatus

Two methods are employed—metallic and carbon electrode. In the former method, the metal of electrode is added to the weld, producing greater strength and smoother appearance. This is the only method which will deposit metal successfully on overhead surfaces. The carbon electrode method used for building up metal, plugging holes in castings, welding and joining parts where strength and appearance are not so essential or where surface is to be planed off. Greater speed can be attained with carbon electrodes because of greater current capacity. The method of operation is similar to soldering process. The carbon electrode method is also used for cutting and melting away metal.



Generator Control Panel

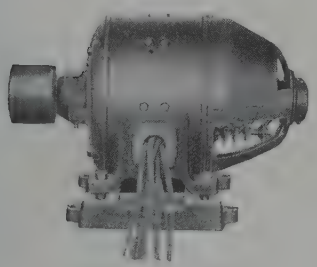
In some cases the tensile strength of metal in a weld may be as high as 55,000 to 60,000 lbs. A safe figure is 40,000 lbs. where work is done by experienced welders.

Approximate power input required for various systems ranges from 5 to 15 kw. or kv-a.

Principal types: Constant energy, self-excited generator; constant energy balancer sets; constant potential generator with auxiliary equipment; A. C. welder. All except constant potential type are primarily single-operator equipments suitable for bare metallic electrode welding only. Constant potential type may be used as a single operator equipment for either carbon or metallic electrode welding or a number of operators may work from one machine. This type also permits use of carbon electrode for cutting.

Each outfit consists of following apparatus:—

Constant energy, self-excited generator arranged for belt drive or direct connected to A. C. or D. C. motor, or engine, the maximum motor voltage being 550.



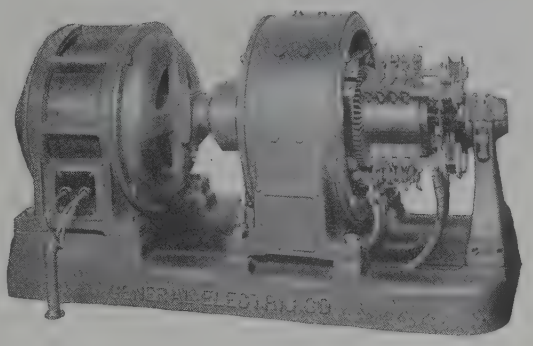
Arc Welding Generator, Constant Energy Type

Constant energy balancer sets of 150 amperes capacity are suitable only when 110 to 125 volts D. C. is available. If circuit has positive side grounded, it is entirely satisfactory. If not, special precaution must be taken.

Constant potential generators can be direct connected to D. C. motor, A. C. motor, or gas, oil, or steam engines.

The General Electric Company has developed also an automatic welder which can be operated from any of the above D. C. welding generators.

A. C. welders may be used on 60-cycle circuits of 220, 440 or 550 volts maximum. The welder is single



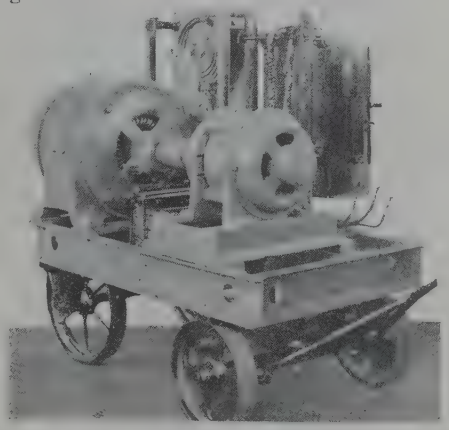
Arc Welding Generator Set, Constant Potential Type

phase, but where several are in use on a polyphase system, they may be distributed among the phases to partially balance the load.

Ratings and Current Requirements

Standard capacities of G-E arc welding outfits range from 150 to 1250 amps. Portable outfits are made in 3 sizes, 200, 300 and 400 amps.; stationary outfits in 9 sizes, 150, 200, 300 400, 500, 600, 800, 1,000 and 1,250 amps. Outfits of 300 to 400 amps. portable can be arranged for 2 operators by adding an auxiliary switchboard panel, as in case of all stationary outfits.

Current requirements vary with thickness of the metal to be welded. Maximum for metallic electrode welding is about 200 amps. Where several operators are working from one set under average conditions, it is safe to figure on 125 to 150 amps. per operator, taking advantage of intermittent nature of operation. For light work this value will be reduced.



Portable Arc Welding Generator With Starter and Control Panel

With carbon electrode, light work can be welded with 150 to 250 amps. Medium welding with carbon electrode requires 250 to 350 amps. and heavy welding 350 to 500 amps. The capacity of a set used for cutting depends upon speed required. 300 amps. will cut light metal, but currents up to 1,000 amps. are desirable for metal 2 in. thick or heavier. Cutting speed per minute per 100 amps. For heavy sections this may be estimated on basis of ½ sq. in. cross-section figure is somewhat high and for thin sections low.

Bulletin 48932A.

G-E Electric Rivet Heater

The G-E electric rivet heater is particularly adapted to shipyard use. It combines low first cost with simplicity of operation, is foolproof in construction and gives maximum efficiency. The advantages of the G-E electric rivet heater are:

No time wasted in starting production.

Rivet heats from inside, giving more uniformity of heat and best upsetting conditions in shank. Also minimum of scale forms due to even quality of heat.

Clean and cool—no smoke, ashes or contaminating gases, and minimum of heat radiation. Energy used only when heating rivet, giving high economy by eliminating wastage of fuel. High efficiency by localizing heat in the rivet.

Close heat regulation. Heats rivets from 7/8" to 5" in length without adjustment. Heater is portable.

Construction and Operation

A transformer rated at 15 Kw. is mounted on angle iron legs. At the front of the transformer, two copper bars are fitted with heavy electrode blocks and under these is another copper electrode block which acts as a support and electrical connection for two rivets. When the rivets are stood up on the block and the electrodes allowed to drop on the rivet heads, the circuit is completed and heating begins. The two top electrodes may be raised independently by two foot pedals. A primary tap switch gives all the variation needed for different lengths and diameters of rivets and rate of heating desired.

Electric Rivet Heater in Use

In operation, the G-E electric rivet heater overcomes many difficulties encountered with other methods of heating rivets. Large quantities of rivets are frequently rejected, after having been driven, due to uneven heating and the consequent failure to upset properly. The electric rivet heater insures uniform heating throughout the rivet.

Where rivet heating apparatus must be located in the holds of ships, the improvement in atmospheric conditions and the elimination of all difficulty in getting fuel to the heater, make the G-E electric rivet heater particularly valuable.

Sizes and Capacities of Electric Rivet Heater

The standard sizes of G-E electric rivet heaters are 5 Kw. two-jaw, for rivets up to one-half inch and 15 Kw. two-jaw, for rivets up to seven-eighths inch. The two-jaw heaters are intended to supply the maximum requirements of one gang. Bulletin 69701.

G-E Electric Furnaces

Electric Muffle Furnace

The electric muffle furnace meets the demand for a convenient, economical and durable furnace for temperatures up to about 850° C. For heat treating carbon steel, baking vitreous enamel, experimental purposes, etc., this furnace is very economical.

For heat treating processes requiring a temperature from 900 to 1800° F., the Company has developed a type of electric heating unit which is adapted to either horizontal furnaces or vertical cylindrical furnaces.

Electrically Heated Oil Tempering Baths

G-E oil tempering baths, electrically heated, afford a uniform and definite process of tempering from which the personal element, uncertainty, oxidizing and fire hazard are entirely eliminated. They may be used on either direct or alternating current. The temperature of the bath can be fixed within very close limits by regulating switches, a thermometer indicating exact temperatures. The operation is, therefore, largely automatic and only unskilled labor is necessary. Bulletin 69700.

Electric Sherardizing Machines

Metal to be rendered noncorrosive is sherardized by being electrically heated in the presence of zinc. Electric heat is ideal for this purpose as the temperature can be maintained with absolute certainty. Described in bulletin 48926.

Metal Melting Pots

The General Electric Company has developed a new electrically operated device for melting lead, babbit and similar metals, called the Self-Regulating Metal Melter, its principal feature being automatic heat regulation. Bulletin 69703.

Other Industrial Heating Equipment

G-E electric heating units are applied also to the following forms of apparatus:

Electric Soldering Irons. Bulletin B3514. Soldering Iron Muffle Furnaces. Bulletin 69702. Electric Glue Pots, Bulletin 69100. Kettles for melting compounds, heating oils, solutions, etc.

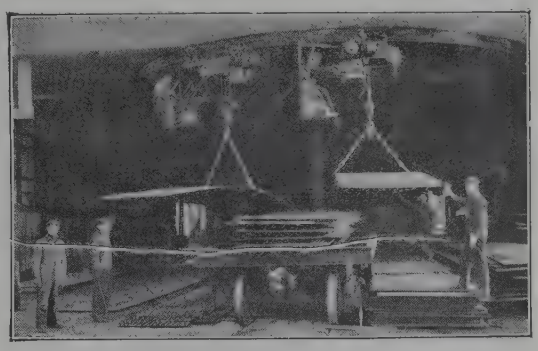
Sprague Electric Hoists and Winches

Sprague Electric Monorail Hoists

Sprague Electric Monorail Hoists are made either floor controlled or cage controlled in capacities from ¼ to 6 tons.

Indoor and outdoor monorail systems have proved to be great labor savers in handling materials in shipbuilding and fabricating.

The electric monorail hoist running on its I-beam track travels at a high rate of speed and can go anywhere that the single I-beam runway can be supported. There is a great saving of valuable floor space over the hand truck method, much less confusion and material can be piled high to the best advantage.



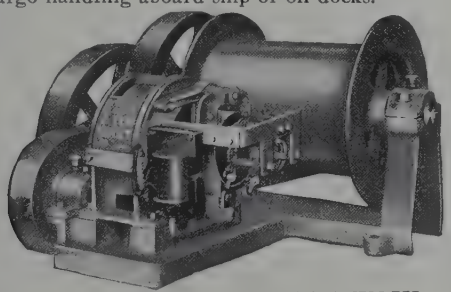
Handling Ship Plates in the Skinner & Eddy Shipbuilding Yard

RATINGS AND WEIGHTS
Standard Monorail Hoists
Cage Controlled

Load Tons	Hoist: Speed Feet per Min.	Hoist: Lift Feet	Hoist: No. of Ropes	Hoist: Hoist Type	Hoist: Motor H. P.	Trolley: Speed Feet per Min.	Trolley: Motor H. P.	Trolley: Min. Radius of Curve Feet	Weight of Monorail Hoist Complete: With Open Cage	Weight of Monorail Hoist Complete: With Enclosed Cage
½	30	28	1	S 1	1½	350	1	8	1835	1960
1	15	13	2	S 1	1½	350	1	8	1865	1990
1	20	30	2	W1	3	350	2	8	1925	2050
1	40	30	2	W1	6	350	2	8	2045	2170
1½	26	50	2	W2	6	350	4	8	2435	2560
2	10	15	4	W1	3	350	4	8	1975	2100
2	20	15	4	W1	6	350	4	8	2095	2220
2	30	50	2	W2	9	350	4	8	2535	2660
2	35	31	2	S 2	6	350	4	6	2660	3370
2	50	31	2	S 2	9	350	4	6	2760	3470
3	13	25	4	W2	6	350	4	8	2525	2650
3	23	21	3	S 2	6	350	6	6	2670	3380
3	33	21	3	S 2	9	350	6	6	2770	3480
3	50	48	2	S 3	12	350	6	6	4640	5300
4	15	25	4	W2	9	350	6	8	2625	2750
4	17	15	4	S 2	6	350	6	6	2710	3420
4	25	15	4	S 2	9	350	6	6	2810	3520
4½	33	31	3	S 3	12	350	8	6	4660	5320
6	25	23	4	S 3	12	350	10	6	4730	5390

Horizontal Winches

Horizontal Fixed Drum Winches are for a variety of purposes. The winch illustrated is used for operating the derrick boom of a ship building crane. A larger size is made for cargo handling aboard ship or on docks.



ELECTRIC HORIZONTAL WINCH

Lbs. Pull on Rope	Motor A. C.	H. P. D. C.	Speed of Rope Feet per Minute	Approximate Weight of Winch
1000	5	6	100	2200 Lbs.
2000	10	12	100	2200 Lbs.
3000	15	15	100	2200 Lbs.
4000	20	20	100	2200 Lbs.

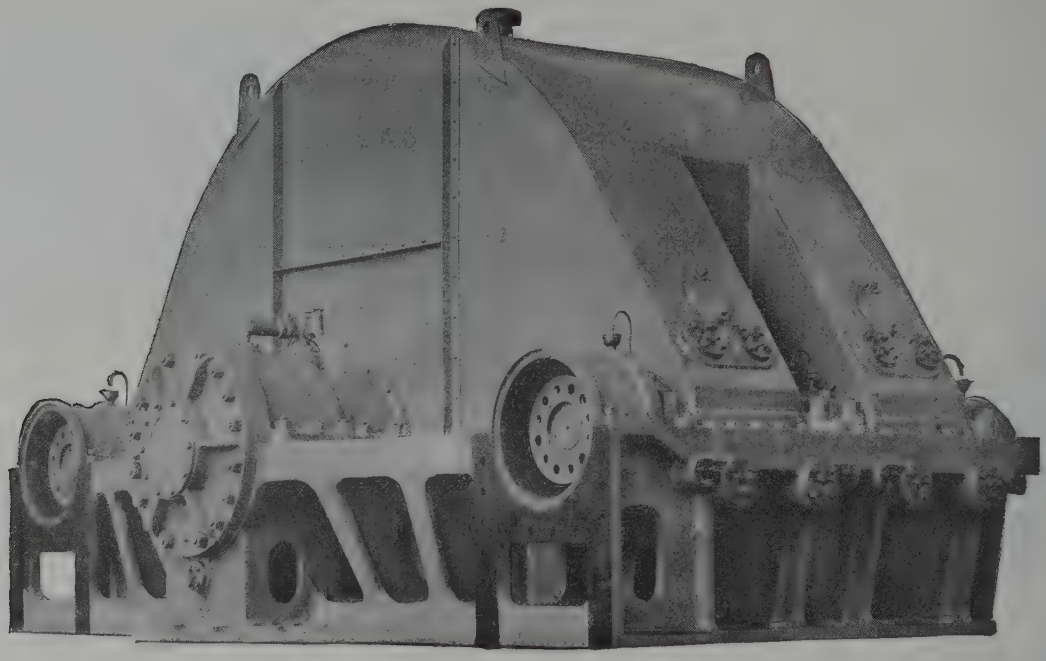
Vertical Winches

The Vertical Winches are totally enclosed and are ideal for outdoor jobs requiring a pull from one to twelve tons. They are used on dry docks, and for warping barges and pulling cars.

ELECTRIC VERTICAL WINCH

Lbs. Pull on Rope	Motor A. C.	H. P. D. C.	Speed of Rope Feet per Minute	Approximate Weight of Winch
12000	10	12	25	2600 Lbs.
6000	10	12	50	2600 Lbs.
4000	10	12	75	2600 Lbs.
3000	10	12	100	2600 Lbs.
2000	10	12	150	2600 Lbs.

Falk Marine Reduction Gears

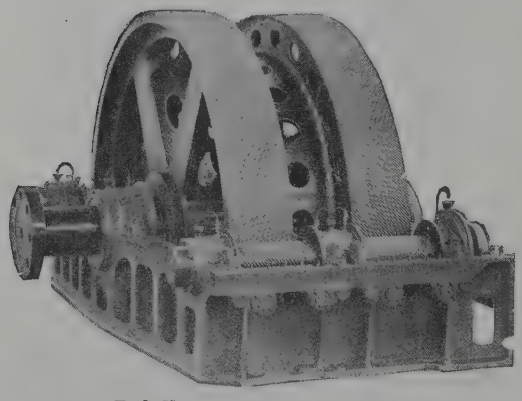


Single Reduction Marine Gear for Compound Turbines, 6000 S. H. P., 1900 to 132 R. P. M., Including Kingsbury Thrust Bearing.

Marine Reduction Gears

Marine Reduction Gears form a necessary and vital part of all modern turbine driven installations for the propulsion of ships because of the fact that there is a very great difference between the economical speed of steam turbines and of screw propellers.

The mechanical reduction gear between the turbine and propeller enables each to operate at the most economical speeds. The same condition is met when screw propellers for ships are driven by oil engines, although the difference in economical speeds is not so great in these cases.



End View with Cover Removed

Types of Marine Reduction Gears

The types of marine reduction gears manufactured by The Falk Company cover the entire range of requirements for war ships, passenger and freight vessels driven by steam turbines or oil engines.

High powered boats of relatively high speed are usually furnished with single reduction units with single or compound turbines, because in such cases the total speed ratio between turbines and propellers does not usually exceed from 8 to 16:1, or in extreme cases 20:1.

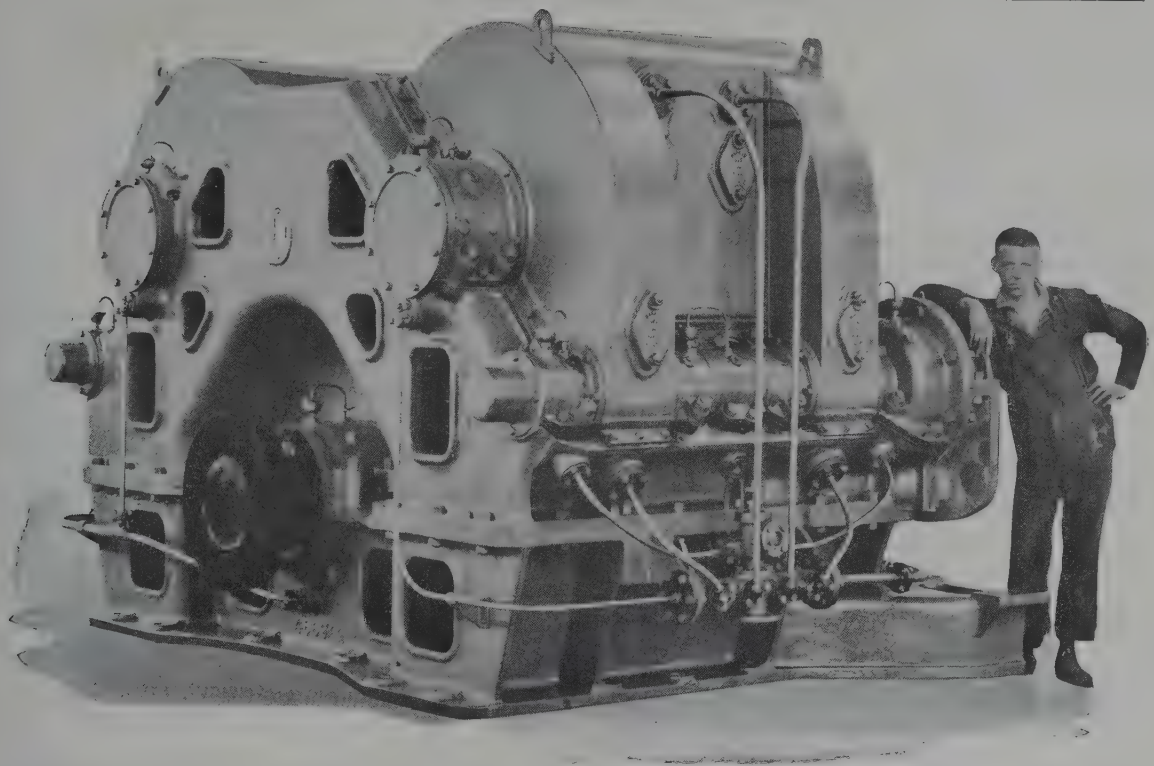
The double reduction type is usually necessary for driving cargo boats and other ships of relatively slow speed and small power. For these drives the smaller turbines require higher speeds for their most economical operation, while the propeller speeds average about 90 R. P. M. and in some cases are as low as 75 R. P. M. These combinations require gear ratios with reductions ranging between 30 and 50:1. Consequently, it is necessary to use a double train of gears to attain a mechanical arrangement of reasonable proportions.

Reduction gears for oil engine drives are invariably single reduction, since the difference between the most economical engine and propeller speeds seldom requires a gear ratio of more than 2 or 3:1.

Advantages of the Falk Gear

The Falk Marine Reduction Gear is a precision product of the highest order. This Company is equipped with the largest and most accurate gear hobbing machines in existence, and has also built for this purpose a number of special precision tools which insure the highest degree of ac-

Falk Marine Reduction Gears



After End of Double Reduction Marine Gear for Compound Turbines, 2800 S. H. P., 3600 to 90 R. P. M., Including Kingsbury Thrust Bearings

curacy in the manufacture of the gear frames and bearings as well as of the gears themselves.

The Falk Company's designs are the result of long experience in this class of work and include extreme rigidity and accuracy with perfect accessibility of all renewable parts. All bearing caps are exposed and the bearing shells can be changed at sea when necessary, with a minimum loss of time.

Facilities

The Falk Company's herringbone gear plant is the largest of its kind in existence and is most completely equipped with every kind of apparatus necessary for producing this specialized product on a very large scale. The Plant is centrally located and well placed for the rapid transportation of its products to any port or shipyard in the United States.

Other Products

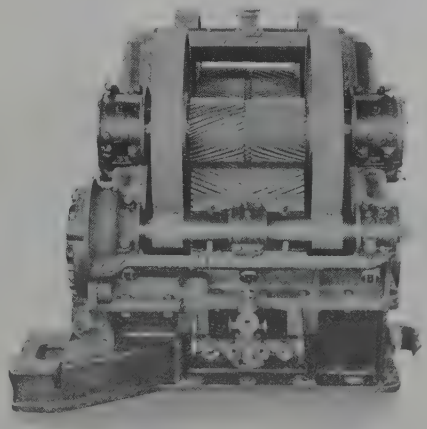
While the Falk Company's Engineering Department is exclusively devoted to the production of precision herringbone gears and gear units, the plant includes, in addition, the largest open hearth steel foundry west of the Pittsburgh District. This is of immense advantage to the gear business because steel castings enter very largely into the construction of reduction gears, and the continual and close co-operation between the foundry and engineering department have made it possible for this Company to produce steel castings for gears of a quality which has never been duplicated elsewhere.

Castings for stern frames and rudder frames are also produced in the foundry.

Branch Offices

Efficient service is rendered by our following Branch Offices where experienced and trained engineers supervise new installations, and follow up the performance of ships with Falk geared installations when they come into port.

M. P. Fillingham, 30 Church St., New York, N. Y.
F. W. Grimwood, Rialto Bldg., San Francisco, Cal.
W. O. Beyer, 1007 Park Bldg., Pittsburg, Pa.



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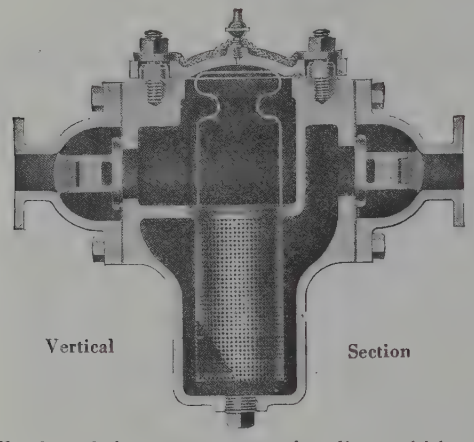
THE FALK COMPANY

MILWAUKEE, WIS., U. S. A.

Twin Oil Strainers

Applications

The Twin Oil Strainer, being two strainers in one, assures uninterrupted service through any line in which it is placed. This is a consideration of greatest importance in the operation of fuel oil and lubricating oil systems in which the interruption of flow would seriously affect the entire plant. The Twin Oil Strainer is equally

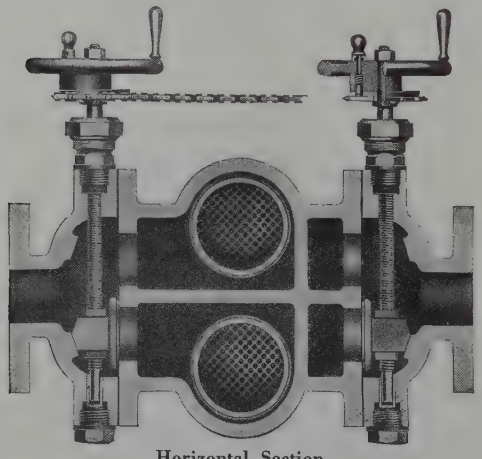


Vertical Section

well adapted for use on any other lines which must be kept free of solids, such as water for turbine bearing glands. The Elliott Company has furnished several thousand of these strainers to the different shipbuilding companies.

Features of Construction

The Twin Oil Strainer is arranged for utmost convenience in operation and adjustment. The body of the strainer is divided into two compartments as shown in the horizontal section, each of which contains a straining basket as shown in the vertical section, to catch and retain the solid impurities in the oil. By a simple arrangement of the



Horizontal Section

valves, the oil is caused to pass through either one of the straining baskets, while the other, being out of service, can be cleaned and replaced without interrupting the flow.

The valves are moved from one position to another by simply turning the handwheels. If desired, a chain drive mechanism as shown in illustration, can be furnished to shift both valves at the same time.

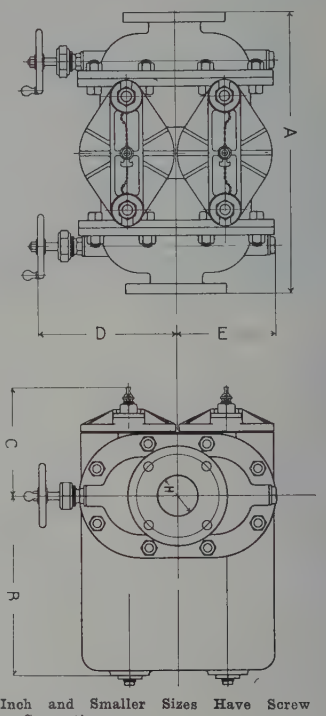
The straining baskets are conveniently accessible through quick detachable doors.

Determination of Proper Size

Good engineering practice as first established by the Navy Department holds that 125 feet per minute should be the maximum velocity employed in handling fuel oil in suction

TABLE OF DIMENSIONS IN INCHES

Size	1	1¼	1½	2	2½	3	4	5
A Length over Flanges	10	10	17	17	17⅞	20⅝	25	28⅝
B C. L. to Drain	5⅜	7⅛	6⅞	9½	11½	13¼	16⅜	21¼
C C. L. over Top	4¾	4¾	6¾	6⅞	6⅞	8	9⅛	10¼
D C. L. over Handwheel without Chain Drive	6	6	8½	9¼	10⅛	12⅛	14⅛	
D C. L. over Handwheel with Chain Drive	7⅛	7⅛	10	10	10⅛	11⅛	13⅛	15½
E C. L. over End	3⅜	3⅜	5⅝	5⅝	6⅛	7⅛	9⅛	10½



Strainers in the 2 Inch and Smaller Sizes Have Screw Connections.

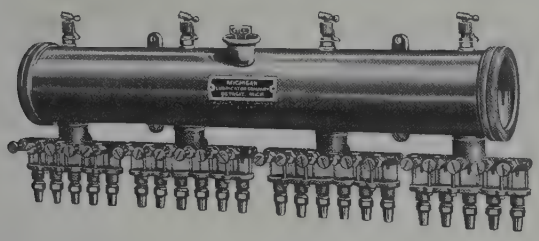
lines, a velocity of 80 to 100 feet per minute being recommended. In fuel oil discharge lines, the maximum velocity permissible is 250 feet per minute. While lubricating oil is less viscous than fuel oil, the same limits are generally used, and these limits will, of course, determine the size of pipe line and of the corresponding strainer to be used.

Twin Oil Strainers are standardized for working pressures up to 125 lbs. per square inch. Strainers of extra heavy construction can be furnished for working pressures up to 300 lbs. per square inch. Baskets for Twin Oil Strainers may be supplied with any size of perforation from 1/64 inches to 1/16 inch in diameter, the standard being 1/32 inch.

Other Products

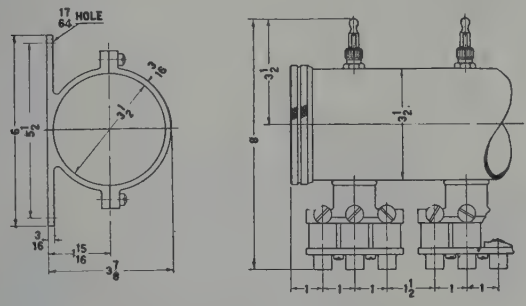
The Elliott Company is also prepared to furnish all types of Condensers, Strainers for Water Service, Oil and Steam Separators, and Boiler Tube Cleaners.

Michigan Lubricators and Valves



Multiple Geed Gravity Oilers

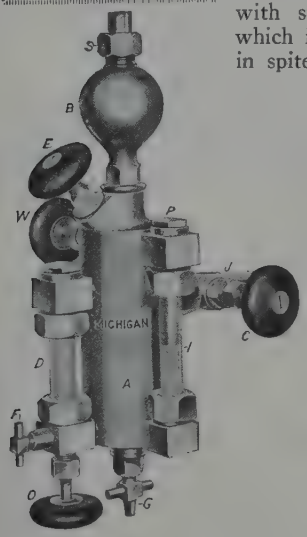
Michigan Multiple Feed Gravity Oilers supply oil to a number of bearings from one tank or reservoir which can be located in the most convenient place available. They are made with any number of feeds desired at the purchaser's option. Each feed has its own regulating screw. The feeds are banked in groups of from two to six and each bank is equipped with a snap lever shut off which starts or stops all feeds in that bank without disturbing the feed adjustment.

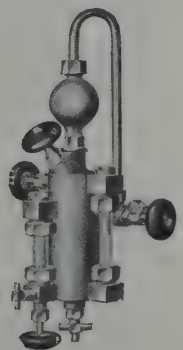


Capacity Averages 6 Oz. Per Feed.

Steam Cylinder Lubricators

Our Cyclone Double Connection Lubricator and its Single Connection mate, the Rural, are known all over the world. These lubricators are provided with steam heating chambers which insures perfect operation in spite of weather conditions.



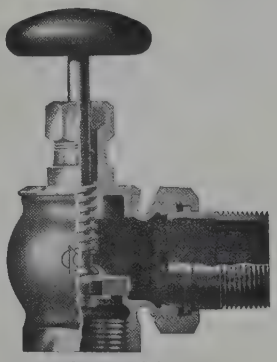


Single Connection Style—The Rural

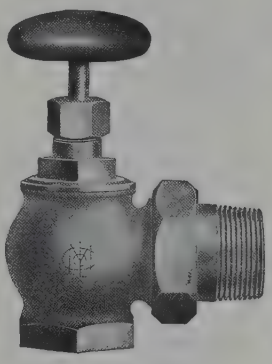
Size—¼ Pt., ⅓ Pt., ½ Pt., 1 Pt., 1 Qt.
Thread—½, ½, ½, ½, ½

Radiator Valves

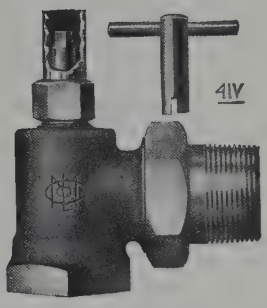
Improved Method of Handle Fastening (Pat. Applied For)



Sectional View



Model 10 V



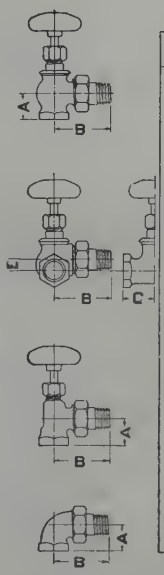
With Lock and Shield

We can make any of our Radiator Valves with lock and shield instead of wood handle. Lock shield type valves are considered special and are therefore not carried in stock but made to order only. Prices and deliveries on application.

Size	⅛	¾	1	1¼	1½	2
Standard Package	24	24	12	12	6	6
Standard Package weights	18¾ lbs.	28 lbs.	22 lbs.	31 lbs.	20 lbs.	30¾ lbs.

VALVE DIMENSIONS

For All Models



SIZE NO. / PIPE SIZE		1 ½	2 ¾	3 1	4 1¼	5 1½	6 2
10V, 11V	A	1	1 1/8	1 5/16	1 9/16	1 3/4	2
	B	2 3/32	2 7/16	2 13/16	3 7/32	3 5/8	4 5/32
20V, 21V, 30V, 31V	B	2 5/32	2 1/2	2 15/16	3 11/32	3 3/4	4 7/32
	E	7/16	9/16	3/4	7/8	1	1 5/16
	C	1 7/32	1 7/16	1 5/8	1 7/8	2 1/8	2 7/16
40V, 41V	A	1	1 1/8	1 5/16	1 9/16	1 3/4	2
	B	2 3/32	2 7/16	2 13/16	3 7/32	3 5/8	4 5/32
5V	A	1	1 1/8	1 5/16	1 9/16	1 3/4	2
	B	2 3/32	2 7/16	2 13/16	3 7/32	3 5/8	4 5/32

MICHIGAN LUBRICATOR CO.

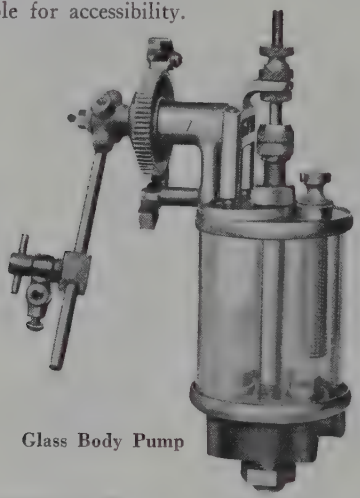
655-669 BEAUBIEN STREET, DETROIT, MICHIGAN

Force Feed Lubricators

Hills-McCanna Products

Hills - McCanna products have been satisfying the exacting requirements of marine engineers for over thirty years. Their reputation is well established. Years of experience in ships' engine rooms gave the designers of the Hills-McCanna line thorough and practical knowledge. The inevitable result of this sound basis for correct design is a simple workmanlike product, standardized and unchanged for over twenty years.

Notable for accessibility.



Glass Body Pump

We illustrate at the left the original glass body design, which is particularly well adapted for marine service.

Below we illustrate a later type of metal body pump, the particular one shown being a 4-feed single compartment.

All Hills-McCanna multiple feed lubricators are built up of complete pump units.

Each unit is independent in action, and can be adjusted, disconnected or removed without affecting the operation of the other units.

Individual feed adjustment, covering a wide range of regulation.

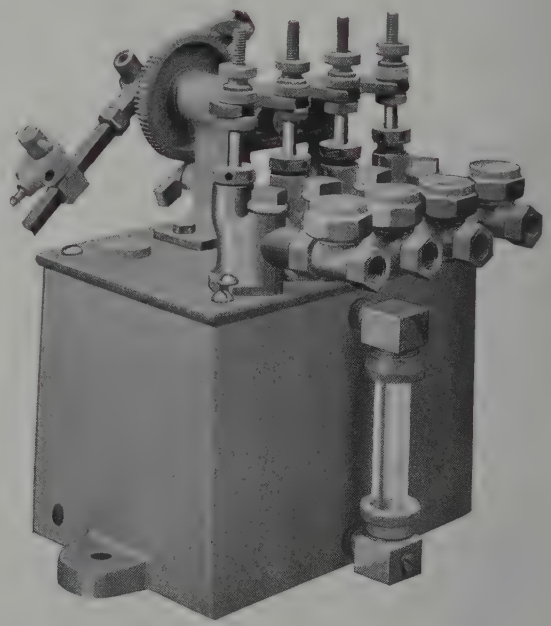
Sight feed is on the discharge side, and shows oil actually being delivered—not a drip to be picked up later.

All working parts on the outside of the reservoir, easy to clean.

These features are readily appreciated by the marine engineer, and give the Hills-McCanna pump the name of the "get-at-able" lubricator.

Separate compartments for different oils in the larger sizes.

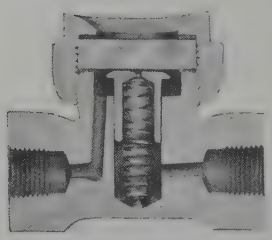
Ratchet driven, taking power from a moving part of the engine, pump or compressor.



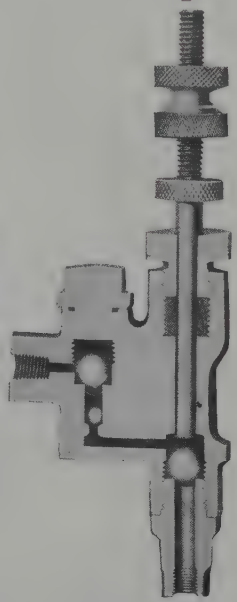
Metal Body Pump
Four Feed

Force Feed Oil Pumps

The Hills-McCanna Company was first in the field of force feed lubrication. The lead obtained by priority has been maintained through the perfection of the lubricating devices. The Hills-McCanna force feed oil pump is well known in every home port and on the high seas.



The Sight Feed
The Eye of the Pump



The Valve
The Heart of the Pump

Features
The Valve
The Sight Feed

The Valve—A pump is no better than its valve. The simplicity of the Hills-McCanna valve is so apparent, and its superiority so universally acknowledged, that no further comment is necessary.

Imitations are many, but there is only one Hills-McCanna valve, standardized and unchanged during the last generation.

The Sight Feed—Lubrication is not insured unless

it is under the watchful eye of the engineer. The Hills-McCanna sight feed insures delivery of oil. If the blinker shows oil feeding the engineer knows his cylinder or bearing is getting every drop that passes "the eye of the pump."

Multiple Feed Special Pumps

Special large pumps are built in sizes from 2-gallon 4-feed to 9-gallon 60-feed.

Multiple oil compartments for use with different oils.

A lubricator designed for use on oil and producer gas engines.

The economy of centralized control for the lubrication of large prime movers is universally acknowledged by engineers—maximum economy is realized by the installation of a Hills-McCanna multiple feed pump as the motive power.

A lubricator that will show a saving of 60% to 80% in oil consumption over hand oiling, giving better lubrication and more satisfactory feed regulation.

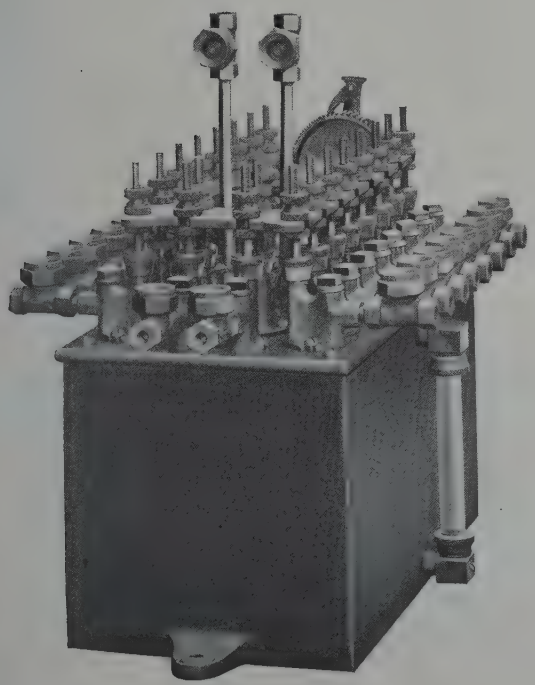
Direct, motor, or belt drive, speed reduction by worm or ratchet as may be selected.

Standard pump parts and equipment.

Each unit can be separately adjusted to cover a wide range of oil deliveries.

Flash sight feed on each line to show positive operation.

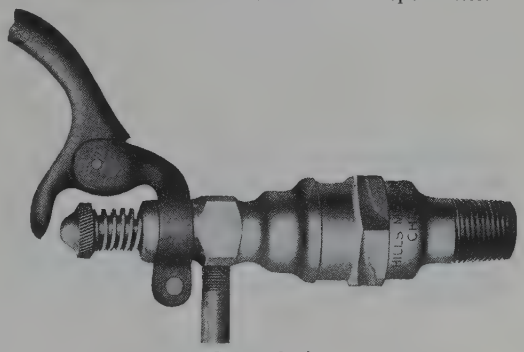
Not a stock size. All pumps of more than 4-feeds are designed for the particular service required, and assembled on order.



Metal Body Pump
Twenty Feed

Other Specialties

The same correct design, simple construction and standardization which charactize the force feed oil pump are the outstanding features of all other Hills-McCanna specialties.



Gauge Cock

High Pressure Gauge Cocks

The Hills-McCanna gauge cock is quick acting, nonleaking and heavily constructed. Rugged proportions, ample port area, and superior metals all combine to make a long-lived gauge cock.

Seats and stems oversize to allow for re-grinding. Easily replaceable at low cost, and with minimum installation expense.

Fusible Boiler Plugs

Made under government supervision of the best obtainable material by careful workmen.

The popularity and demand for Hills-McCanna plugs is due to the quality of the metal shell, superior finish, and generous proportions.

Marine Swing Joints

Designed by practical marine engineers for continuous service.

Strict adherence to the Hills-McCanna policy of quality regardless of price has developed a swing joint of high grade material, carefully machined for long life.

A set will feed and remain tight as long as the engine will run.

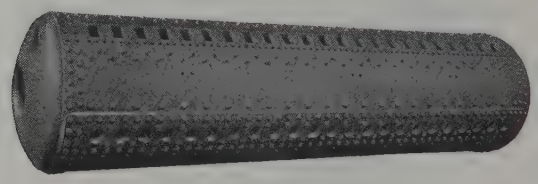
LUBRICATORS

Capacity	Feeds	Reservoir	Weight	Code Word
Pint, glass	1	3½x4	11	Admirable
Quart, glass	1	4½x6	16	Beneficial
Pint, metal	1	5¾x6¼	16	Artistic
Quart, metal	1	6⅛x7½	23	Blameless
Quart, metal	2	6⅛x7½	25	Boastful
Half Gallon, metal	1	7½x8¾	25	Capital
Half Gallon, metal	2	7½x8¾	27	Careful
Half Gallon, metal	3	7½x8¾	29	Conservative
1-Gallon, metal	1	9½x10¾	34	Dependable
1-Gallon, metal	2	9½x10¾	36	Decorative
1-Gallon, metal	3	9½x10¾	39	Deliberate
1-Gallon, metal	4	9½x10¾	42	Defender
2-Gallon, metal	1	11½x12¾	44	Earnest
2-Gallon, metal	2	11½x12¾	46	Easement
2-Gallon, metal	3	11½x12¾	49	Eclipse
2-Gallon, metal	4	11½x12¾	52	Educator

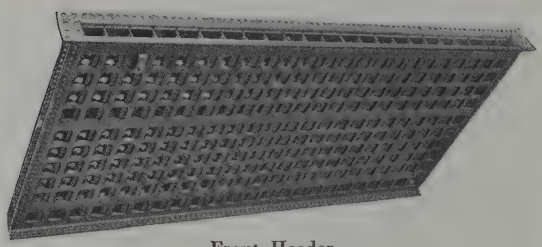
Ward Water Tube Boilers

Distinctive Features of Construction

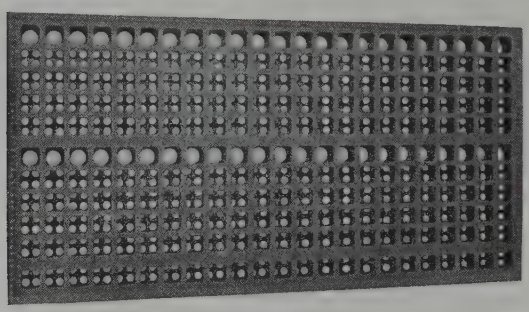
The Ward Water Tube Marine Boiler differs from nearly all others in point of construction by the elimination of all stay bolts and nipple connections. It consists of two parts, the front header and drum as one piece and the rear header as another, the front header being flanged and riveted to the drum throughout its entire length. The



Drum



Front Header



Rear Header

accompanying photographs illustrate the construction of these component parts.

The design and construction of the headers is such that the flat surfaces are practically eliminated and the header becomes a number of rectangular passages or square tubes. The handhole plates and tube plates are of rolled steel 7/8 and one inch in thickness, depending on the working pressure. These plates are connected by means of an "I" section division wall which is fitted in machined "T" slots running vertically between the alternate rows of tubes, as shown in the photograph of a section of header, opposite. This division or stay plate forms a continuous support and entirely eliminates the necessity for stay bolts and the consequent liability to leaks and breakage.

Efficiency of Water Circulation

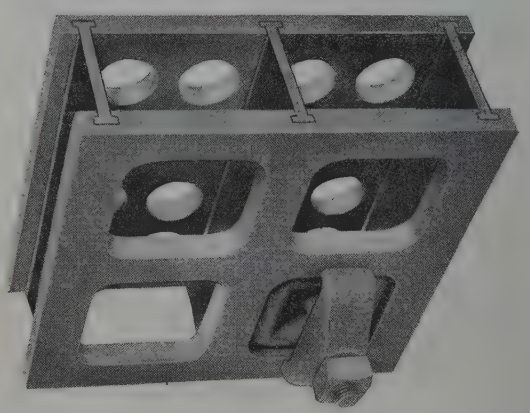
Particular attention is called to the circulation of the water, as indicated on the cross-section view on the opposite page. The boiler proper is divided into upper and lower banks of tubes separated by a row of large down-flow tubes. Experiments have shown that shortly after the fires are started the water begins to rise in the lower bank of tubes and return first through the row of large down-flow tubes. After the boiler begins to steam freely the water flows down through the upper bank of tubes indicating that the baffling as arranged secures the benefit of the counter-current principle throughout the boiler, resulting in extremely high efficiency.

The efficiency of the Ward Boiler is further increased by the method of baffling. This is of the well known horizontal type with intermediate baffles in the larger sizes to insure the gases coming in contact with all the heating surface.

Special provision is made for the installation of soot blowers between the tubes, providing effective means of keeping the generating surfaces free from soot.

Superheaters

Superheaters fitted in Ward Boilers are of the simplest possible construction, consisting of a cross passage in the front header of the boiler and individual inlet and outlet headers at the rear of the boiler. The transverse passage to the inlet and outlet headers is connected by straight tubes expanded in the same manner as the boiler tubes. The individual headers at the rear of the boiler provide for the expansion between the inlet and outlet side of the superheater. The superheater tubes can be withdrawn for repairs, if necessary, through the handholes the same as an ordinary boiler tube. The superheater tubes are cleaned by the same soot blowers as the boiler tubes.



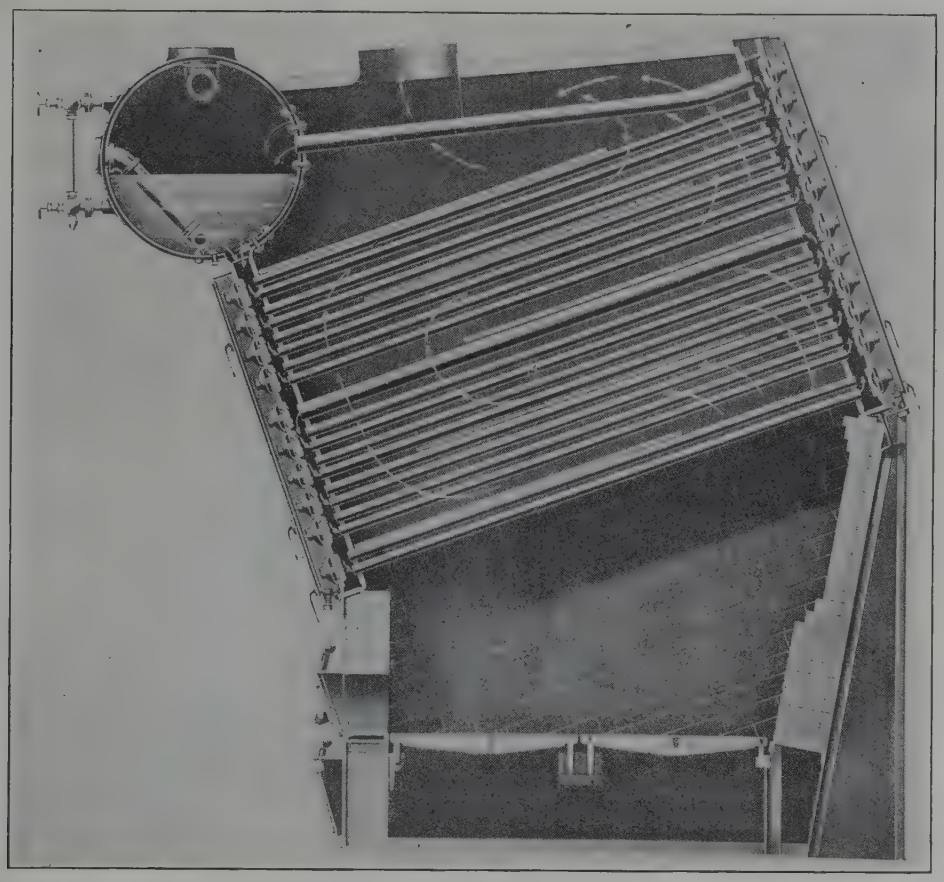
Enlarged Section of Header

THE CHARLES WARD ENGINEERING WORKS

CHARLESTON, W. VA.

Eastern Agent—Kearfott Engineering Co., Inc., New York.

Ward Water Tube Boilers



Section Through Ward Water Tube Boilers

Shipment and Deliveries

Ward Boilers are of such a design that comparatively large units can be shipped complete ready for installation without any work on the part of the purchaser except the lining of the furnace with fire brick. The illustration below shows a shipment of two Ward Boilers, heating surface 2,250 sq. ft., grate surface 55.8 sq. ft., steam pressure 225 pounds.

It is the practice to carry in stock material for a number of boilers. The plant is, therefore, usually in a position to make early deliveries.

Ward Boilers Loaded on Cars for Shipment

High Efficiency Shown in Evaporative Test

Evaporative tests of a Ward Boiler conducted by a Board of U. S. Naval Engineers showed an evaporation of 16.73 pounds of water per pound of oil and a corresponding efficiency of 81.68 per cent

Evaporation per sq. ft. H. S..	5.74	9.13	11.34
Pounds oil per sq. ft. H. S....	.343	.554	.70
Evaporation per lb. oil.....	16.73	16.48	16.21

Capacities, Sizes, Etc.

Ward Boilers can be suppledi to use either coal or oil as fuel. They are built in standard sizes with two inch tubes ranging from 1,000 to 7,000 sq. ft. of heating surface each.

It is, of course, desirable to use standard sizes wherever possible. Ward Boilers, however, can be adapted to fit almost any space or conditions, as the dimensions can be varied to meet special requirements of floor space and height.

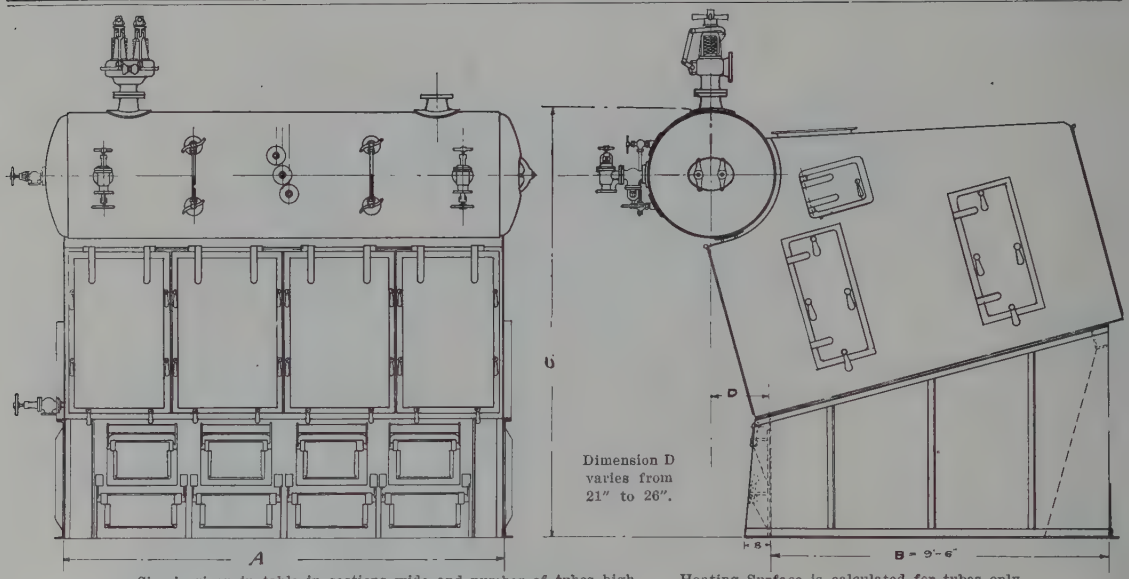
Dimensions of standard sizes shown on following page.

THE CHARLES WARD ENGINEERING WORKS

CHARLESTON, W. VA.

Eastern Agent—Kearfott Engineering Co., Inc., New York.

Data on Ward Water Tube Boilers



Size is given in table in sections wide and number of tubes high.
Weight is given in short tons of 2000 lbs.

Heating Surface is calculated for tubes only.
Grate Bar Length of 6'—6" is used.

Size		H.S.	G.S.	Weight Boiler	Weight Water	A	C	H.S. G.S.
12	12	1449	40.6	19.2	3.0	7'-6"	11'-11"	36.0
	14	1675		20.5	3.3		12'- 5"	41.0
	16	1900		22.2	3.6		12'-11"	46.4
	18	2126		23.4	3.9		13'- 5"	52.0
	20	2239		25.0	4.2		13'-11"	54.7
13	12	1570	44.1	20.3	3.1	8'-¼"	11'-11"	36.0
	14	1815		21.7	3.5		12'- 5"	41.0
	16	2059		23.4	3.8		12'-11"	46.4
	18	2304		24.8	4.1		13'- 5"	52.0
	20	2426		26.4	4.5		13'-11"	54.7
14	12	1691	47.5	21.5	3.3	8'-6¾"	11'-11"	36.0
	14	1954		22.9	3.7		12'- 5"	41.0
	16	2218		24.7	4.0		12'-11"	46.4
	18	2481		26.1	4.4		13'- 5"	52.0
	20	2112		27.8	4.7		13'-11"	54.7
15	12	1812	51.0	22.6	3.5	9'-1"	11'-11"	36.0
	14	2094		24.1	3.9		12'- 5"	41.0
	16	2376		25.9	4.2		12'-11"	46.4
	18	2658		27.4	4.6		13'- 5"	52.0
	20	2799		29.2	5.0		13'-11"	54.7
16	12	1932	54.4	23.7	3.7	9'-7½"	11'-11"	36.0
	14	2234		25.3	4.1		12'- 5"	41.0
	16	2534		27.3	4.5		12'-11"	46.4
	18	2835		28.7	4.9		13'- 5"	52.0
	20	2986		30.5	5.3		13'-11"	54.7
17	12	2054	57.9	24.8	3.8	10'-2"	11'-11"	36.0
	14	2373		26.5	4.3		12'- 5"	41.0
	16	2693		28.4	4.7		12'-11"	46.4
	18	3012		29.9	5.1		13'- 5"	52.0
	20	3172		31.8	5.5		13'-11"	54.7
18	12	2174	61.3	26.0	3.9	10'-8¼"	11'-11"	36.0
	14	2513		27.7	4.4		12'- 5"	41.0
	16	2851		29.8	4.9		12'-11"	46.4
	18	3190		31.3	5.3		13'- 5"	52.0
	20	3359		33.3	5.8		13'-11"	54.7
19	12	2295	64.8	27.1	4.1	11'-2¾"	11'-11"	36.0
	14	2652		28.9	4.6		12'- 5"	41.0
	16	3010		31.0	5.1		12'-11"	46.4
	18	3369		32.6	5.6		13'- 5"	52.0
	20	3545		34.6	6.0		13'-11"	54.7
20	12	2416	68.2	28.2	4.3	11'-9"	11'-11"	36.0
	14	2792		30.1	4.8		12'- 5"	41.0
	16	3168		32.3	5.3		12'-11"	46.4
	18	3544		33.9	5.8		13'- 5"	52.0
	20	3732		36.0	6.3		13'-11"	54.7
21	12	2537	71.7	29.3	4.5	12'-3½"	11'-11"	36.0
	14	2931		31.3	5.0		12'- 5"	41.0
	16	3326		33.5	5.5		12'-11"	46.4
	18	3721		35.3	6.1		13'- 5"	52.0
	20	3918		37.4	6.6		13'-11"	54.7
22	12	2658	75.1	30.5	4.7	12'-9¾"	11'-11"	36.0
	14	3071		32.5	5.2		12'- 5"	41.0
	16	3485		34.8	5.8		12'-11"	46.4
	18	3898		36.5	6.3		13'- 5"	52.0
	20	4105		38.7	6.8		13'-11"	54.7
23	12	2778	78.6	31.6	4.8	13'-4¼"	11'-11"	36.0
	14	3211		33.7	5.4		12'- 5"	41.0
	16	3643		36.1	6.0		12'-11"	46.4
	18	4076		37.9	6.5		13'- 5"	52.0
	20	4292		40.1	7.1		13'-11"	54.7
24	12	2899	82.0	32.7	5.0	13'-10¾"	11'-11"	36.0
	14	3350		34.9	5.6		12'- 5"	41.0
	16	3802		37.3	6.2		12'-11"	46.4
	18	4253		39.2	6.8		13'- 5"	52.0
	20	4478		41.5	7.4		13'-11"	54.7
25	12	3020	85.5	33.9	5.2	14'- 5"	11'-11"	36.0
	14	3490		36.1	5.8		12'- 5"	41.0
	16	3960		38.6	6.4		12'-11"	46.4
	18	4430		40.4	7.0		13'- 5"	52.0
	20	4665		42.8	7.6		13'-11"	54.7
26	12	3141	88.9	35.0	5.4	14'-11½"	11'-11"	36.0
	14	3630		37.3	6.0		12'- 5"	41.0
	16	4118		40.1	6.6		12'-11"	46.4
	18	4607		42.1	7.3		13'- 5"	52.0
	20	4852		44.2	7.9		13'-11"	54.7
27	12	3261	92.4	36.1	5.6	15'- 5¾"	11'-11"	36.0
	14	3769		38.5	6.2		12'- 5"	41.0
	16	4277		41.4	6.9		12'-11"	46.4
	18	4784		43.4	7.5		13'- 5"	52.0
	20	5038		45.5	8.1		13'-11"	54.7
28	12	3382	95.8	37.3	5.7	16'	11'-11"	36.0
	14	3909		39.6	6.4		12'- 5"	41.0
	16	4435		42.7	7.1		12'-11"	46.4
	18	4962		44.8	7.7		13'- 5"	52.0
	20	5225		46.4	8.4		13'-11"	54.7
29	12	3503	99.3	38.4	5.9	16'- 6½"	11'-11"	36.0
	14	4048		41.0	6.6		12'- 5"	41.0
	16	4594		44.0	7.3		12'-11"	46.4
	18	5139		46.1	8.0		13'- 5"	52.0
	20	5411		48.3	8.7		13'-11"	54.7
30	12	3624	102.7	39.5	6.0	17'- 1"	11'-11"	36.0
	14	4188		42.2	6.8		12'- 5"	41.0
	16	4752		45.2	7.5		12'-11"	46.4
	18	5316		47.4	8.2		13'- 5"	52.0
	20	5598		49.6	6.9		13'-11"	54.7
31	12	3745	106.2	40.7	6.2	17'- 7½"	11'-11"	36.0
	14	4328		43.4	7.0		12'- 5"	41.0
	16	4910		46.5	7.7		12'-11"	46.4
	18	5493		48.8	8.5		13'- 5"	52.0
	20	5785		51.0	8.2		13'-11"	54.7
32	12	3866	109.6	41.8	6.4	18'- 1¾"	11'-11"	36.0
	14	4467		44.6	7.2		12'- 5"	41.0
	16	5069		47.8	8.0		12'-11"	46.4
	18	5670		50.1	8.7		13'- 5"	52.0
	20	5971		52.2	9.5		13'-11"	54.7
33	12	3986	113.1	42.9	6.6	18'- 8¼"	11'-11"	36.0
	14	4607		45.8	7.4		12'- 5"	41.0
	16	5227		49.1	8.2		12'-11"	46.4
	18	5848		51.5	8.9		13'- 5"	52.0
	20	6158		53.7	9.7		13'-11"	54.7
34	12	4107	116.5	44.0	6.8	19'- 2½"	11'-11"	36.0
	14	4746		47.0	7.6		12'- 5"	41.0
	16	5386		50.4	8.4		12'-11"	46.4
	18	6025		52.8	9.2		13'- 5"	52.0
	20	6344		55.1	10.0		13'-11"	54.7
35	12	4428	120.0	45.2	7.0	19'- 9"	11'-11"	36.0
	14	4886		48.2	7.8		12'- 5"	41.0
	16	5544		51.6	8.6		12'-11"	46.4
	18	6202		54.1	9.4		13'- 5"	52.0
	20	6531		56.1	10.2		13'-11"	54.7

THE CHARLES WARD ENGINEERING WORKS

CHARLESTON, W. VA.

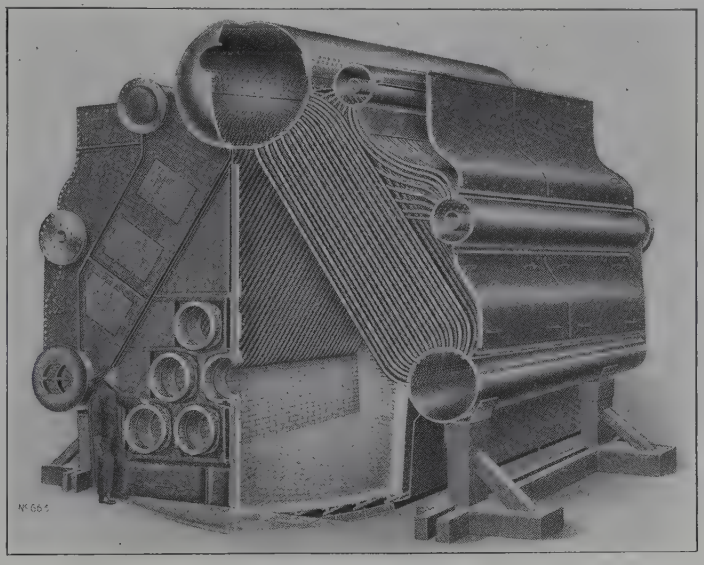
Eastern Agent—Kearfott Engineering Co., Inc., New York.

Ward Boilers, Dyson Type—River Steamers

Dyson Express Type Boiler

There is a growing demand for high powered boilers of extreme light weight with a high degree of superheat. To meet this demand The Charles Ward Engineering Works has purchased the patent rights issued to Admiral C. W. Dyson, U. S. N., Washington, D. C., covering the design of an express type of boiler and superheater. These boilers can be built in a very wide range of sizes, if necessary, up to 12,000 sq. ft. of heating surface, for almost any working pressure, with or without superheaters.

The superheaters are of such a design that they are of generous proportions, free from extremely long tubes and provide unrestricted flow for the steam, eliminating the loss or drop due to exceedingly high velocities. This boiler is clearly shown by the accompanying cut, which shows the accessibility of the tubes both in the boiler proper and the superheater. If repairs are needed to the superheater tubes the upper drum can be disconnected and thrown over into the space occupied by the uptake thus permitting renewal or removal of the tubes. These boilers are extremely light in weight and will stand excessive rates of evaporation.



Dyson Express Type Boiler

Full details on Dyson Express Type Boilers, of any specific size or capacity, will be supplied promptly. The Charles Ward Engineering Works is also fully equipped to co-operate with designers and shipbuilders.

Shallow-Draught River Steamers

The Charles Ward Engineering Works also specialize in the design and construction of River Steamers and vessels of similar character, particular attention being given to steamers of the Twin Screw Tunnel Type, for service on inland rivers. Vessels of this type are shown on pages 456 to 462 of the Ship Plan Section. The photographs reproduced illustrate two of these boats, as built by The Charles Ward Engineering Works.

The Twin Screw Tunnel Type of construction is particularly adapted for fast passenger and freight steamers and for high powered towboats, where restricted draught is necessary. It secures the higher efficiency of the screw propeller, over the paddle wheel, yet has all the manouvering qualities of the latter. Rapidity and certainty of handling is an important factor in the design of river steamers.

The tunnel construction permits the use of a screw propeller of sufficient size, on a reduced draught. The steamer A. M. Scott, for example, is 150 feet long with 26 foot beam, and draws but 3 feet with 70 tons of coal aboard. The towboat James Rumsey, with length 120 feet and beam 22 feet, draws less than 30 inches with 40 tons of coal aboard.

The Charles Ward Engineering Works is prepared to advise regarding the best type of Shallow-Draught River Steamer for any particular service and to design and build the vessel.

Shallow-Draught River Towboat "Clairton"

Shallow-Draught River Steamer "Inspector"

THE CHARLES WARD ENGINEERING WORKS

CHARLESTON, W. VA.

Eastern Agent—Kearfott Engineering Co., Inc., New York.

Deck, Engine and Boiler Room Equipment

Service

As direct marine representatives of manufacturers of high grade machinery we are able to offer not only direct factory prices but also the services of our staff of experienced engineers who are conversant with every type of marine installation and practice.

Our organization presents the great advantage of being able to supply a complete ship equipment, thus insuring balance and correct relation of auxiliaries to main equipment.

Among our customers are the largest shipyards in the country, to whom we have furnished equipments wholly or in part for boats built for the Shipping Board, Navy, War Department and Merchant Marine.

Engines

Our compound and triple expansion engines built in standard sizes for tugboats and ships, are carefully designed and constructed to withstand hard servive. Our engines meet the instant approval of operating engineers due to their simplicity, accessibility and ease in handling. All sizes from 200 to 3200 IHP are available.

Boilers

Ward Water Tube Boilers, fully described on pages 966 to 969, are well known for their excellent steaming qualities. In a test conducted by a Board of U. S. Naval Engineers the Ward Boiler showed an evaporation of 16.73 pounds of water per pound of oil and an efficiency of 81.68 per cent.

We are prepared to advise the type and size of boilers to meet fully any conditions of marine service, and to submit specifications on any particular installation.

Condensers

We can furnish main and auxiliary condensers in various sizes, together with combined pumping equipment, to meet the most exacting requirements. The Shipping Board and the Navy have purchased a large number of condensers from us. In this vitally important part of propelling equipment of a vessel, we offer the highest grade apparatus backed by an engineering organization which insures the proper co-ordination of all parts of the condensing outfit.

Turbines

The design and operation of the Terry Steam Turbine, fully described on page 1041, adapts it particularly for use as an auxiliary drive in marine service. Simplicity gained by the use of a single, solid wheel totally enclosed in horizontally split casing results in extreme reliability, low cost of maintenance and true accessibility to all wearing parts. The flow of steam being at right angles to the shaft eliminates end thrust which is always a source of trouble and repair. Pump, blower and generator units of various sizes have been furnished to the Navy and Merchant Marine.

Evaporators

The Lillie double effect vapor reversing evaporator is designed for continuous operation. The patented vapor reversing feature has enabled this evaporator to stay in continuous service under Government test for 720 hours with no diminution in capacity or cleaning during the entire run or at the conclusion of the run. Guaranteed to produce 1.8 lbs water per pound of low pressure (5 lbs.) steam with ease. This apparatus makes it possible to dispense with make up feed for boilers and insures fresh water at all times. Our equipments are in every day operation in ships of the U. S. Navy. Investment in a Lillie evaporator will pay for itself in two trips due to saving in space and weight formerly required for make up boiler feed.

Mechanical Draft

Our fan equipments are designed for induced and forced draft service in any capacity required. Our vertical and horizontal turbine driven fans are noted for their efficiency, low upkeep and ease of operation. We furnish reciprocating engine sets especially designed with a view to compactness and durability.

Deck Machinery

Complete equipments of winches, windlasses, capstans, steering engines, etc., can be furnished in all sizes. Our line of deck machinery has proved its high quality through many years of hard service and has the endorsement of both the shipbuilder and the ship operator.

Pumps

We can recommend and supply both direct acting and centrifugal pumps to meet the most exacting requirements of the shipbuilder or naval architect. We have furnished complete pumping equipment on many of the boats built by the Emergency Fleet Corporation, and other contractors. Our pumps have the approval and recommendation of all users.

Chains and Anchors

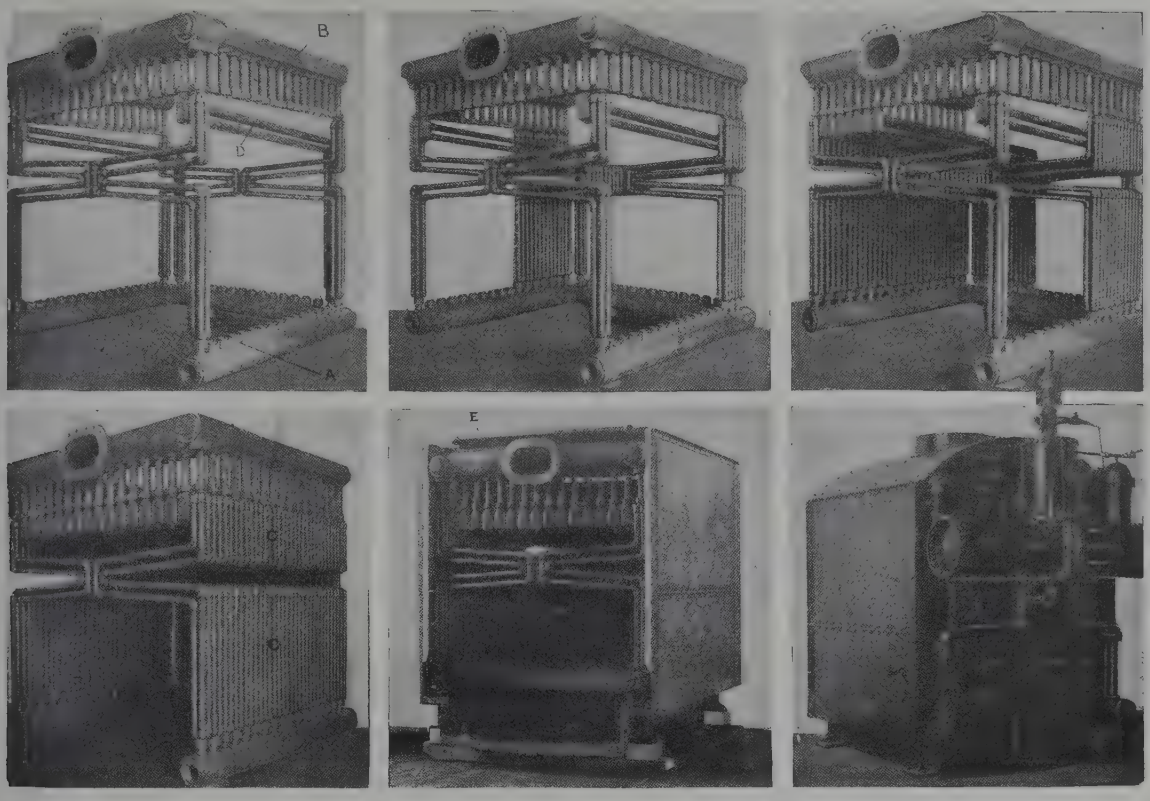
We can supply in all sizes and types anchors of recognized reputation at satisfactory prices.

Stud link chain to both American Bureau and Lloyd's dimensions made in all sizes for early shipment.

KEARFOTT ENGINEERING CO.

95 LIBERTY ST., NEW YORK CITY

Almy Water-Tube Boilers



Successive Stages in the Construction of the Almy Water Tube Boiler

Details of Design

Boilers of this type are designated as Classes D and E. Tubes in both classes are 1″ Standard Pipe Size. Class D has a Single-Fire-box. Class E—Two Fire-boxes.

The heating surface of the double tube type consists of side and fore-and-aft sections made up with four series of tubes in each section.

The side sections (C) rise from the bottom manifold (A) to a proper height to form the crown of the fire-box. They then extend half way across the furnace and back again, then rise vertically to the top manifold (B).

The fore-and-aft sections (D) rise from the top of the back bottom manifold (A) to a proper height and pass over the side sections, connecting to the top manifold (B) at the front. These sections are connected to the bottom and top manifolds by unions and nipples.

Tubes of this class are 1 5/16″ outside diameter, and .18 thick unless otherwise specified. The height below is based on having 20″ height of ash pan for Class D and 24″ for Class E and height of fire-boxes 26″. Higher fire-boxes may be furnished.

LIST OF SOME OF THE SIZES

Class D						Class E					
Width of Casing In.	Length of Casing In.	Total Height In.	Grate Area Sq. Ft.	Heating Surface Sq. Ft.	Approxi. Weight Dry (Water Adds 10%) Pounds	Width of Casing In.	Length of Casing In.	Grate Area Sq. Ft.	Heating Surface Sq. Ft.	Total Height	Approxi. Weight Dry (Water adds 10%) Pounds
61 7/8	65 9/32	95	19.0	672	10700	79 15/16	89 1/8	33.05	1342.2	103.8	19,000
65 9/32	65 9/32	95 1/2	20.3	703	11300	86 9/32	89 1/8	36.72	1419.4	105.9	19,900
65 9/32	68 11/16	95 3/4	21.6	740	11800	86 9/32	92 17/32	38.34	1474.1	106.1	20,630
68 11/16	68 11/16	96 3/8	22.9	772	12200	93 3/32	89 1/8	40.39	1499.2	108.0	20,800
68 11/16	72 3/32	96 5/8	24.3	820	13100	99 29/32	89 1/8	44.06	1580.8	110.1	21,700
72 3/32	72 3/32	97 7/8	25.7	844	13400	99 29/32	92 17/32	46.00	1639.7	110.3	22,400
72 3/32	75 1/2	97 1/2	27.2	883	14100	99 29/32	99 11/32	49.87	1757.9	110.7	23,700
72 3/32	85 23/32	98	31.5	1004	16100	106 23/32	95 15/16	51.92	1781.0	112.6	23,900
75 1/2	89 1/8	98 7/8	34.8	1088	17400	106 23/32	99 11/32	54.02	1842.3	112.8	24,600

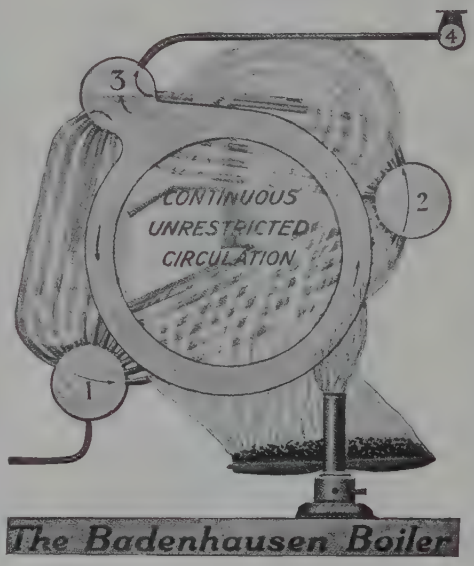
Marine Boilers

Satisfying the Demand for Better Boilers

The Badenhausen Marine Water-Tube Boiler is satisfying the demand made today by the Marine Engineering Profession for boilers to be operated at higher pressures than heretofore, to meet the demands of modern engine design.

The Badenhausen Boiler is essentially different from other marine boilers in that it embodies the best and soundest circulation theory known in the engineering world, and has the additional feature of delivering, at the boiler outlet, steam that is not only dry, but also superheated to a guaranteed average of 10° F.

Gurney's tests, made in 1825, proved the most successful shape of vessel for rapid generation of steam to be a tube bent round in the form of a hoop or ring, with an opening near the top for escape of steam. Partly filling this ring with water and applying heat by a lamp causes the water to circulate swiftly and quietly through an unrestricted path. John P. Badenhausen designed and perfected the Badenhausen Water-Tube Boiler on this principle. Steel drums are connected by steel tubes to form a perfect cycle of circulation. Herewith is shown the glass ring superimposed upon a cross-section of the boiler. The positive, continuous, unrestricted circulation of the water in the glass ring is carried out practically in the boiler. The strong water current moves in the direction of the arrows and prevents any part of the boiler from being left dry to the action of the fire.



Demonstration of the Continuous Unrestricted Circulation in the Badenhausen Marine Water Tube Boiler

Unlimited Overload Without Waste

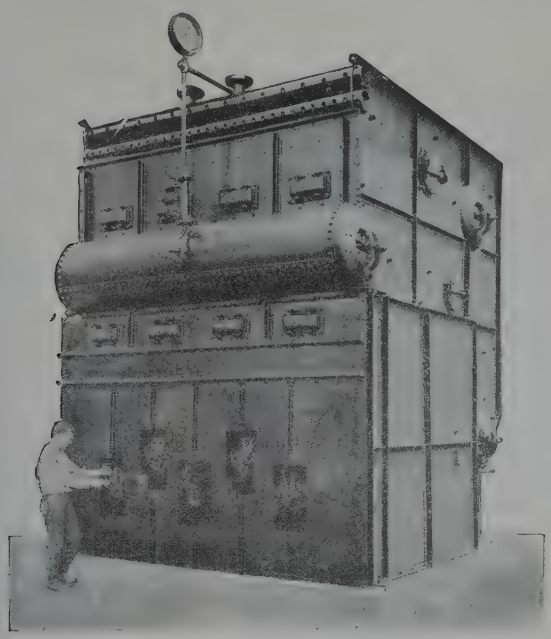
An increase of heat application simply increases the steam production with a corresponding increase of speed of the current through the tubes; hence the heat transfer in the Badenhausen Boiler is bound to be unlimited with the result that it can meet the demand, on the instant, tests have proved, for any overload of which the furnace is capable of producing. The furnace is designed for efficient combustion. The correct placing of the simple baffling directs the gases against the entire heating surface of the boiler, and the water current in the boiler moves on swiftly, quietly, and through the continuous, unrestricted path, thoroughly absorbing all available heat throughout the range of the heating surfaces. The low escaping gas temperatures resulting therefrom, eliminate the wasteful and dangerous overheating of boiler settings and breechings. This is evident in every installation of the many thousands of square feet of Badenhausen water-tube boilers. This feature is of particular advantage in marine service where flexibility of power is an important factor.

Features of Construction

The steam is carried over to drum 4 from drum 3 through steam tubes so advantageously exposed to the hot furnace gases as to thoroughly dry and superheat the steam 10 degrees Fahr. (many degrees higher oftentimes) at any rating. When

Badenhausen Marine Water Tube Boilers Erected on Dock and Being Hoisted, Bodily, into Waiting Vessel

BADENHAUSEN CO., PHILADELPHIA, PA.



Installation of Badenhausen Marine Water Tube Boiler

high degrees of superheat are desired, we install Simplex Superheaters.

The method of flexible, as well as secure, support provides free expansion for all parts. This insures safety, long life, and little repairing or renewing of parts. Whatever may be the variations in temperature, there is no likelihood of tubes being distorted or torn from the drums.

The Badenhausen Marine Water-Tube Boiler fulfills the severest marine boiler inspection requirements. The absence of all flat-stayed surfaces, stay-bolts, stay-tubes, crow-foot braces, and strong backs, forms a conspicuous feature. The simplicity of the parts of the Badenhausen boiler and their convenient sizes assure easy handling for "knocked down" shipment.

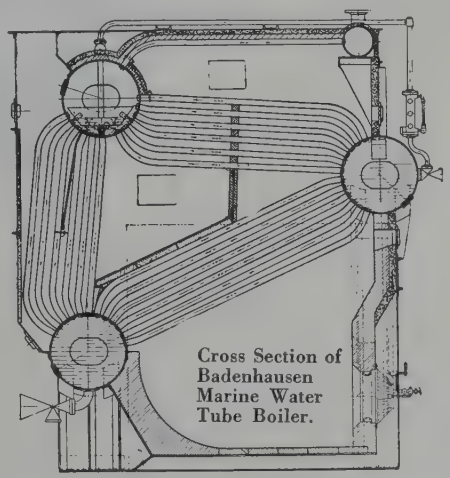
Boiler can be inspected and cleaned inside by opening the hinged drum manhole doors and entering the drums bodily. A water turbine cleaner passed through every tube will cut out all scale. Tubes are spaced alternately 5¼ and 3¾ inches apart throughout the length of the drums. Hence every part of heating surface can be touched by the hand and only one hour's time of one man is needed to replace the most remote tube. Soot is efficiently removed by steam lance from the front, or by mechanical cleaners. Baffling is simple, durable, and readily kept in proper condition.

The furnace is adaptable to hand firing, stoker firing, or to equipment for oil burning.

Typical Boiler Data

The Badenhausen Marine Water-Tube boiler is built in sizes required to contain the quantity of water best adapted to the service demanded, hence dimensions and weights vary to meet varying conditions. The following data covers a popular size:

Boiler heating surface	3210 sq. ft.
Width overall, including casing	12 ft. 10 in.
Height overall to steam outlet	15 ft. 6 in.
Greatest depth at base, including casing	12 ft. 7¼ in.
Diameter of drums No. 1, No. 2 and No. 3	30 in.
Diameter of drum No. 4	8 in.
Length of each drum	12 ft.
Diameter of tubes	2½ in.
Spacing of tubes throughout length of drums	5¼ and 3¾ in.
Average length of tubes	8 ft.
Number of tubes	570
Water capacity of boiler	18,530 lbs.
Weight of empty boiler	82,000 lbs.



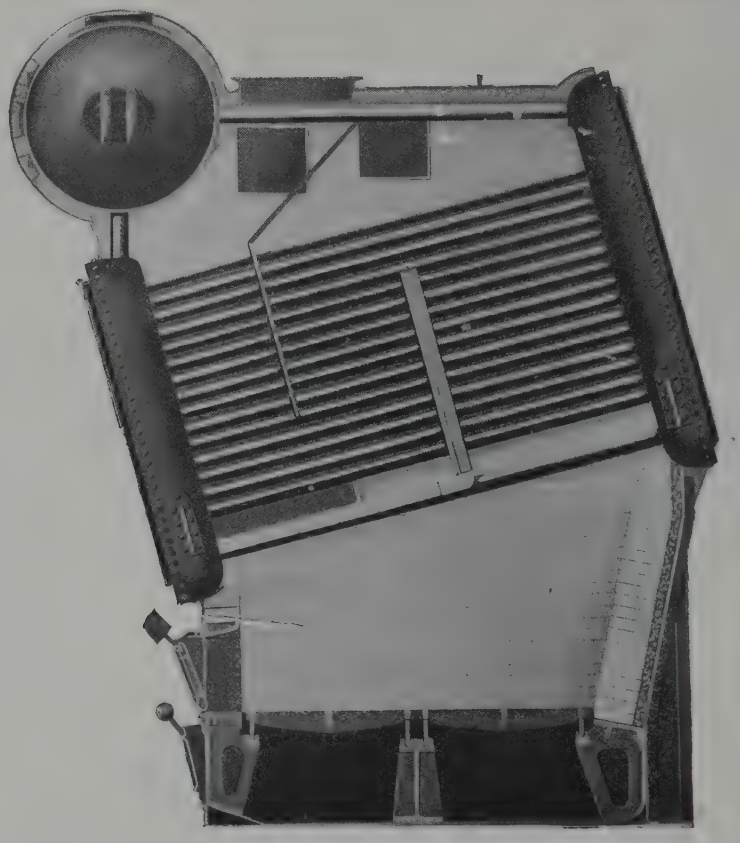
Cross Section of Badenhausen Marine Water Tube Boiler.

Our Plant and Engineering Facilities

Our plant is located at Cornwells, near Philadelphia, where we build the Badenhausen Water-Tube Marine Boiler, the Simplex Superheater, Scotch Marine Boilers, and also Marine Engines. This plant is located on the Pennsylvania Railroad and Delaware River where large steamers can be accommodated. Our expert engineers are always available. Our Philadelphia, New York, and San Francisco offices will furnish, upon request, detailed information to boiler owners and operators who desire further information on the Badenhausen Marine Boiler or our other products.

Our Cornwells, Philadelphia, Plant

Marine Water-Tube Boilers



Type of Construction

The Wickes Boiler is of the marine water tube type, with straight tubes expanded into a continuous steel plate, one-joint headers, and is stayed with hollow steel staybolts. It is designed for burning coal or fuel oil.

The boiler is built to conform to the general rules and regulations prescribed by the Board of Supervising Inspectors of the Steamboat Inspection Service, Department of Commerce.

Headers

The headers of the Wickes Boiler are constructed entirely of open hearth steel plates, so formed as to be closed by one hydraulically riveted seam. The caulking edge is visible when the boiler is in operation and may be caulked under pressure if necessary.

Drums

The steam drum is 42 inches inside diameter, of open hearth steel plate, made in one length, with longitudinal seam butted and strapped inside and outside and triple riveted, as shown. The butt straps are pressed to the proper curvature of the drum before assembling for riveting. The drum heads are dished under pressure and the edges and flange turned off in a boring mill.

Shop Operations

All plates have the edges planed to a bevel for caulking. Rivet holes are drilled from the outside after plates are assembled; and before riveting, which is done with hydraulic pressure where possible, the plates are dismantled, all burrs removed, oil cleaned off, and reassembled and closely bolted. Holes for tubes and staybolts are drilled full size from the solid plate; not punched and reamed.

Baffles

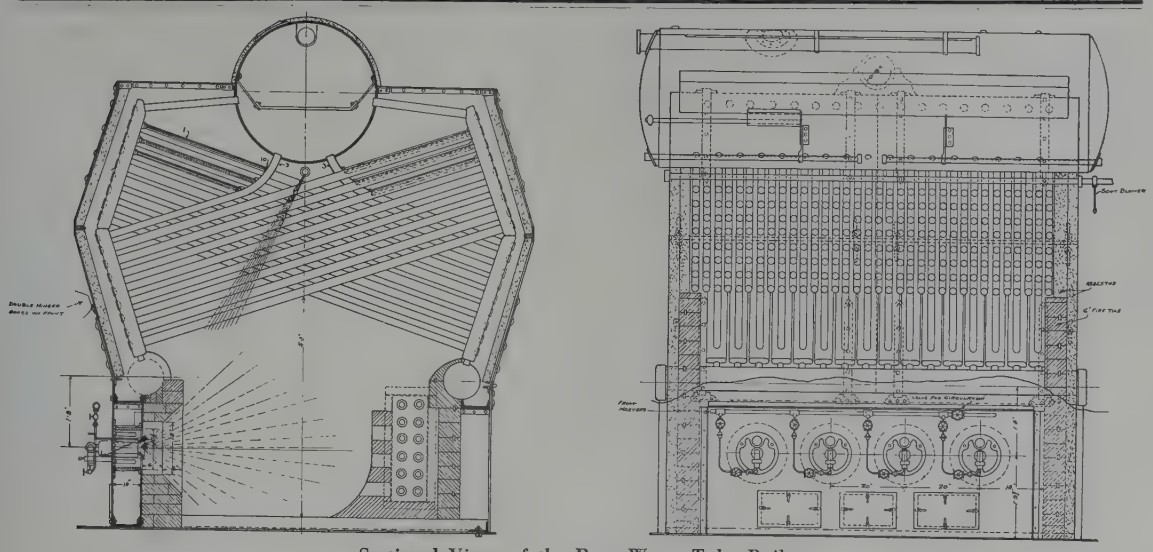
The baffles consist of 3 inches of monolithic tile, backed up by cast iron segments. This arrangement compels the products of combustion to cover every foot of the heating surface without possibility of short circuiting.

Points of Excellence

There is no wrapper sheet in the header and no riveted joints near the fire. All rivets in the header are driven hydraulically. One riveted seam and one caulked joint in the header are visible at all times. There is a large water supply to the tubes, and the tube space is arranged to provide wide tube ligaments. Free liberation of steam is secured without counter-currents. Soot is cleaned through simple and adequate doors in the sides of the casing. Front and rear passes can also be cleaned through hollow staybolts in the headers.

WICKES BOILER CO., SAGINAW, MICH.

Page Water Tube Boilers



Sectional Views of the Page Water Tube Boiler

Distinctive Advantages

The Page Boiler was designed to perform not only the established and essential functions of any high-grade boiler, but to fulfill two additional requirements,—the need of a boiler capable of generating high capacity in small space and of such a design and size that it can easily be delivered through a small opening. The Page is the most compact and the greatest producer of steam per cubic foot of space occupied.

Weight, Weight Distribution, Heating Surface

The weight of the Page boiler varies directly with each additional horsepower, and is figured on the basis of 150 lbs. per H.P. A 2000 H. P. Page, for example, weighs 300,000 lbs. For every horsepower ten sq. ft. of heating surface is used.

The Page Boiler is so constructed that its weight is equally distributed at all four corners with its center of gravity at approximately the actual central point.

Construction

The Page boiler consists virtually of two boilers in one—a double capacity boiler condensed in a minimum amount of space, and directly exposed to heat convection from the fuel bed. The entire boiler and furnace enclosure consists of an air tight steel casing lined with asbestos cell-board throughout and an additional furnace lining of durable fire brick. The unique feature of its construction is the arrangement of water tubes, which consist of a series of vertical tubular sections each having an independent water intake from upper drum and outlet to steam drum, the number of sections depending on the capacity of the boiler. Tubes are inclined at a pitch of 1 inch per ft. more than in most tube boilers and are 3 inches in diameter, which offers a greater heating surface per unit of volume than could be obtained with tubing of larger diameter. The tubes, as shown on the cut, are arranged in two series of sections, one arranged diagonally across the boiler in one direction and the other half in the opposite direction, thereby breaking up the gases very effectively. The alternate crossings of tubular sections act as vertical and horizontal baffles in the center of the boiler and cause gases to flow to the extreme ends of the tubes. With this one pass boiler a three-pass effect is accomplished. Page boilers are built for working pressures up to 500 lbs.

Efficiency

Page boilers frequently show efficiencies of from 72 to 75 per cent. Water can easily be raised from 200° Fahrenheit to boiler pressure in 30 minutes. An important feature of the Page boiler is its compactness and small over-all dimension without sacrifice of capacity. By the unique interwoven arrangement of water tubes and the elimination of bulky brick settings, the entire boiler is concentrated into a remarkably small space. Boilers under 300 H.P. can easily be passed through a 4 ft. by 4 ft. opening. Page boilers are shipped knocked down and completely erected by us on the foundation.

Soot Cleaning and Sediment Removal

The Page soot cleaning attachment consists of a perforated pipe hung just below the water drum. When in operation, steam exhausts from the perforations in jets which are caused to strike directly against every tube by the oscillating motion of the pipe. Soot or ashes can be quickly blown from all sections without causing loss in efficiency due to in-rush of air by opening doors.

Sediment is easily removed by opening blow-off valves at one end of each of the two mud drums below the lower headers. These headers act as filters through which precipitation and scale forming elements settle into the mud drums below.

The Page Boiler Co. maintains an engineering service department capable of giving expert advice on Marine Boilers, without obligation.

PAGE BOILER CO., CHICAGO, ILL.

Marine Boilers

Manufacturing Facilities

Since 1882 the Heine Safety Boiler Company has been building water tube boilers. At present two modern factories, at St. Louis, Mo., and Phoenixville, Pa., are supplying the demand for high grade steam boilers. The Heine Company has built marine boilers for a number of years and during the war produced boilers for more than one hundred ships. The first boilers were of the "longitudinal drum" type, but by far the greatest output has been of "cross drum" boilers, which have shown themselves superior for marine service, and have therefore been standardized as the Heine Marine Water Tube Boiler.

Simplicity of Design

The Heine Water Tube Marine Boiler consists of two box headers, straight tubes, and a drum. The headers or water legs are the strongest part of the Heine Boiler. They may be subjected to great stress without danger of rupture or failure, thus permitting the boiler to be retubed without injury to the waterlegs. The boiler proper is supported by a strong steel structure, resting upon and secured to proper foundations in the vessel.

The Heine Boiler can be arranged to suit almost any space conditions, both as regards floor area and height, due to the simplicity of the design, and may be arranged for either coal or oil burning.

Advantages of Horizontal Baffling

The Heine Water Tube Marine Boiler is arranged for horizontal baffling. This method of baffling reduces the size of the dead corners so that a larger percentage of the total boiler surface is active than with the vertical method. Horizontal baffling has been applied to boilers designed originally with vertical baffling with a result that comparative tests have shown a marked increase in efficiency with the horizontal baffling.

Soot Cleaning

The design of the boiler and the horizontal baffle lend themselves readily to the application and use of the simplest soot cleaning system. The hollow stay-bolts used in the waterlegs are arranged to accommodate the nozzles of the soot cleaning system.

The Heine Safety Boiler Company was the first to recognize the importance of complete mechanical equipment for keeping boiler surface clean, by regular blowing with steam jets. Soot cleaners have been furnished as a permanent part of the Heine Boiler for six years.

In tests at a U. S. Government plant made by the operating force, a gain of 9% in efficiency was found due to the soot cleaner of a Heine Boiler.

Superheaters

Heine Marine Boilers can be equipped with superheaters for any degree of superheat. For high superheats, the boilers are fitted with superheaters below the middle baffle. For medium or low superheats, the elements are of the "waste heat" type, placed in the base of the uptake. Closing the superheater damper isolates the tubes from hot gases, when raising steam or when the load goes off suddenly. Under these conditions the superheater becomes simply so much additional steam storage space.

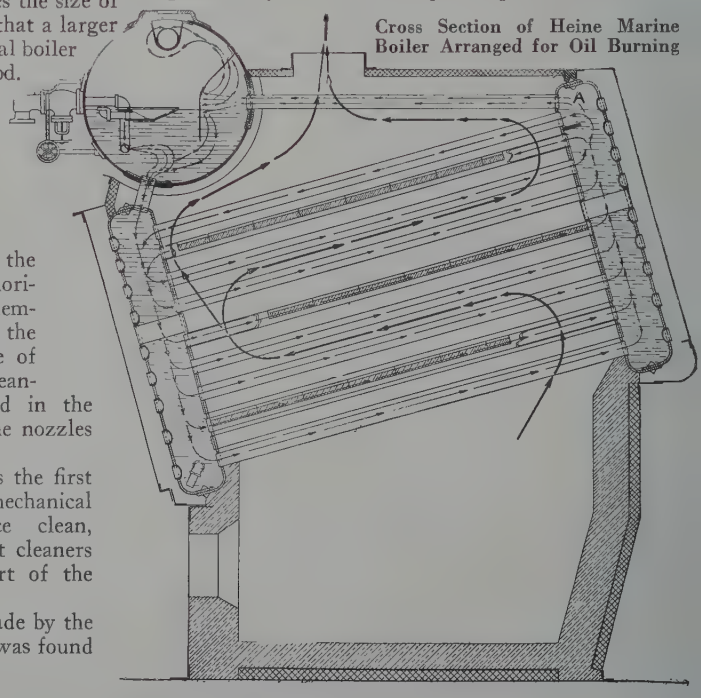
Typical Specifications

The Heine Marine Boiler can be designed for any heating surface required, and the length of boiler, floor space and height can be varied within wide limits to meet any specific condition. A number of marine boilers have been built to the following specifications:

Boiler heating surface	3,014 sq. ft.
Superheating surface	400 sq. ft.
Width overall at base	11 ft.
Height overall	15 ft.
Length overall, front to rear, about	12 ft.
Diameter of drum	3 ft. 6 in.
Length of drum, about	9 ft. 8 in.
Length of tubes, between headers	10 ft.

Technical Data

The general design of marine power plants is taken up in a treatise, Marine Boiler Logic, which is published by the Heine Company for the benefit of all interested in marine engineering. A copy will be sent upon request.



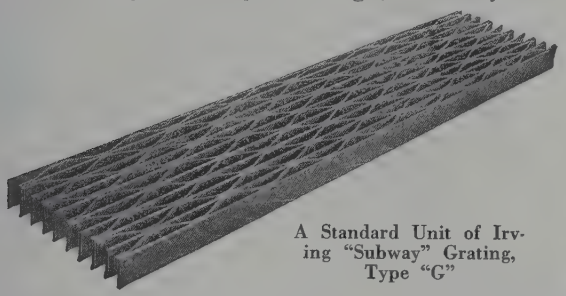
Cross Section of Heine Marine Boiler Arranged for Oil Burning

HEINE SAFETY BOILER CO.
5335 MARCUS AVE., ST. LOUIS, MO.

Ship Gratings, Walkways and Ladder Steps

Exclusive Advantages of Irving "Subway"

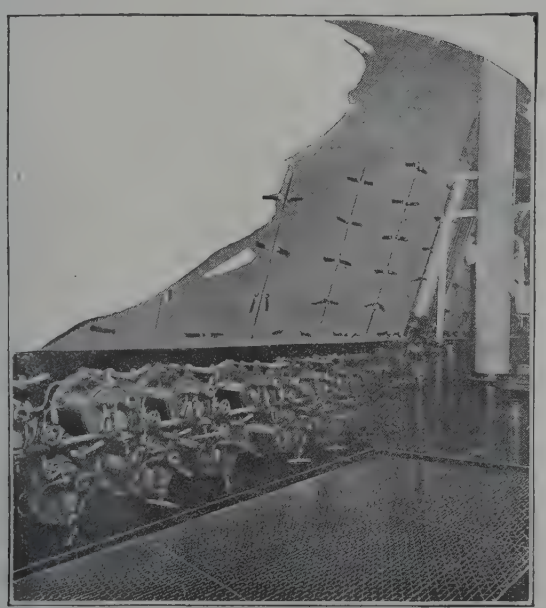
Irving "Subway" grating offers to ship builders the following distinctive and exclusive advantages:—maximum strength with minimum weight; maximum load carrying capacity per unit of weight and span; distribution of a shock or concentrated load over full panel area, by virtue of the truss construction; absolutely rigid, permanently non-rattling; a surface absolutely and permanently non-slipping, even with water, snow, ice, oil or grease upon it; 80% opening for lighting and ventilation; a surface over which trucks, ribhooped barrels, etc., can be rolled; individual openings so small that only the smallest objects can pass through; absolutely fire-proof and non-warping; openings for pipes, columns, etc., can be cut without impairment of strength; can be fitted into irregular areas; absolutely uniform quality in every panel; extremely low cost, due to manufacture in large quantities by means of special machinery.



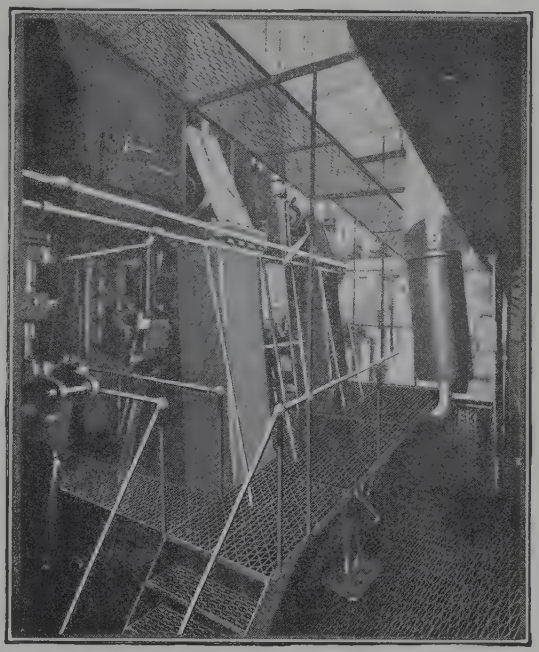
A Standard Unit of Irving "Subway" Grating, Type "G"

Construction and Types

Irving "Subway" grating consists of alternate straight and reticuline bars of steel, accurately punched to templates, pressed to shape with dies, and solidly riveted together. As a result, each individual member is reinforced by its two adjacent members, which share its load and which, in turn, share their load with their adjoining members. Thus any load or shock, however concentrated, is distributed over and resisted by the entire panel—which explains the unequaled load-carrying capacity of this grating. Two standard types of Irving "Subway" are offered, alike in rated load capacity and differing only in the length of the crimp of the reticuline members. In Type "G" the length of the crimp of the rivet spacing is 7 inches—"open mesh." In Type "E", the length of crimp and rivet spacing is 3½ inches—"close mesh." In both types, the depth and thickness of the individual bars or members are determined by the load and span. Usually an area of any shape or size can be filled by an arrangement of standard and interchangeable unit panels—which facilitates installation and makes re-arrangement or alterations an easy matter.



Irving "Subway" Grating Installed as a Flooring in the Boiler Room of an Oil-Fired Steamship



Engine Room Galleries and Walkways of Irving "Subway" Grating, with Ladders of Irving "Safsteps"

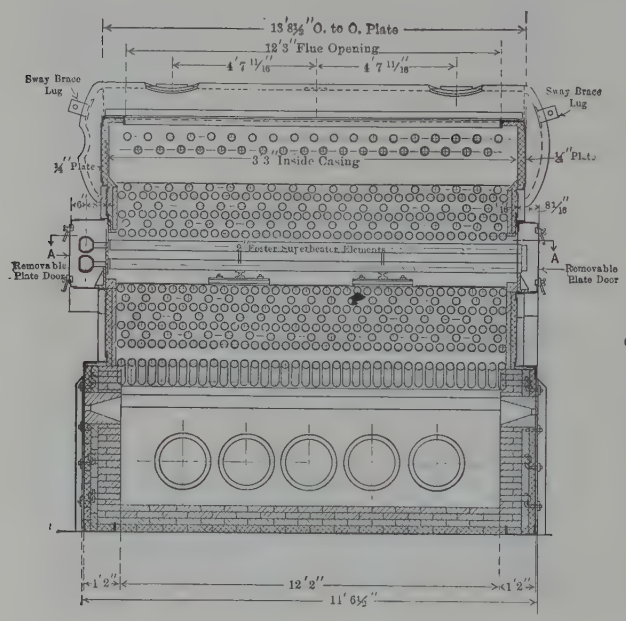
Irving "Safstep" Ladder Steps

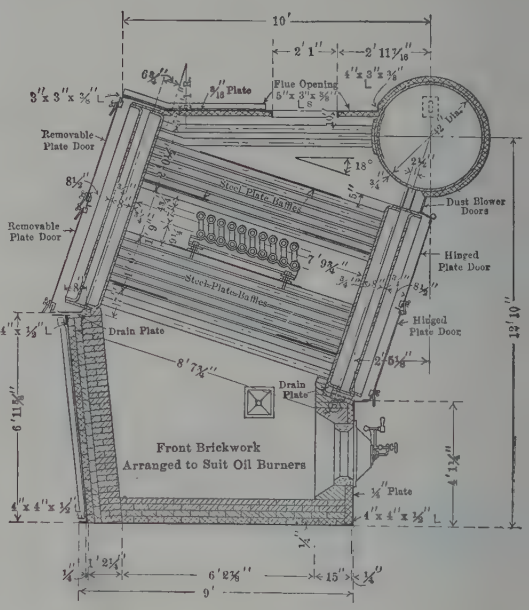
These are small panels of a special section of Irving "Subway" grating, made up as a complete and self-contained unit with its own carriers, ready for attaching to the ladder strings, and possessing all the advantages of Irving "Subway" grating. Nine standard units in convenient size are offered, self-contained and ready for mounting. A ladder of Irving "Safsteps" is a safe, accident-proof ladder.

Catalog, Sizes, Specifications, Etc.

Catalog 2A42, gives detailed description of Irving "Subway" grating and Irving "Safstep" ladder steps, with specifications, weights, spans, load capacities, standard units, and illustrations of applications in great variety. It will be sent on request.

IRVING IRON WORKS CO., LONG ISLAND CITY, N. Y.





Special Features

The Foster Marine Boiler is the latest development of the cross-drum straight-tube type which has been used so successfully for many years both in naval and merchant marine service.

The characteristic features which distinguish the Foster Boiler from similar marine water tube boilers are close tube spacing, steel baffles, superheating chamber in the center of the tube nest, method of support for necessary expansion, increased furnace insulation, improved handhole caps with metal to metal joint, large furnace volume and the air tight steel casing. These features improve fuel economy, lower the draft loss, give less radiation and make this boiler simpler to operate and easier to clean and repair than the ordinary cross-drum straight-tube boiler. When operated at its designed capacity of approximately 5 pounds of evaporation per square foot of heating surface per hour, from and at 212° F., the stack temperatures of the Foster Boiler will not exceed 450 to 500° F.

Construction Details

The tubes are usually 3-inch, arranged vertically and horizontally on about 4-inch centers, giving a minimum height and width for the tube nest, with corresponding reduction in overall dimensions.

The baffles are of steel plate and fit horizontally between the tubes in a way to be gas tight and cooled top and bottom by contact with the tubes. The gases are compelled to take a sinuous path without right angle turns and sweep over the entire heating surface with minimum draft loss.

The furnace insulation consists of one 2½-inch layer of Sil-O-Cel and another 2½-inch layer of Calcined Sil-O-Cel, inside of which is a full 9-inch layer of high grade fire brick. In most ships equipped with Foster Boilers the hand can be held against the hottest part of the casings.

The headers are 8 inches deep to assure ample water for circulation and heat storage.

The circulation is rapid, well defined and follows the U-tube principle.

The steam space and disengaging surface are ample to give dry steam when operating with fresh water.

The patented method of support not only holds the boiler rigidly in proper position but allows for expansion of the tubes and headers.

The use of soft gaskets, except for a few master handhole plates at the bottom of each header is eliminated by metal-to-metal handhole plates. The handhole plate openings are reamed to a 3-degree taper and the openings closed with a circular Key Cap. These caps can be removed and replaced through the master handholes.

The solid well-designed steel casing has a removable upper panel, is solid riveted in the lower half and completely eliminates air infiltration.

A simple efficient type of Diamond Soot Blower makes thorough soot removal easy and practical as often as desired. No hand blowing is required.

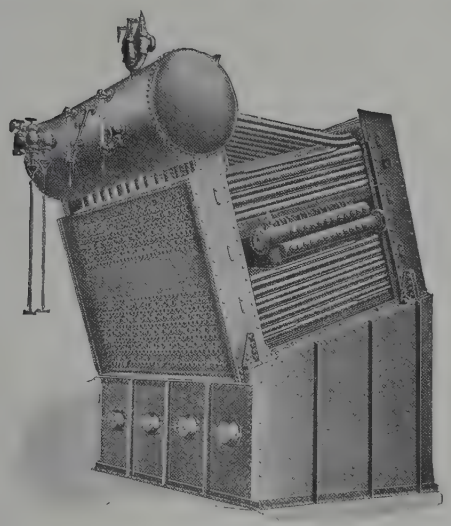
The furnace brick work is of standard 9-inch fire brick properly held to the casing with hook bolts.

When superheat is to be employed, the well known and highly efficient Foster Superheater is furnished (See description on opposite page).

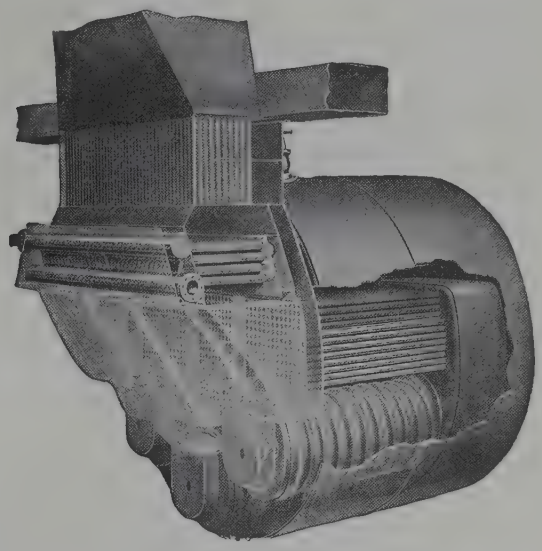
Special literature issued by the Foster Marine Boiler Corporation, 111 Broadway, New York, describes the Foster Boiler in detail.

FOSTER MARINE BOILER CORPORATION, NEW YORK

Marine Superheaters



Typical Foster Superheater in Foster Marine Water-Tube Boiler



Typical Foster Waste Heat Type Superheater in a Scotch Marine Boiler

Advantages and Types

Foster Superheaters on marine boilers effect a fuel saving of from 6 to 40%, eliminate condensation losses in pipe lines and engine cylinders, increase efficiency of turbines at least 10% due to absence of water, and protect turbine blades from erosion. Superheating 100° F. effects about the following savings in steam used: turbines 10%, triple expansion engines 12%, compound engines 14%.

Foster Marine Superheaters are built in the "attached type" for attachment within the setting of water tube boilers and "waste heat type" for Scotch marine boilers for location in the path of the furnace gases after they have left the boiler heating surface.

Construction Details

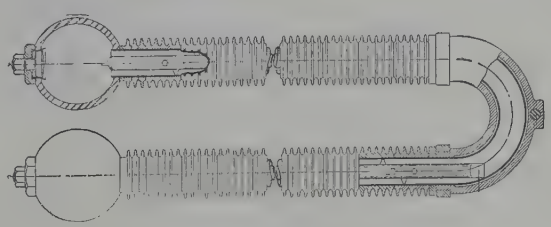
The superheater consists of a series of U-bend tubes or sections set parallel to each other, expanded into steel manifolds, the saturated steam being led through these tubes to the outlet piping to the steam main.

The heating elements of the Foster Superheater are U-shaped steel tubes covered with cast iron rings and split cast iron sleeves over the U-bends. The ends are expanded into inlet and outlet manifolds having reamed holes.

All parts exposed to steam pressure are of steel, thus giving maximum strength. All parts exposed to gases of combustion are of cast iron, thus insuring long life.

Opposite the end of each element a handhole is fitted with a steel plug and metallic gasket, in order to give free access to every part of the interior for inspection and cleaning.

The extended surface formed by the cast iron annular rings or gills on the outside of the steel tubes greatly increases the absorption of heat from the hot gases,



Typical Foster Superheater Element

thus making the heat transfer to the steam flowing through the tubes much more effective than that of a bare tube construction. The cast iron outer surface also protects the steel tubes from the erosive and corrosive action of the furnace gases.

This construction provides a section of great ultimate strength with absolute freedom from internal strains and forms a large reservoir for the storage of heat which is given up to the steam as required by the variations in gas temperature. This keeps the temperature of the steam constant.

Central inner cores provide annular spaces through which all steam must pass close to the heating surface. Figure 3 shows the construction including headers and handhole plugs.

Catalogs containing detailed explanation of theory of superheating, construction of apparatus, illustrations, data on savings, etc., will be sent on request by the Power Specialty Co., 111 Broadway, New York.

Fire Tube Superheaters

Purpose of Fire Tube Superheaters

The fire tube superheater for marine boilers was developed with the purpose in view of overcoming the difficulties which led to the unsuccessful operation of many of the marine superheaters that have been experimented with in the past. Its successful operation in the many classes of marine service is a sufficient testimonial to the fact that its aim has been accomplished.

Advantages of the Fire Tube Superheater

The advantages and economies resulting from the use of highly superheated steam are most obvious when compared with the action of saturated steam. Saturated steam at a given pressure has a known temperature. If heat be added to the steam while it is still in contact with water (for instance in the boiler) more water will be evaporated and the quantity of the steam thus will be increased, but the saturation temperature will remain constant so long as the pressure is constant. On the other hand, if heat be taken from it by cooling or by the performance of useful work during expansion, a part of the steam will be condensed.

Superheated steam may be defined as steam which contains a surplus of heat, or in other words has a temperature greater than that of saturated steam at the same pressure. Furthermore, superheated steam contains no free moisture, whereas saturated steam taken from a boiler and carried to an engine, contains a certain amount of moisture. This amount of moisture or water increases as the steam comes in contact with the cylinders and receivers, and condensers. As water is useless as a working fluid, the heat already expended in raising its temperature is a dead loss, and the effect of presence of the water even in small quantities is only too well known, being evidenced by broken cylinder heads, bent pistons, etc. The ill effect produced on turbine blades by the impact of particles of water and the other evils in the operation of this class of engine, due to the presence of water, are entirely eliminated by the use of dry or superheated steam. The economy resulting from the use of superheated steam in turbines has been demonstrated many times and is apparent in the reduction of the maintenance cost as well as the increase in the efficiency of the machine. Operation with superheated steam, therefore, approaches the ideal in the efficient use of steam.

The following are some of the practical advantages obtained in our fire tube superheater:

1st. It is adaptable to either new or existing boilers of the fire tube type, and can be supplied with no changes in design or construction.

2nd. It increases the output of power from a given marine power plant from 12% to 20%. When heat is added to steam the volume increases per unit weight.

For example, steam at 170 pounds pressure, the temperature of which has been raised 200 degrees above the temperature of saturated steam has a volume of 3.27 cubic feet per pound as against 2.47 cubic feet per pound for saturated steam at the same pressure. By reason of this fact engines operating on superheated steam at a given cut-off will use the same volume but less weight of steam.

3rd. It will produce the same power output with fewer or with smaller boilers.

4th. It allows no deterioration in steam pipes or valves due to the presence of hydrochloric acid in boiler water.

5th. It reduces the size of the coal bunkers, thereby reducing the draft of the vessel with a given cargo, or making possible an increase in revenue cargo.

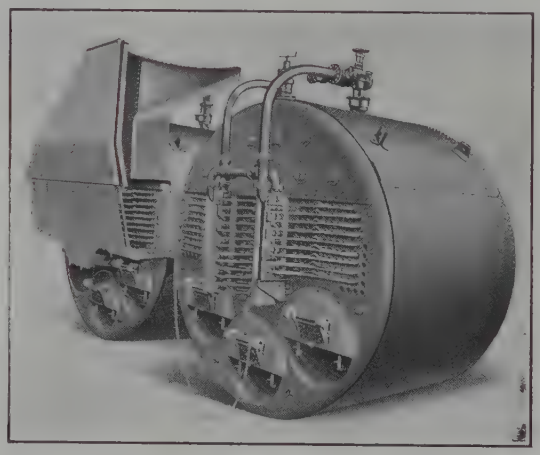


Fig. 1. Fire Tube Superheater Installed in an Internally Fired Marine Boiler

6th. It effects a fuel saving over similar plants not equipped, operating with natural or forced draft, as follows:

Compound Engines	20%
Triple Expansion	15%
Quadruple Expansion	12%

7th. It reduces the maintenance cost by the prevention of water hammer, leaky flanges and cylinder condensation.

8th. It permits rapid, thorough and frequent cleaning without opening the smoke box door.

9th. Its construction provides access to all joints and permits all units to be readily removed.

10th. It does not obstruct the draft.

11th. It eliminates steam driers, separators and tube retarders.

12th. The smooth surface of the tubes prevents an accumulation of soot.

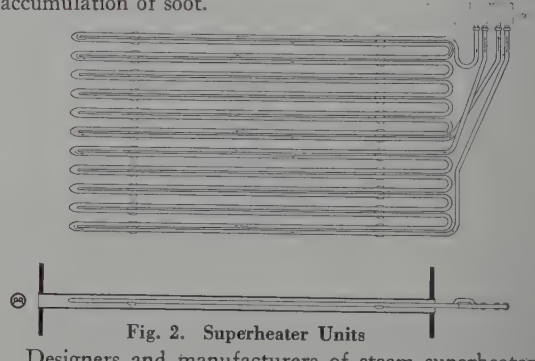


Fig. 2. Superheater Units

Designers and manufacturers of steam superheaters for all classes of boilers and purposes—also pipe coils for all purposes.

PITTSBURGH
OLIVER BLDG.

LOCOMOTIVE SUPERHEATER CO.
GENERAL OFFICES, 30 CHURCH ST., N. Y.

CHICAGO
PEOPLES GAS BLDG.

Fire Tube Superheaters

Construction of Fire Tube Superheaters

The fire tube superheater consists of collector castings, and a system of units or elements, made up of U bent pipes, the material of which is cold drawn seamless steel. The collector castings are situated either in a vertical or horizontal position and located in the uptake end of the boiler. The units, which are arranged in groups, leading in and out of the uptake end of the flues, are expanded into flanges or collars, which in turn are fastened to the collector castings. In joining the ends of the unit pipes to the collector castings, one end of

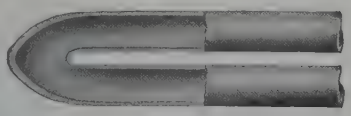


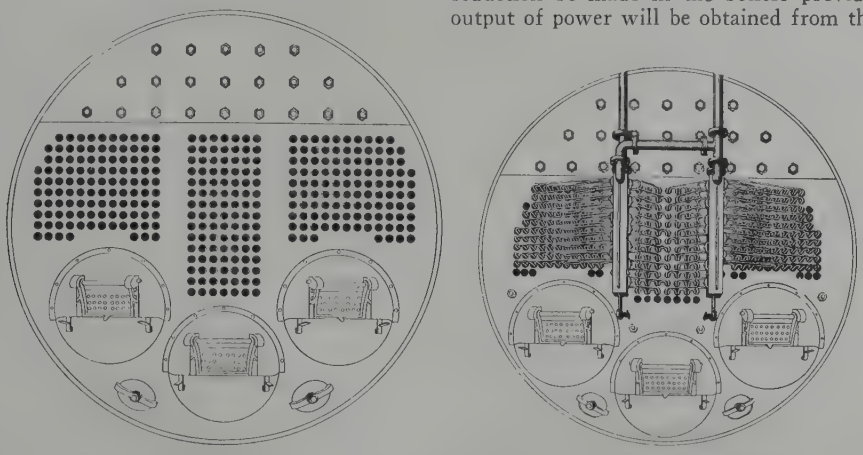
Fig. 2. Sectional View of Continuous Return Bend Used in Fire Tube Superheater Elements

the pipe is in communication with the header from the boiler and the other with the header to which is connected the steam pipe leading to the engines. Thus the steam in passing from the boiler to the engines must pass through the units or elements in the tubes, where the superheating takes place. The connection between the units or elements and the collector castings is made by means of a simple clamp, using but one bolt or stud, thus facilitating the removal of the units, should occasion demand their removal.

The units conveying the steam are formed by bonding the straight sections of the pipe at the rear end by a return bend forged integrally with the tubing. By this form of construction each unit consists of a single continuous pipe and does away with screwed joints or connections, which might be contributory to leaks. The construction of the superheater is clearly evident from Figure No. 1, which shows its application to an internally fired Scotch marine boiler. The construction of the return bends in the unit pipes is shown in Figure No. 2.

Saving in Fuel, Space and Weight

In considering the installation of this superheater in new vessels, the increased boiler capacity provided thereby should be taken into account. For the same engine power a smaller boiler plant may be provided, if the superheater is included in the equipment, than would be necessary if the engines used saturated steam. For example, basing calculation on 20% economy in steam consumption which the superheater provides, a battery of four superheater boilers would replace five boilers in which the superheater equipment was not included, or, should not reduction be made in the boilers provided, a greater output of power will be obtained from the engines.



Boiler Without Superheater **Boiler With Superheater**

Fig. 3. Showing Relative Sizes of Scotch Boilers of Equal Power Output

COMPARATIVE FIGURES SHOWING RELATIVE SIZES AND WEIGHTS OF SCOTCH BOILERS, WITH AND WITHOUT HIGH DEGREE FIRE TUBE SUPERHEATERS

	Without Superheater	With Superheater
Outside Diameter	15 feet 3 inches	13 feet 6 inches
Length	11 feet 6 inches	11 feet 7 inches
Evaporative Heating Surface	2389 square feet	2080 square feet
Weight	85 tons	70 tons (including weight of Superheater)
Saving in Weight	.....	15 tons

Designers and manufacturers of steam superheaters for all classes of boilers and purposes also, pipe coils for all purposes.

PITTSBURGH OLIVER BLDG.

LOCOMOTIVE SUPERHEATER CO.

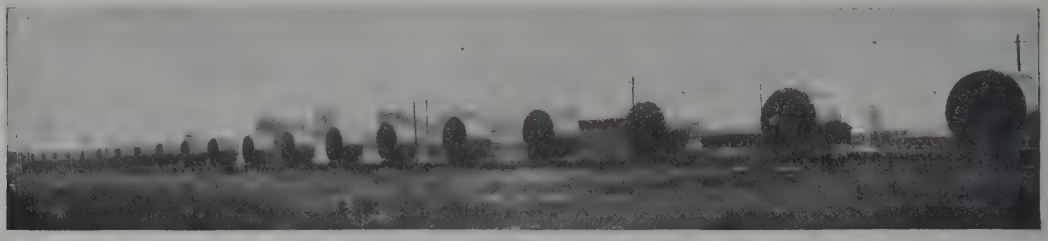
GENERAL OFFICES, 30 CHURCH ST., N. Y.

PEOPLES GAS BLDG. CHICAGO

Charcoal Iron Boiler Tubes

The Ideal Material for Marine Boiler Tubes

The growing demand for boiler tubes of Charcoal Iron, in spite of the lower first cost of steel, goes far to prove, that especially for Marine work, genuine charcoal iron possesses advantages which make it the ideal material for boiler tubes. Fibrous in nature, and free from crystallization under shock or vibration. Ductile and easily threaded and securely beaded, pre-eminently weldable, non-corrosive, practically free from pitting, it is easy to understand why Charcoal Iron Tubes hold first place for marine boiler tubes.



Scotch Marine Boilers built by the Moore Shipbuilding Company, San Francisco, equipped with Parkesburg Charcoal Iron Tubes (357 2½ in. O. D. x 7 ft. 5 in. x No. 10 and 148 Stay Tubes 2½ in. x 7 ft. 5 in. x No. 3.)

Reasons for Superiority

The superiority of charcoal iron for boiler tube service can be best explained by the fact that iron is homogeneous in composition but not in structure, while steel is homogeneous in structure but not in composition. As to the reasons of the superiority of the Boiler Tube of Charcoal Iron over that of any other substitute material, briefly stated, they are—Longer life when exposed to the oxidizing influence of impure and pure water due to less electro-chemical action—avoided by the low percentage of impurities. Freedom from pitting, due to homogeneous structure and low manganese, and the intimate mixture of cinder surrounding each filament of iron thus affording a protective coating. Better welding properties. The melting point of iron being 400 degrees higher than steel thus separating the welding and melting points of iron widely, whereas, with steel they are close together. Charcoal iron will withstand the fire box temperature.

Due to the fact that Parkesburg Charcoal Iron has a higher elastic limit than steel of the same tensile strength, the result is that tubes rolled and beaded in the flue sheet resist the tendency to loosen up due to vibration, contraction and expansion, and hence stay tight longer than steel tubes under similar conditions. Then too, from the nature of the metal, Charcoal Iron Tubes are not distorted so much by rolling, and will therefore have a longer life.

Boiler tubes of Charcoal Iron, too, offer far greater resistance to fatigue.

Parkesburg Skelp

Ever since the early '70's when the Parkesburg Plant was established, Parkesburg Skelp has filled an important place in the manufacture of boiler tubes, in fact up to 1908, when the manufacture of Charcoal Iron boiler tubes was discontinued by the National Tube Company, the entire output of the Parkesburg Plant—20,000 tons annually—was absorbed in the manufacture of the famous Allison tube. Ever since November 9th, 1908, this skelp which made the Allison tube famous, has been fashioned into boiler tubes by the Parkesburg Iron Company, in their modern tube mill with a capacity of about 18,000 tons annually.

What this has meant in economy and service to users of such tubes is best told by the fact that out of 5,750,310 tubes shipped from the mill in the last ten years, only .0434% have been reported as failing in application or actual service.

Parkesburg Tubes

The same care which has always been an important factor in the manufacture of skelp is continued in the production of the Parkesburg tubes. Only selected scrap is used, only experienced men do the work. Care and "know how" are always employed. This care, coupled with rigid inspection and test, are maintained to be sure each tube is worthy of the name of "Parkesburg," and sure to assure the greatest ultimate economy.

Parkesburg Tubes in Marine Service

For years the question of the superiority of iron or steel has been before the consumer, and in regard to boiler tubes for marine service in this connection, the remarks of a certain ship's engineer are of particular interest. This man stated that when his ship's boilers were equipped with Charcoal Iron tubes, he carried only two or three extra tubes for emergencies, but that when his boilers were otherwise equipped, he insisted on carrying a full set of spare tubes.

While speaking of this man's experience, it is of interest to note that an expert in marine boilers stated that "practically" all the people who call for renewal of boiler tubes in marine work, call for Charcoal Iron Tubes.

The same man also stated that in installing Charcoal Iron Boiler Tubes in a large steamer, they took out some Charcoal Iron tubes which had been in fifteen or more years, and found them pitted at the end—true, but in view of the fact that salt water had been used all those years in the boilers, it was both a mighty severe test and mightily conclusive evidence of the longer service and ultimate economy of the boiler tube of Charcoal Iron.

THE PARKESBURG IRON COMPANY

PARKESBURG, PENNSYLVANIA

Charcoal Iron Boiler Tubes

Three High Bar Train

Parkesburg tubes will meet either the requirements of Lloyd's Register of Shipping, or American Bureau of Shipping, U. S. Steamboat Rules, American Society of Mechanical Engineers, American Society for Testing Materials, the Pennsylvania Railroad and other leading Railroads of the United States.

A new book on the origin and development, service and ultimate economy of Charcoal Iron Boiler Tubes, and containing information and tabulated data of decided value may be obtained on request.

Crushing Test

Average Chemical Analysis and Tensile Strength

"Parkesburg" Charcoal Iron Boiler Tubes show the following average chemical analysis: Carbon .03, Manganese .03, Sulphur .015, Phosphorus .03, Silicon .03.

Average Tensile Strength: Tubes full size 47,000 lbs. per sq. in.—Iron Strip longitudinal 48,000 lbs. per sq. in.—Iron Strip Transverse: 44,000 lbs. per sq. in.

STANDARD SIZES AND WEIGHTS OF LAP-WELDED CHARCOAL IRON BOILER TUBES

External Diameter	Internal Diameter	Standard Thickness	Birmingham Wire Gauge	Internal Circumference	External Circumference	Internal Area		External Area		Length of Tube Per Sq. Ft. Inside Surface	Length of Tube Per Sq. Ft. Outside Surface	Length of Tube Per Sq. Ft. Mean Surface	Nominal Wt. Per Lineal Foot	Average Wt. Per Lineal Foot
						Square Inches	Square Feet	Square Inches	Square Feet					
2	1.810	.095	13	5.683	6.283	2.573	.0178	3.142	.0218	2.110	1.910	2.010	1.91	2.08
	1.782	.109	12	5.598		2.494	.0173			2.144		2.027	2.17	2.37
	1.760	.120	11	5.529		2.433	.0169			2.171		2.041	2.38	2.62
	1.732	.134	10	5.441		2.357	.0164			2.205		2.058	2.64	2.90
	1.704	.148	9	5.353		2.281	.0159			2.242		2.076	2.87	3.05
	1.670	.165	8	5.246		2.190	.0152			2.287		2.099	3.17	3.36
	1.640	.180	7	5.152		2.112	.0147			2.329		2.120	3.43	3.66
	1.500	.250		4.712		1.767	.0123			2.547		2.229	4.58	4.90
	1.438	.281		4.518		1.625	.0113			2.656		2.283	5.06	
	1.374	.313		4.316		1.483	.0103			2.780		2.345	5.55	5.88
2¼	2.060	.095	13	6.472	7.069	3.333	.0231	3.976	.0276	1.854	1.698	1.776	2.16	2.25
	2.032	.109	12	6.384		3.243	.0225			1.880		1.789	2.45	2.65
	2.010	.120	11	6.315		3.173	.0220			1.900		1.799	2.70	2.96
	1.982	.134	10	6.227		3.085	.0214			1.927		1.808	2.99	3.30
	1.954	.148	9	6.139		3.000	.0208			1.955		1.822	3.26	3.40
	1.920	.165	8	6.032		2.895	.0201			1.989		1.844	3.60	3.82
	1.890	.180	7	5.938		2.805	.0195			2.021		1.860	3.90	4.17
	1.750	.250		5.498		2.405	.0167			2.183		1.941	5.24	5.60
	1.688	.281		5.303		2.239	.0156			2.263		1.981	5.80	
	1.624	.313		5.102		2.072	.0144			2.352		2.020	6.34	6.76
2½	2.282	.109	12	7.169	7.854	4.090	.0284	4.909	.0341	1.674	1.528	1.601	2.75	3.00
	2.260	.120	11	7.100		4.012	.0279			1.690		1.609	3.00	3.33
	2.232	.134	10	7.012		3.913	.0272			1.711		1.620	3.35	3.60
	2.204	.148	9	6.924		3.815	.0265			1.733		1.631	3.67	3.88
	2.170	.165	8	6.817		3.698	.0257			1.760		1.644	4.12	4.27
	2.140	.180	7	6.723		3.597	.0249			1.785		1.657	4.37	4.66
	2.094	.203	6	6.534		3.431	.0238			1.837		1.683	4.88	5.19
	2.060	.220	5	6.427		3.333	.0231			1.867		1.698	5.25	5.59
	2.000	.250		6.283		3.142	.0218			1.910		1.719	5.89	6.30
	1.938	.281		6.088		2.951	.0205			1.988		1.758	6.54	
	1.884	.313		5.919		2.789	.0194			2.027		1.778	7.16	7.63
2¾	2.532	.109	12	7.954	8.639	5.035	.0350	5.940	.0412	1.508	1.389	1.449	3.04	3.20
	2.510	.120	11	7.885		4.948	.0344			1.522		1.456	3.31	3.51
	2.482	.134	10	7.797		4.862	.0337			1.539		1.464	3.67	3.90
	2.454	.148	9	7.710		4.732	.0329			1.556		1.473	4.03	4.29
	2.410	.165	8	7.571		4.562	.0317			1.585		1.487	4.47	4.75
	2.250	.250		7.069		3.976	.0276			1.698		1.544	6.55	7.00
3	2.782	.109	12	8.740	9.425	6.079	.0422	7.069	.0491	1.373	1.273	1.322	3.33	3.55
	2.760	.120	11	8.671		5.983	.0415			1.384		1.329	3.63	4.00
	2.732	.134	10	8.583		5.862	.0407			1.398		1.336	4.05	4.40
	2.704	.148	9	8.495		5.745	.0399			1.413		1.343	4.46	4.75
	2.670	.165	8	8.388		5.599	.0389			1.431		1.352	4.90	5.35
	2.630	.180	7	8.262		5.433	.0378			1.452		1.363	5.32	5.90
	2.594	.203	6	8.149		5.287	.0367			1.473		1.373	5.95	6.35
	2.500	.250		7.854		4.909	.0343			1.528		1.401	7.20	7.75
	2.438	.281		7.659		4.670	.0324			1.567		1.420	8.01	
3¼	3.010	.120	11	9.456	10.210	7.116	.0495	8.296	.0576	1.269	1.175	1.222	3.96	4.19
	2.982	.134	10	9.368		6.987	.0485			1.281		1.228	4.39	4.87
	2.954	.148	9	9.280		6.856	.0476			1.293		1.234	4.81	5.11
	2.920	.165	8	9.173		6.697	.0465			1.308		1.242	5.33	5.67
	2.890	.180	7	9.079		6.560	.0456			1.322		1.249	5.79	6.15
	2.844	.203	6	8.935		6.355	.0441			1.343		1.259	6.48	6.89
	2.750	.250		8.639		5.940	.0418			1.389		1.282	7.85	8.39
	2.688	.281		8.445		5.677	.0394			1.421		1.298	8.74	
3½	3.260	.120	11	10.242	10.996	8.347	.0580	9.621	.0668	1.172	1.091	1.132	4.28	4.70
	3.232	.134	10	10.154		8.204	.0570			1.182		1.137	4.74	5.10
	3.204	.148	9	10.066		8.066	.0560			1.192		1.142	5.19	5.65
	3.170	.165	8	9.959		7.892	.0548			1.205		1.148	5.66	6.13
	3.140	.180	7	9.865		7.744	.0538			1.217		1.154	6.17	6.68
	3.094	.203	6	9.720		7.521	.0522			1.235		1.163	7.01	7.45
	3.000	.250		9.425		7.069	.0491			1.273		1.182	8.51	8.80
	2.938	.281		9.230		6.782	.0471			1.300		1.196	9.48	
	2.874	.313		9.029		6.490	.0451			1.329		1.210	10.43	11.12

In estimating the effective steam-heating or boiler surface of tubes, the surface in contact with air or gases of combustion (whether internal or external to the tubes) is to be taken.

For heating liquids by steam, superheating steam, or transferring heat from one liquid or gas to another, the mean surface of tubes is to be taken.

Marine Boiler Insulation

Sil-O-Cel Insulation

Heat which is not allowed to penetrate boiler walls is converted into energy by being held to its assigned task of making steam. In Marine Boiler practice, the insulating of the fire zone to prevent heat penetration is new, because heretofore no effective medium has been available.

Sil-O-Cel Insulation applied according to our specifications effectually prevents heat loss from boiler settings, drums, surfaces, etc.—maintains the heat at its maximum effectiveness.

Sil-O-Cel is a light weight insulating material made from the mineral Celite. Being composed of Silica and free from organic matter, it is uneffected by temperatures which completely destroy other forms of insulation.

Sil-O-Cel is manufactured in the form of brick, blocks, powder and cements, providing convenient forms for the insulation of all types of equipment. It has an unusually high thermal resistivity and mechanical strength. These desirable properties are permanent and it is not subject to deterioration.

Insulation of Water Tube Boilers

Pans:—A 2½″ course of Sil-O-Cel Insulating Brick is laid directly on the pan. Over this is placed either a 2½″ course of Sil-O-Cel C-22 Brick or a 3″ layer of Sil-O-Cel C-3 tamped down. In either case two courses of 2½″ fire brick are laid over the insulation. All brick are laid with broken joints and the insulating brick are laid in Sil-O-Cel Mortar.

Casing—A 2½″ course of Sil-O-Cel Insulating Brick is laid against the steel casing. Then a 2½″ course of Sil-O-Cel C-22 Brick, backed by a refractory lining as shown in illustration. The two courses of Insulating Brick are laid in Sil-O-Cel Mortar and with broken joints.

Scotch Marine Boilers

A 2½″ thickness of Sil-O-Cel Insulating Brick is applied to the clean steel surface with Sil-O-Cel Mortar. One inch galvanized wire mesh is then tightly drawn over the brick and wired firmly in place with 12 gauge galvanized wire spaced 9″ on centers. A half inch of Sil-O-Cel Hard Finish Cement is troweled on over the brick in two coats.

All types of steam drums are insulated by the same method.

Breechings

Sil-O-Cel Sticking Cement to a thickness of ¼″ is applied by spotting to the clean steel surface. 85% Sil-O-Cel Insulating Cement is applied with a trowel to the Sticking Coat and to a thickness of 1½″.

One inch galvanized wire mesh is drawn over the insulation and laced wherever possible. Sil-O-Cel Hard Finish Cement is then troweled over smoothly to a thickness of ½″, applied preferably in two coats.

An alternate method of insulating breechings is by the use of Sil-O-Cel Blocks, wired on and finished with Sil-O-Cel Hard Finish Cement as above.

Fire Box of Oil Fired Marine Boiler Insulated with Sil-O-Cel C-22 and Sil-O-Cel Insulating Brick

Bulkheads

Bulkheads, particularly those separating the boiler room from other compartments are effectively insulated with either Sil-O-Cel Brick, Blocks or Powder depending upon the design.

Advantages

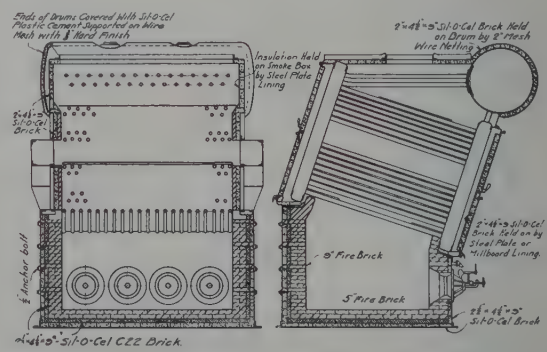
Increased capacity of boiler.

Increased thermal efficiency, hence, a saving in fuel.

More constant temperatures are maintained in the boiler and settings, increasing their life by reducing strains and stresses.

Better working conditions are maintained about the boilers.

These advantages are permanent, because Sil-O-Cel Insulation is permanent and does not deteriorate in use.


Insulation Held on Smoke Box by Steel Plate Lining
9" Fire Brick
5" Fire Brick
Sil-O-Cel Brick Held on by Steel Plate or Hillboard Lining.

Insulation of Marine Steel Encased Boiler with Sil-O-Cel

Engineering Service

Our engineers will gladly advise you on any type of insulation construction. For Blueprints and Literature, address Celite Products Company at New York, 11 Broadway; Philadelphia, Liberty Bldg.; Pittsburgh, Oliver Bldg.; Chicago, Monadnock Bldg.; Los Angeles, Van Nuys Bldg.; Cleveland, Guardian Bldg.; Detroit, Book Bldg.; St. Louis, 1532 West Olive St., or San Francisco, Monadnock Bldg.

"85% Magnesia" Steam Pipe and Boiler Coverings

Economy

It is very essential from the standpoint of economy that all marine steam power apparatus such as steam and hot water pipes, boilers, heaters, etc., be properly insulated or covered with an efficient non-heat-conducting material. The following table illustrates the tremendous economy of such procedure:

Efficiency

Furthermore, good insulation makes for smooth operation by elimination of moisture from the steam, which is the cause of so many accidents and delays due to leaky joints, corroded valves, etc. The power plant of a ship must operate smoothly and continuously for long periods, and dry steam, obtained by the use of proper heat insulation, makes for that condition. In addition the keeping of the heat inside the steam pipes, boilers, etc., reduces engine and boiler-room temperatures, making much better working conditions for the men.

S. S. Magneric, 8500 Tons, Named for Magnesia Association of America

Monthly Coal-Saving, in Dollars and Cents, by Use of "85% Magnesia" Pipe Covering, Standard thickness, per 100 lineal feet of Steam-pipes.
Compiled by the Mellon Institute of Industrial Research, University of Pittsburgh.

Size of Pipe	5 Lbs. Steam-Pressure	10 Lbs. Steam-Pressure	50 Lbs. Steam-Pressure	100 Lbs. Steam-Pressure	150 Lbs. Steam-Pressure	200 Lbs Steam-Fressure	200 Lbs. Steam-Pressure 100° Sup.-Heat
½	$1.44	$1.58	$2.20	$3.28	$3.66	$4.11	$6.80
¾	1.72	1.89	2.87	3.70	4.26	4.89	8.03
1	2.11	2.30	3.56	4.80	5.35	6.04	10.00
1½	2.86	3.10	4.73	6.14	7.29	8.17	13.70
2	3.53	3.74	5.86	7.63	8.93	10.11	16.80
3	5.00	5.33	8.30	10.90	12.60	14.30	23.82
4	6.50	7.06	10.60	14.05	16.40	18.40	30.85
5	7.97	8.64	13.16	17.20	20.00	22.72	38.00
6	9.36	10.15	15.60	20.38	23.82	26.88	44.90
7	10.90	11.70	18.38	23.68	27.60	30.80	52.00
8	12.26	13.22	20.40	26.60	31.20	34.90	58.55
9	13.80	14.70	22.70	29.00	34.52	38.61	64.80
10	15.08	16.33	25.00	32.70	38.40	43.08	72.40
Flat Surface 100 sq. ft. 1¼" thick	5.26	5.67	8.80	11.50	13.48	15.12	25.44

These savings are based on pipes carrying steam for 24 hours per day and 30 days per month.
Coal is figured at $5.00 per ton, delivered, with 14,000 B. T. U. per pound. Boiler efficiency is calculated at 70 per cent.

It is always economical to use the very best insulation obtainable. "85% Magnesia" coverings have long been recognized as the most durable and efficient coverings both for marine and for stationary practice, and it is significant to note that for 30 years "85% Magnesia" coverings have been the standard of the United States Navy Department. They were also adopted as a standard by the Emergency Fleet Corporation.

Not only is "85% Magnesia" the best non-heat-conducting covering, but it is practically immune to steam or water leakage and will withstand prolonged immersion due to stranding, collision or even sinking of the vessel without suffering permanent damage. As soon as steam is admitted to the pipes, it dries out, as good as ever.

Application

"85% Magnesia" pipe covering is furnished in sections 3 feet long, split in half lengthwise and canvas jacketed, for all pipe sizes up to and including 10" size; for larger sizes segmental blocks are furnished. The sectional pipe covering is furnished in standard thickness (approximately 1"), 1½" thickness, 2" thickness, double standard thickness (2 layers), double 1½" thickness (2 layers).

For exposed situations and exceptionally high pressures these thicknesses can be further increased by additional layers of covering.

For covering boilers and large surfaces "85% Magnesia" blocks are furnished in standard sizes 6" by 36" or 3" by 18" and in any thickness from ⅞" up to 4". For large size pipe segmental blocks 36" long and of any thickness from 1½" up are furnished.

"85% Magnesia" plastic cement is furnished in dry form in 60 pound bags. This material mixed with water to the consistency of mortar is used for applying to irregular surfaces or to fill in cracks or to give a finished coating to block work.

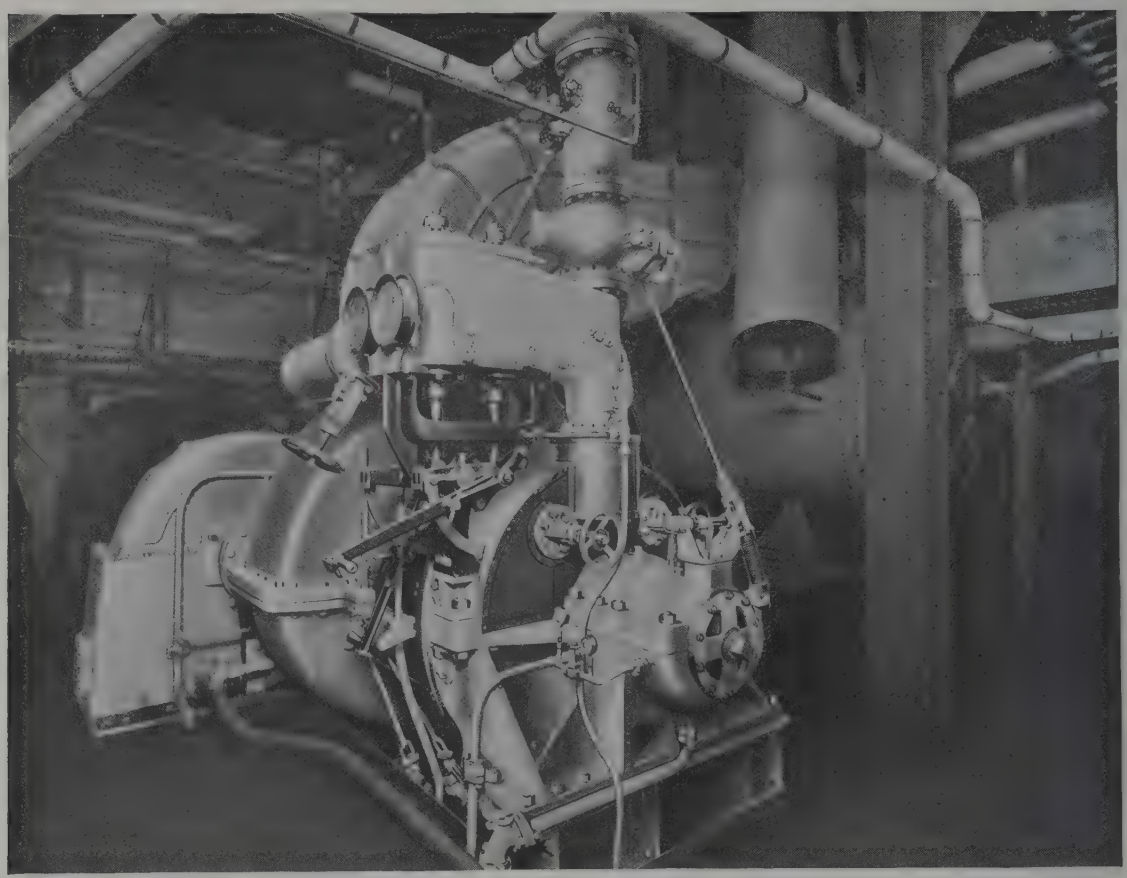
Weight

The approximate weights of 85% Magnesia Sectional Pipe Coverings and Blocks are about 18 lbs. per cubic foot.

Because of its large percentage of dead air cells 85% Magnesia is the lightest of all heat insulating materials. This lightness is not obtained by any sacrifice of structural strength since, as has been proved by over 25 years of continuous service in ships of the International Mercantile Marine Co., 85% Magnesia amply withstands all the vibriations and strains of the severest marine service without cracking, falling away from the pipe or any other form of disintegration.

MAGNESIA ASSOCIATION OF AMERICA
721 BULLETIN BUILDING, PHILADELPHIA, PENNA.

"85% Magnesia" Steam Pipe and Boiler Coverings



G-E Turbine
Pipes Covered with "85% Magnesia"

Specifications

The following paragraphs give specifications for the insulation of all inside and outside steam power and heating services insuring adequate protection and maximum conservation of heat.

I. Non-Heat-Conducting Material

Non-heat-conducting covering material for all heated surfaces shall be "85% Magnesia" covering consisting of hydrated Carbonate of Magnesia ($4MgCO_3MgO_2H_25H_2O$) and asbestos fibre in the proportions of not less than 85% Carbonate of Magnesia and not less than 10% asbestos fibre.

II. Thickness of Covering

"For each individual steam pressure and for each individual cost of steam there is a most economical thickness of pipe covering to use. A complete specification containing tables and curves giving the correct economic thickness can be obtained upon request. It is assumed, however, that in marine practice there will be considerable variation in the cost of producing steam in any one vessel, depending upon quality, cost of coal, etc., at different coaling points; therefore, the following specification of fixed thickness is recommended as best suited to meet average conditions found in marine practice."

Superheated steam pipe	double 1½" thickness
High pressure saturated steam pipes	double standard thickness
High pressure drips	standard thickness
Feed water pipes	standard thickness
Steam heating pipes	standard thickness
Exhaust pipes	standard thickness
Boiler shell	3" thickness
Feed water heater and similar appurtenances	1½" thickness

Application, Steam Piping

All single-thickness pipe coverings shall be carefully applied so that seams and butt joints are tight. Coverings shall be finished with canvas jacket pasted on, and black japanned bands on 18" centers.

(Where pipe is so located that the coverings may be damaged, or where a particularly fine finish is desired, there should be applied over the standard canvas jacket, sheathing paper, followed by an extra 8 oz. canvas jacket sewed on approximately 3 stitches to the inch.

MAGNESIA ASSOCIATION OF AMERICA
721 BULLETIN BUILDING, PHILADELPHIA, PENNA.

"85% Magnesia" Steam Pipe and Boiler Coverings

United States Destroyers in Wet Dock of the New York Shipbuilding Corporation
All Pipes and Boilers Covered with "85% Magnesia"

All double thickness coverings shall be applied by the broken joint method. The first layer of sectional or segmental covering shall be securely wired in place with No. 18 annealed iron wire; the second layer shall be applied so as to break both butt and lateral joints, and be secured in place by No. 18 annealed iron wire, not less than three separate loops to the section. Any cracks on the surface between the sections or segments shall be carefully filled with 85% Magnesia plastic.

All double thickness covering shall be finished with an 8 oz. canvas jacket, neatly applied over heavy sheathing paper and well sewed on—approximately three stitches to the inch.

All coverings exposed to the weather shall have an extra protection of 2-ply roofing wired on and joints cemented. Where pipes are laid along decks or in places where they are liable to damage, the covering should be further protected by a wood or sheet iron casing over the exposed sections.

Application, Fittings

Pipe fittings, valves, and all appurtenances, shall be covered with 85% Magnesia blocks and plastic, or all 85% Magnesia plastic, to a thickness not less than the covering on the pipes. The finishing coat shall be smoothly troweled and finished with a canvas jacket to match the sectional covering.

Application, Flanges

All flanges shall be covered with 85% Magnesia blocks and plastic, or all plastic, to a thickness not less than covering on pipe, made up on framework of ½" mesh iron wire netting, in two sections, so as to be easily removable and replaceable. Flange covers shall be finished with a canvas jacket to match the sectional covering.

The covering on pipes at flange bolts shall be cut back and neatly beveled to allow sufficient space for the removal of the bolts without injury to the covering.

Boilers and Boiler-Hatch Lining

Cover all exposed boiler surface with 2½" thick Magnesia blocks firmly wired on and finished with a ½" thick coat of Magnesia plastic cement and a light coat of hard finish cement.

Insulate all other exposed surfaces with 85% Magnesia Blocks of standard thickness, protected by suitable sheet metal lining properly secured and painted.

Smoke Breeching and Stack

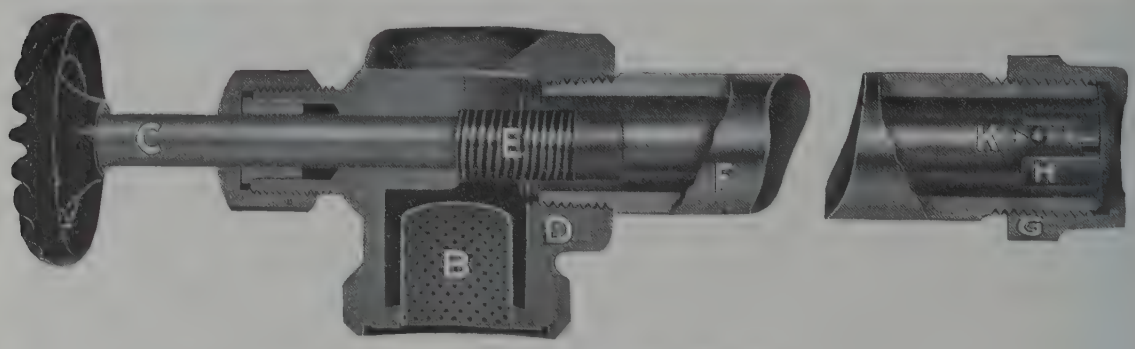
Cover the smoke breeching and the smoke stack inside of the boiler room with 2" thick 85% Magnesia blocks, applied and firmly wired to ½" mesh black iron wire cloth with ¾" "V" iron attached, which has been firmly secured to the breeching and stack to form an air space. Finish with a coat of hard finish cement, troweled smooth.

Painting

All canvas jacketing is to be sized and painted with two coats of lead and oil paint of colors to be selected.

MAGNESIA ASSOCIATION OF AMERICA
721 BULLETIN BUILDING, PHILADELPHIA, PENNA.

Mechanical Oil Burning Equipment



The Coen Adjustable Tip Mechanical Oil Burner

B—Burner Strainer C—Adjusting Rod D—Burner Valve
E—Burner Spring F—Burner Tube G—Burner Cap H—Burner Tip

Burners

One of the most important features of a mechanical oil burning system is the burner or atomizer, for, aside from being constructed in a manner that will insure the complete atomization of the oil, it should be subject to immediate adjustment and control, so as to produce a light, medium or heavy fire without the necessity of changing the oil pressure at the pump.

The Coen Burner

The Coen Burner is a flexible mechanical oil burner. By flexible we mean a burner that can produce a full fire or a small fire at the will of the fireman, and change from one fire to the other instantly without extinguishing the flame, altering the oil pressure, or impairing the quality of the flame.

The common method of taking care of a fluctuating load by cutting burners out and then relighting them is crude; it is slow, is injurious to the furnace and increases the opportunities for furnace explosions and flare backs.

If you have ever been in the fireroom of an oil burning steamer when the ship was maneuvering in a fog, making a landing or operating under any conditions where a full head of steam was necessary, and bells for different speeds ahead or astern were sounding in the engine room, you have seen firemen running up and down in front of the boilers with lighted torches in their hands, now cutting out burners—now relighting them. Sometimes they don't light readily—the burner tip has carbonized during its temporary shut down—it has to be changed for a clean burner. Sometimes the firemen considers that the furnace is hot enough to ignite the burner without a torch and he opens the burner—if he has guessed wrongly he is liable to experience a flare back with disastrous results.

All of these difficulties are overcome by the use of the Coen Adjustable Tip Mechanical Burner.

With this burner, the fireman has at his immediate command, not only means for regulating the size of his operating fire, but means whereby he can instantly substitute a stand-by fire and vice versa, with one quick turn of the burner valve wheel.

The advantages to be derived from the use of a burner of this construction are too obvious to dwell upon. To the initiated, an illustration showing the mechanical simplicity and the positive action of this latest Coen Burner will prove sufficient.

Construction

The simplicity in the construction of the Coen Mechanical Oil Burner is shown in the accompanying cut.

The complete burner consists of a special angle valve, a short piece of tubing, a tip, a cap to hold the tip in place and a steel rod running through the burner to provide means for regulating the discharge from the tip.

Nothing to get out of order and no wearing parts.

The Coen burner will operate with equal efficiency with fuel oil of any gravity.

Operation

The regulating rod "C" has a rotative movement of one-quarter of an inch only. When turned to the extreme left the burner is wide open, delivering the maximum fire. By turning the rod to the right the fire is gradually diminished until the pin "K" is brought into contact with shoulder of burner tip "H" when the minimum or stand-by fire is produced. The rod cannot be turned far enough to extinguish the fire; this permits of quick and positive action when throwing in small fires. The burner valve is a regulating valve; not a shut off valve.

BURNER TIP "H"—SIZES.

No. 20	—.03125	dia.–	Recommended	for	150	lbs.	per hr.
" 25	—.03906	" —	"	"	175	"	"
" 30	—.04687	" —	"	"	200	"	"
" 33	—.05208	" —	"	"	225	"	"
" 35	—.05469	" —	"	"	250	"	"
" 40	—.0625	" —	"	"	300	"	"
" 45	—.0703	" —	"	"	350	"	"

COEN COMPANY

112 MARKET ST., SAN FRANCISCO, CAL.

Address nearest office. For list of offices see fifth page following.

Mechanical Oil Burning Equipment

Duplex Strainers

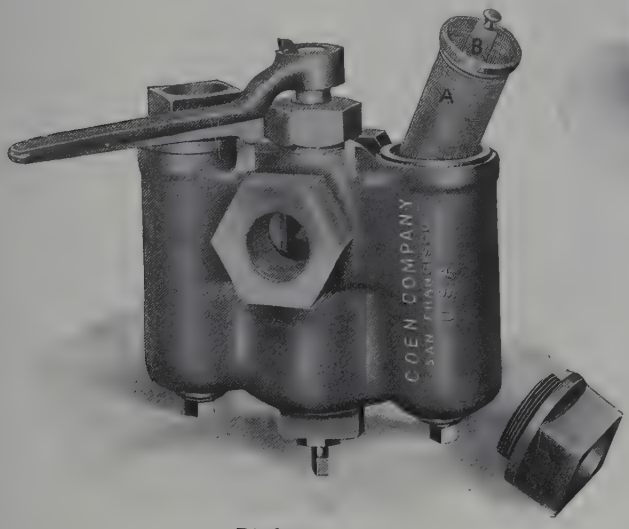
The principal advantages of Coen Duplex Strainers are as follows:

No valves—a 90-degree turn of the handle changes from one to the other basket.

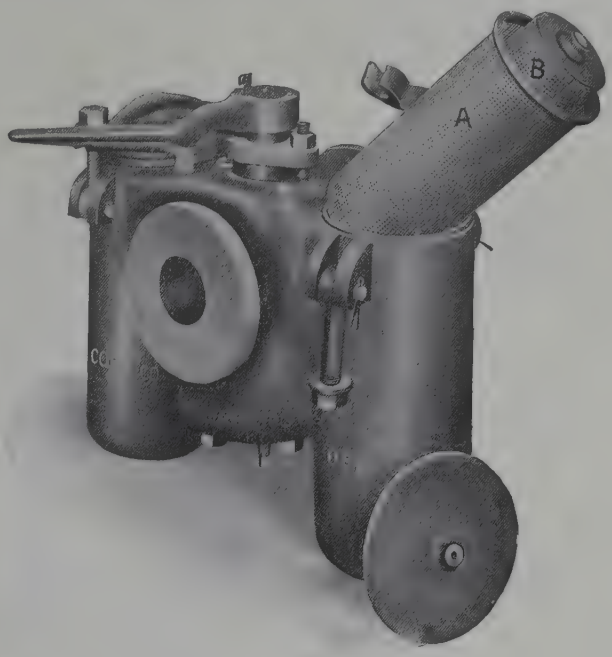
Tell-tale hole in plugs of screwed strainer which gives warning of any pressure before plug is completely removed.

Vacuum breaker in cover of flanged type, allowing easy removal of basket cover when strainer is working on suction.

Positive adjustment of plug by means of jack screw.



Discharge



Suction

Strainer basket being in two parts is more readily cleaned.

Double basket (the combined area of whose perforations is from six to ten times the cross sectional area of the pipe and about twice the area of other makes of strainers), which allows a much more compact body, allowing a smaller casting, which in turn allows the customary hangers on the run of the pipe to carry the strainer.

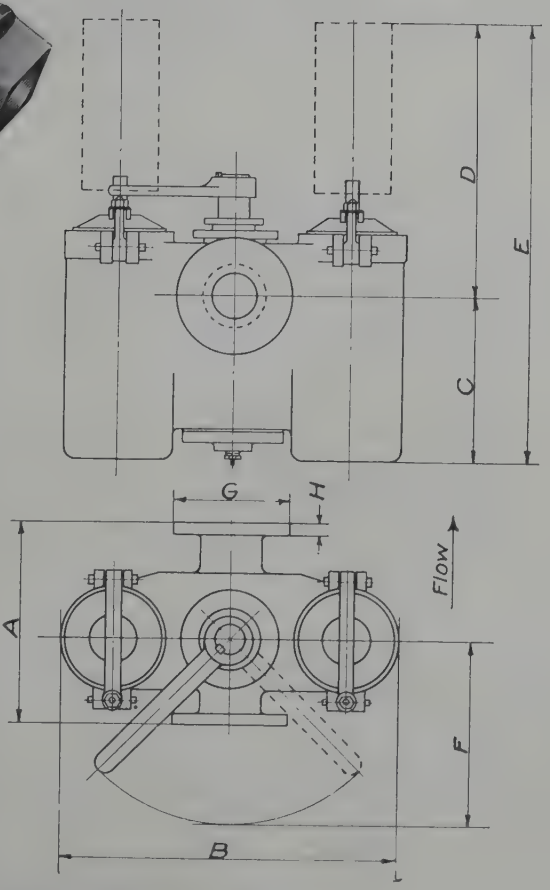
Designed so that when well cover is removed level of oil in well is lowered, exposing the top of basket for removal.

Tongue and grooved joints on well covers.

Handle partially covers basket-well which is in use, leaving exposed the well which is out of commission and free to be cleaned.

In no position of handle is it possible to stop the flow.

Elimination of the many joints necessary in a duplex strainer made up with valves and fittings.



OUTLINE DIMENSIONS—WEIGHTS.

	Size	A	B	C	D	E	F	G	H	Weight Net	Weight Boxed
Flanged Threaded	½"	4¾	9	5½	6	11½	6	—	—	15	22
	¾"	"	"	"	"	"	"	—	—	"	"
	1"	6½	12	6¼	7¼	13½	8	—	—	36	46
	1¼"	"	"	"	"	"	"	—	—	"	"
	2"	9½	16	8	12	20	10	6	½	95	120
	2½"	"	"	"	"	"	"	7	⅝	100	125
	3	13	22	12	17	29	12	7½	⅝	250	300
	4"	16	29	15¼	22	37¼	20	9	1	520	605

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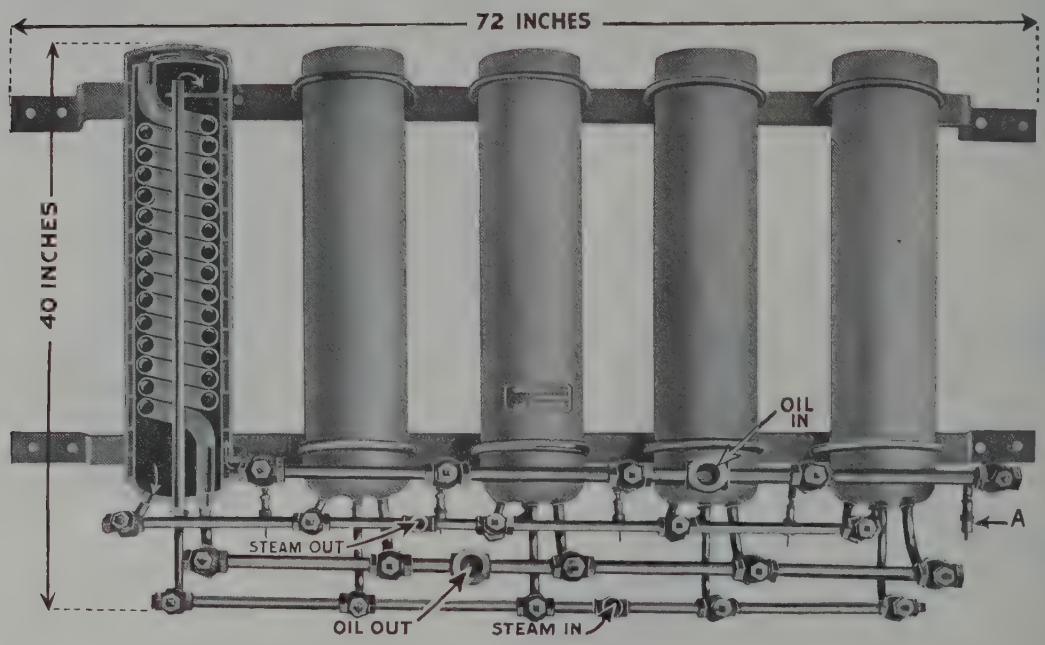

The Coen Multiunit Semi-Film Oil Heater

Oil Heaters

The Oil Heater is an important unit in a mechanical oil burning system and the type, construction and material should be given careful consideration by the purchaser.

The heating of the oil for a mechanical system is accomplished with live steam. The necessity for heating is, primarily, to reduce the viscosity of the oil, for as the atomizing of the fuel is accomplished by the centrifugal force imparted to it as it passes through the burner tip, the lower the viscosity of the oil the more readily it distintegrates.

A standard temperature for all fuel oils cannot be fixed, for the "efficient temperature" will vary as the different oils vary in viscosity and gravity. However, a temperature ranging from 210 degrees F. to 230 degrees F. has been proven to be the most efficient stage for residuum Fuel Oil. Lighter oils, such as those from the Texas fields, require a much lower temperature. "Tops" or Stove Distillate can be used at atmospheric temperature with the Coen System. Heavy Mexican oils require a temperature of 275 to 300 degrees F.

Construction

Until recently, the popular oil heater construction was a cast iron shell or drum containing one or more copper coils. In some heaters the oil flowed through the copper coils with the steam on the outside, in others the steam flowed through the coils.

We are strongly opposed to the use of copper coils or cast iron in the construction of oil heaters for mechanical oil burning systems.

The sulphur content in crude oil, small as it is, attacks the copper, gradually weakens the coil and eventually makes its renewal imperative.

Cast iron shells are too heavy and of uncertain strength.

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Address nearest office. For list of offices see third page following.

Mechanical Oil Burning Equipment

Operation

The improved Coen Oil Heater, as illustrated on the opposite page, was so designed as to combine strength, flexibility and efficiency with compactness and light weight.

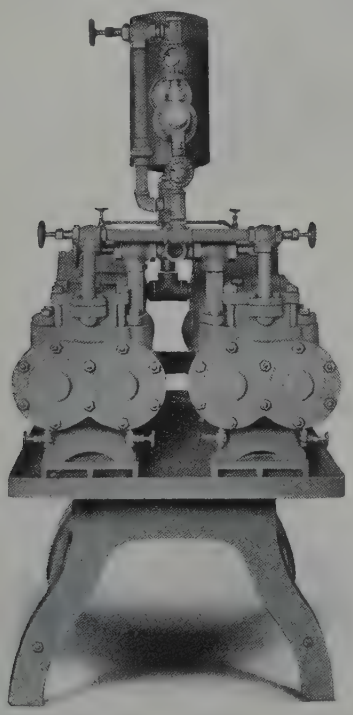
The oil entering the heater unit between the two shells takes a spiral course upward to the space between the two shell heads from whence it flows down through the seamless steel coil and out to the discharge header. In the event of an operator closing the inlet and outlet oil valves without cutting out the steam to heater, thereby causing the dead oil in the unit to heat and expand to a pressure which might create a rupture, a safety valve "A" is provided for each unit and set to operate before an excessive pressure can be attained. Steam is admitted and condensate carried off as shown.

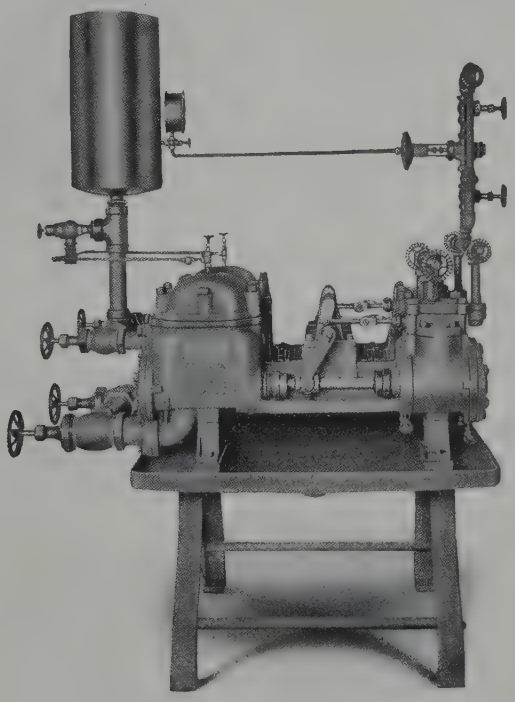
All Coen Heaters are subjected to a 500-lb. hydrostatic test before leaving the factory and although the chance for a leak developing is very remote, we furnish this heater in batteries of a sufficient number of units to allow of one or more units being held in reserve when full power is being developed.

Features

The features of the Coen 1919 Multiunit Semi-Film Oil Heater are as follows:

1. Everlasting.
2. No joints except in header connections.
3. No necessity nor opportunity for repairs.
4. Each unit capacity 850 lbs. oil per hour.
5. Strong—compact—flexible—light—efficient.
6. No cleaning required except blowing out with steam.
7. Furnished in batteries of 2—3—4—5 and 6 units each. Each individual coil is under control and can be cut in or out independently of the others.
8. Guaranteed against defects in material or workmanship for a period of three years.
9. Constructed of wrought steel shells, wrought steel heads and seamless steel coils welded into one.
10. The inner shell being a floating member eliminates expansion and contraction strains.
11. The cold oil entering and circulating between the inner and outer shells acts as an insulator, making covering of the units unnecessary.





Pumping Sets

Pumping Sets

Coen Oil Pumping Sets are fitted up especially for use with the Mechanical System of Oil Burning, all valves, pipe and fittings being extra heavy and designed for working pressures up to 200 lbs. Sets consist of two duplicate, duplex pumps, mounted on cast iron stand, and fitted up complete with automatic pump governor, relief valve, air chamber, pressure gauge and all necessary fittings as illustrated above. Pumping Sets are furnished in the following sizes.

3	x 2	x 3
4 1/2	x 2 3/4	x 4
5 1/4	x 3 1/2	x 5
6	x 4	x 6

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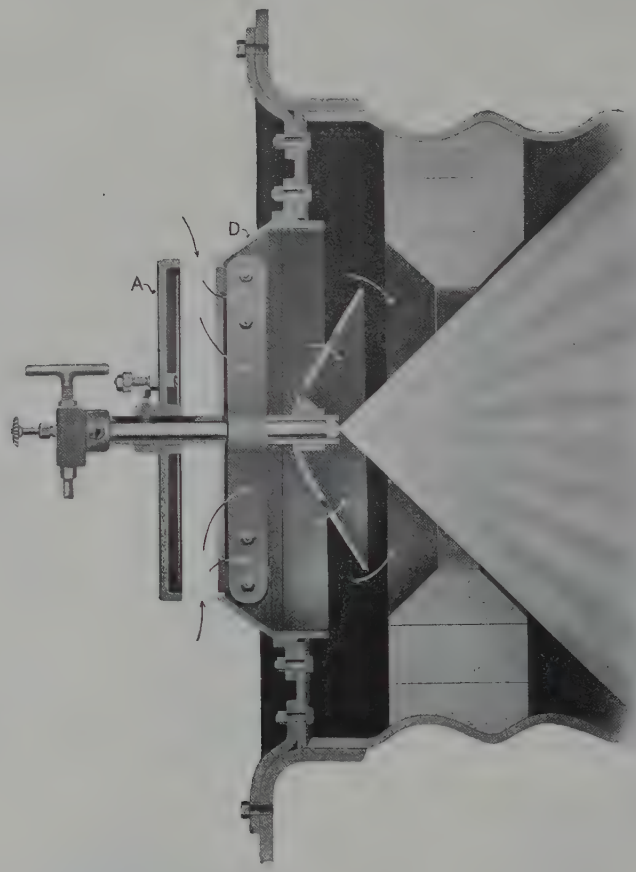

The Latest Coen Firing Front for Scotch Marine Boilers

Firing Fronts for Oil Fired Boilers

To obtain the highest efficiency when burning oil fuel, or for that matter any fuel, under boilers, it is not sufficient to accomplish complete combustion,—in order to obtain the most economical results you must bring about complete combustion with the least excess of air.

The uninstructed fireman will invariably reason that if he has maintained the required steam pressure without a smoky stack, he has handled the job efficiently. This is a costly error, for the reason that while the steam pressure may be maintained and combustion complete, (as evidenced by a clear stack) 40%, 50% or 60% more air than is necessary may be passing through the furnace and up the stack, carrying with it thousands of heat units which, if it were not for the excess air, would be absorbed by the water in the boiler.

Air enters the furnace ordinarily at fireroom temperature and before reaching the stack attains a temperature 400 degrees to 700 degrees higher. Where does it get this additional temperature? Directly from the heat produced by the burning of the fuel in the furnace. Excess air gets the first chance at the heat generated in the furnace, the water in the boiler the second chance. Therefore, it is obvious that the heat carried out of the furnace and up the stack by excess

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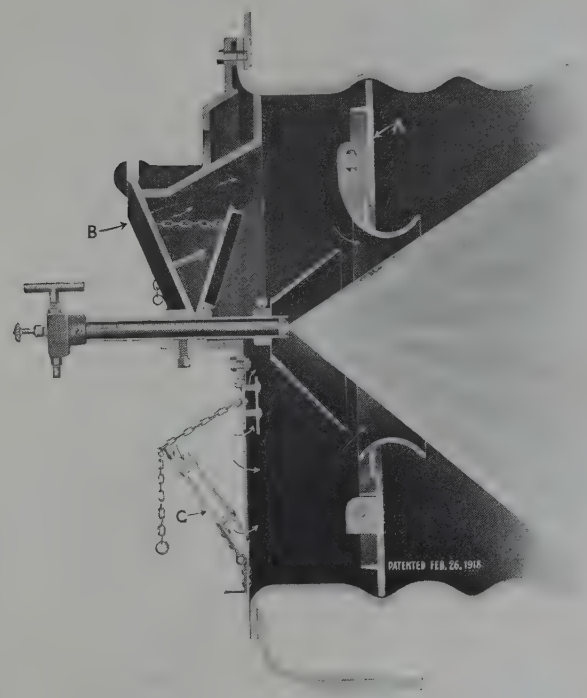
Mechanical Oil Burning Equipment



The Coen Combination Coal and Oil Firing Front for Natural Draft Scotch Boilers

air must be made up by burning more fuel if the water is going to absorb the required amount for evaporation.

In order to burn oil fuel with the minimum amount of excess air, firing fronts should be employed which permit of the air for combustion being admitted to the fires in such a manner as to give the proper supply to each fire, uniformly introduced, and so directed that an intimate mixture of atomized oil and oxygen be attained immediately upon the introduction of the two elements to the furnace.

With the numerous types of boilers and furnaces in use in both marine and stationary boiler plants, with their various draft conditions, it is obvious that a standard firing front cannot be designed that will produce the most economical results for all conditions.

The different types of firing fronts manufactured by Coen Company are the results of many years of study and practical experience, and have been so designed as to meet the different conditions referred to above and produce the highest efficiency and economical results attainable.

Firing Front for Scotch Marine Boilers

This front is for oil fuel only. Designed for use with natural draft induced draft or closed stokehold system of forced draft.

Part "D" is hinged, allowing it to be swung open. Access to the furnace is available at any time without disconnecting or removing any parts.

Adjustable damper "A" controls air supply to interior of firing front.

Firing Front for Natural Draft Scotch Boilers

Oil fire door "B" is interchangeable with the Standard coal fire door on the Coen Combination and Oil Firing Front for Natural Draft Scotch Boilers as shown above.

Cast iron combustion ring "A" is made up of four sections and a throat piece,—easily removed when grate bars are to be substituted for coal burning.

Branch Offices

The Branch Offices of the Coen Company are in a position to render efficient service to those who desire information, regarding the Coen System of Mechanical Oil Burning. Inquiries should be addressed to the nearest office.

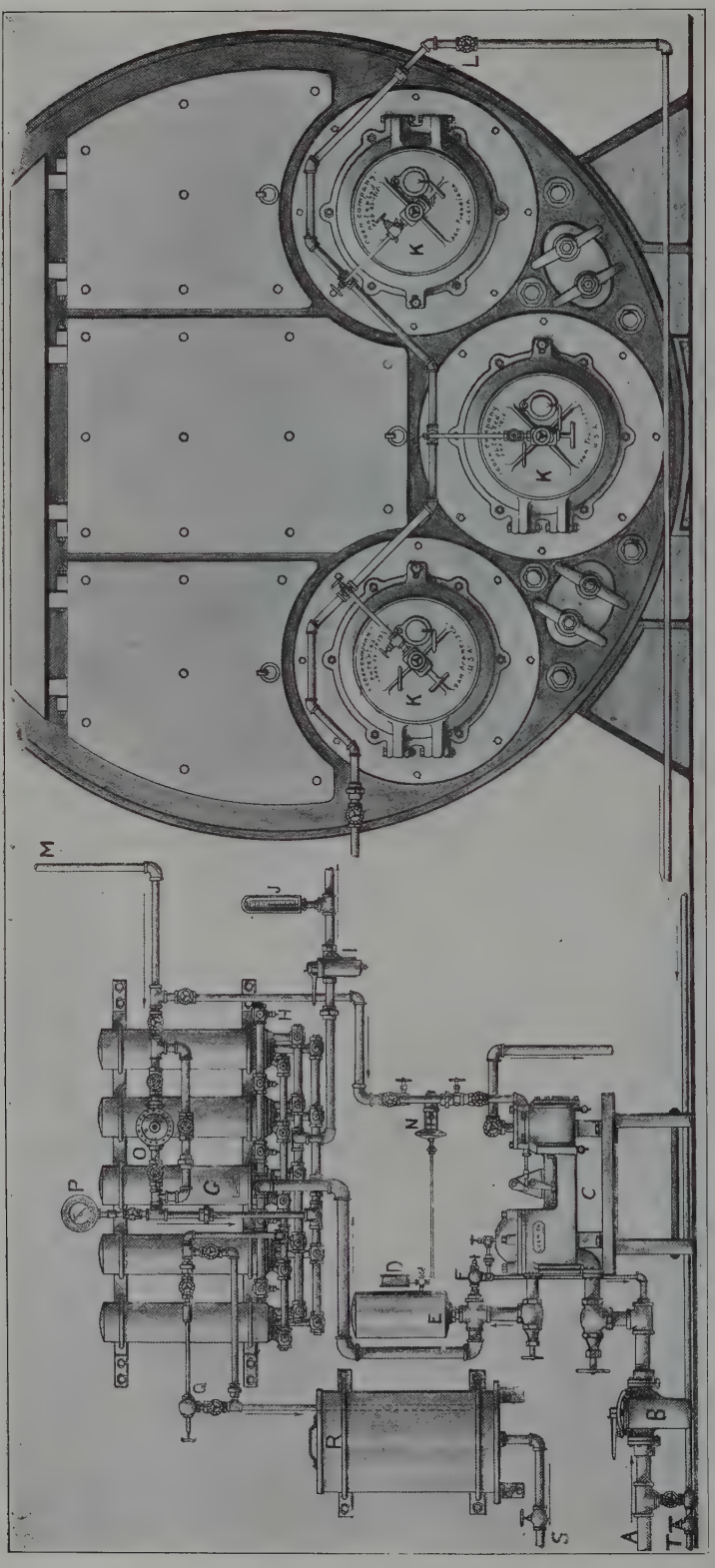
The Branch Offices of the Coen Company are located at:

New York, N. Y., 50 Church St.
Philadelphia, Pa., 263 South 10th St.
Seattle, Wash., 303 Railroad Ave., South.
Portland, Ore., 51 First Street.

COEN COMPANY

112 MARKET ST., SAN FRANCISCO, CAL.

Address nearest office. For list of offices see above.



General Arrangement of Oil Burning Equipment and Piping to Burners

A—Oil Suction
B—Suction Strainer
C—Oil Pumps
D—Pressure Gauge
E—Air Chamber
F—Relief Valve
G—Oil Heater
H—Heater Safety Valve
I—Discharge Strainer
J—Thermometer
K—Firing Front
L—Return Line
M—Steam Line
N—Pump Governor
O—Reducing Valve
P—Steam Pressure Gauge
Q—Steam Trap
R—Drain Tank
S—Drain Tank Outlet
T—Return Line Valve

COEN COMPANY
112 MARKET ST., SAN FRANCISCO, CAL.
Address nearest office. For list of offices see page preceding.

Mechanical Oil Burning Equipment

FIRE ROOM S.S. "LIBERTY GLOW"
HOG ISLAND HULL N°517
"COEN" OIL BURNING SYSTEM
FOLLOWING AVERAGES OBTAINED ON TRIAL TRIP
FLUE GAS ANALYSES - CO2 - 14.6%
STACK TEMPERATURE —— 480°
EVAPORATION F & A. —— 16.02 LBS.
BOILER EFFICIENCY —— 82%

COEN COMPANY

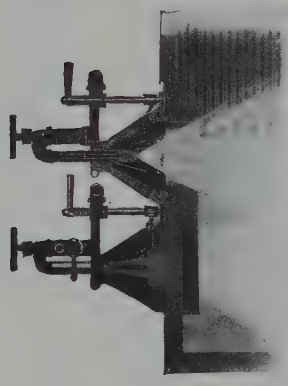
112 MARKET ST., SAN FRANCISCO, CAL.

Address nearest office. For list of offices see second page preceding.

Oil Burners

The Koerting Mechanical Oil Firing systems, particularly the burners have been the best known, most used and highest developed in the marine field for over twenty years.

The first high pressure mechanical burner introduced into this country was developed by the Schutte & Koerting Co. Today practically all marine oil firing systems are pressure atomization. The cut shows the "Koerting" burner as operated in registers of the destroyer type.



Fuel Oil Burners

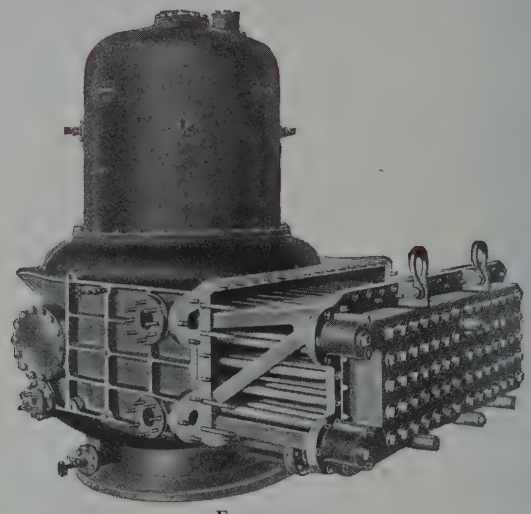
Oil Heaters

The heating of fuel oil is an item of the greatest importance in these days of very heavy crude oils. Features which have been incorporated in the design of the heater are: Minimum space and weight for capacity and strength. Maximum surface and fuel oil travel through the heater. Low resistance and adequate provision for expansion due to changes of temperature. This heater is made up of standard 5/8" steel tubes, which material has been found free from deterioration when used in conjunction with high sulphur oils when heated.

Fuel Oil Heater

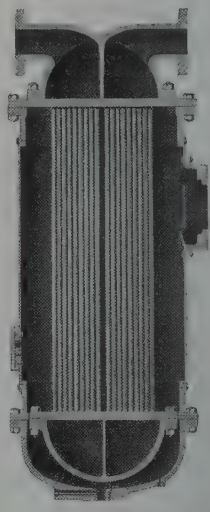
Evaporators and Feed Water Heaters

The Schutte & Koerting Company design and manufacture upon a test basis evaporating plants meeting the most severe requirements. The cut shows the arrangement of one of the latest and largest evaporators at present in use in the U. S. Navy. A generous allowance of heating surface and steam space with strong rugged construction make this line reliable, capable of withstanding the everyday usage aboard ship and always a reserve capacity to fall back upon in case of emergency. The commercial plants, evaporators, distillers and equipments which are made up in cast iron have proven their worth for years as demonstrated by the praise they receive from the operators. Our sizes handle requirements from 250 to 12,500 gallons per twenty-four hours or multiples thereof.



Evaporators

Where minimum space and weight requirements must be considered, the Type "L" feed water heaters manufactured by this company deserve the buyer's most careful consideration. As with the oil coolers, our heaters have an absolute maximum of heat exchange capacity consistent with low resistance through the heater. The prime and surpassing features of the type are: Removable tube bundle for inspection. The use of standard condenser tubes. Expansion provided for with floating head arrangement. Capacities 500 to 500,000 lbs. per hour.



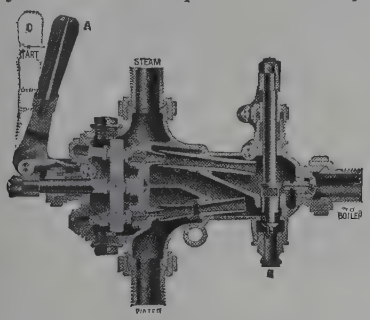
Feed Water Heater

SCHUTTE & KOERTING CO.

PHILADELPHIA, PA.

Injectors

The term "Koerting Universal Double Tube Injector" is synonymous with the highest requirements in marine practice. These injectors will perform all that might be asked of jet apparatus. Only one lever need be operated and no adjustments are required. This injector will take up water at 150 degrees F. and deliver it into the boiler at a temperature near the boiling point. While simplicity of construction is not claimed for these injectors, reliability is one of their greatest features. They have been used extensively for over forty years.



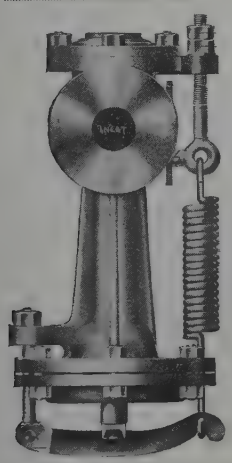
Universal Double Tube Injector

TABLE OF CAPACITIES OF INJECTORS
(Made from actual test)

Size No.	Size of Iron Pipe	Steam 50 lbs. Gals.	Steam 50 lbs. H. P.	Steam 100 lbs. Gals.	Steam 100 lbs. H. P.	Steam 150 lbs. Gals.	Steam 150 lbs. H. P.	Size of Copper Pipe O. D.
0	¼	83	17	101	20	112	22	⅝
1	⅜	112	23	143	30	180	36	⅝
2	½	172	35	210	40	232	46	⅝
3	¾	278	56	338	70	397	80	⅞
3½	¾	398	80	472	95	547	110	⅞
4	1	533	108	622	125	720	150	1⅛
5	1¼	675	136	802	160	922	190	1⅛
6	1¼	825	165	990	200	1125	230	1⅛
7	1½	1072	215	1372	280	1612	320	1¾
8	1½	1388	280	1800	360	2115	430	1¾
9	2	1688	340	2100	420	2475	500	2¼
10	2	2025	400	2438	500	2850	570	2¼
11	St. & D. 2½ / Suc. 2½	2530	500	3050	625	3515	712	St. D. 2¼ / Suc. 2¾
12	2½	3000	600	3638	750	4252	850	2¾
14	3	3867	780	4635	930	5500	1100	3¼
16	3	5025	1000	6075	1200	7000	1400	3¼
20	4	9000	1800	10840	2200	12525	2500	4¼

Reducing Valves

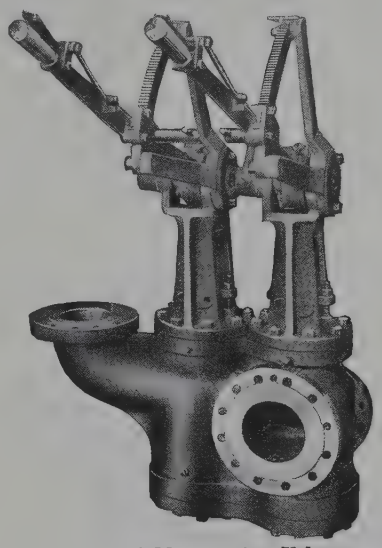
Our "Auld" type reducing valves need no introduction having been in use for over sixty years in the home of shipbuilders, Scotland. Refer to any literature on the subject of reducing valves and one will find a description of the merits and features of the "Quitetite." Our new patents cover a valve which will supply reduced pressure steam at a constant outlet pressure with any variation or fluctuation of boiler pressure. It has been designed to give positive closing control, thus obviating leak and creep of the low pressure steam. It is simple in construction and has no complicating sleeves nor stuffing boxes.



"Quitetite" Reducing Valve

Maneuvering Valves

Schutte and Koerting Maneuvering valves have practically commanded the big field opened with America's great ship building expansion. In connection with the turbines used both in the Navy and Merchant Marine ships of recent type, these valves have proven themselves beyond compare. Positive, but easy of operation, they make it possible to vary the speed of the turbine within the narrow limits that either make for or destroy economy. The main essential, besides a full speed area through the ports is the interlocking device making it impossible to use the reversing gear when the "ahead" valve is open, and yet permitting the valve to be operated quickly from "ahead" to "astern."



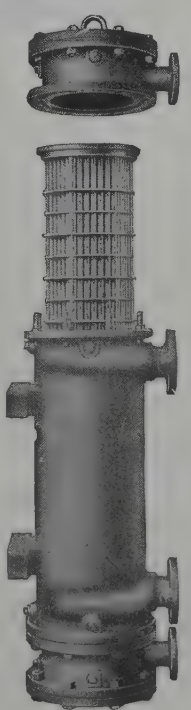
"Duplex" Maneuvering Valve

Oil Coolers

Throughout the marine world where lubricating oil is circulated to bearings, coolers of this design are used. They are the most compact, reliable, high grade coolers manufactured. The maximum rate of heat transfer for consistent pressure loss through the cooler has been obtained.

This cooler has all external joints so that it is impossible for oil to leak into water spaces or vice versa.

Inspection and repair are points which have not been overlooked in design. The "Z" type coolers range in sizes capable of handling five (5) gallons a minute or five hundred (500) gallons a minute.



Oil Cooler

Soot Blowers

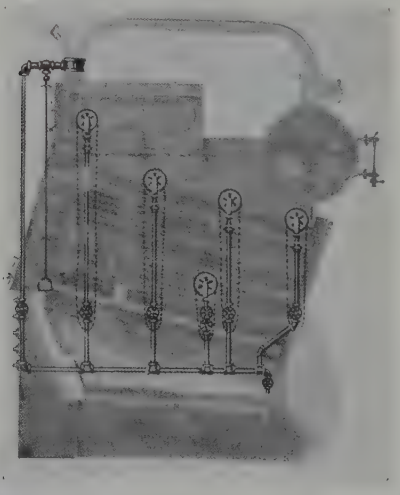
Soot Blowers Essential on Marine Boilers

One of the principal means of increasing boiler efficiency is by frequent mechanical removal of soot from the heating surfaces of the boiler. The presence of soot has caused, and still causes, a loss of hundreds of thousands of tons of fuel a year to ship owners. Soot waste has been elminated on many ships and it can be eliminated on all, with a consequent notable increase in boiler efficiency and a consequent great increase in marine profits.

The Diamond Mechanical Soot Blower System will effect the following economies, with reference to the best results obtained by the use of hand lance.

1—Fuel: A saving of 4 to 8 per cent.

2—Boiler Efficiency: An increase in overall boiler efficiency of 3 to 4 per cent or more.



Diamond Installation on B & W Marine Boiler

3—Steaming Radius: A notable increase.

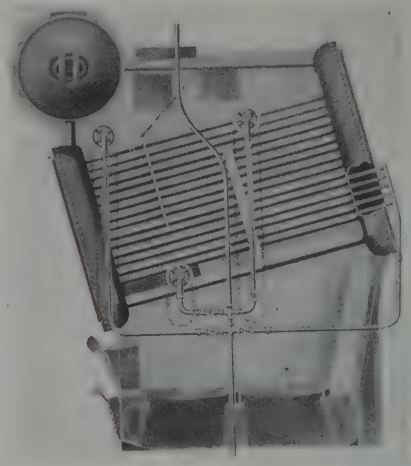
4—Speed: Increase, if greater steaming capacity of boilers is utilized.

5—Longevity: An increase in the length of service of boiler tubes, through the prevention of corrosion.

An increase in boiler efficiency of only a few per cent means hundreds of thousands of dollars to American vessel operators. The maintenance of clean heating surfaces in the boiler will increase efficiency.

Soot Blowers for Every Type of Boiler

Diamond Soot Blowers have for eighteen years been the standard marine equipment for effecting rapid and thorough mechanical soot removal. There is a Diamond Soot Blower for every type of marine boiler. Design and construction of all types of soot blowers is shown in detail in Bulletin 184, "How Some Ship Owners Have Increased Their Profits," a copy of which will be sent upon request. The following data should be included when requesting information; make, size and steam pressure of boiler, fuel used, etc.



Diamond Installation on Standard Emergency Fleet Boiler, Vertically Baffled Type

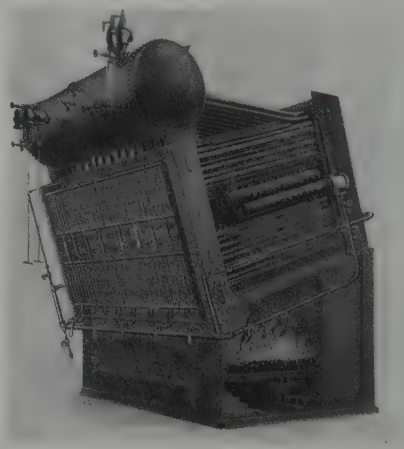
Diamond Equipment for Water Tube Boilers

The Diamond Mechanical Soot Blower System for all Marine Water Tube Boilers, except the Hollow Stay Bolt type, consists of a permanent installation of standard Diamond Model "G" blowers. It is the most effective cleaning device ever developed for water tube boilers.

The units are arranged to effect the cleaning of the fire surfaces of the boiler, particularly the tubes, by means of steam jets. When the steam is released among the tubes at a velocity of approximately 2700 feet per second, a perfect whirlwind of currents is created, reaching all the nooks and crannies of the boiler, and thoroughly removing the particles of soot and ash accumulation.

The Model "G" Blower consists of five principle elements, as follows:—

1—A Head through which the steam passes from



Diamond Installation on Foster Water Tube Boiler

the main soot blower supply line when the valve is opened.

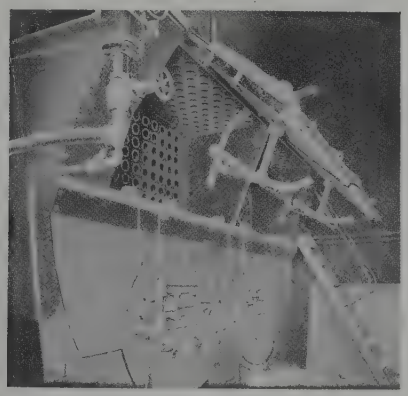
2—A Wall Box which is bricked into the setting.

3—A Blower Element running cross-wise to the bank of tubes, and consisting of a small header with nozzles so placed as to discharge steam between the boiler tubes.

4—A Sheave or Hand Wheel by means of which the blower element is rotated.

5—Bearings attached to the boiler tubes which support the blower element and permit it to revolve freely.

The Diamond Model "G" Blower is especially suitable for cleaning air heaters, superheaters, etc., when installed in connection with water tube boilers.



Diamond Installation on Scotch Marine Boiler

Diamond Hollow Stay-Bolt Boiler Equipment

The principles of design of this blower will be evident from the illustration of the installation on Foster Water Tube Boilers. Several hundred of these blowers were purchased by the Emergency Fleet Corporation for use on their vessels.

One of the most valuable features of the Diamond Model "E" Hollow Stay Bolt Blower is its sectional construction, which is especially adapted for use with fuel oil fired boilers, where draft conditions are very low, running from .02" in the furnace up to .08" in the uptake. If soot blowers were so designed that all nozzles emitted steam at the same time a curtain or blanket of steam would be ejected into the boiler at high velocity, with the result that it would either put out the fire or materially interfere with the draft.

Diamond Equipment for Scotch Boilers

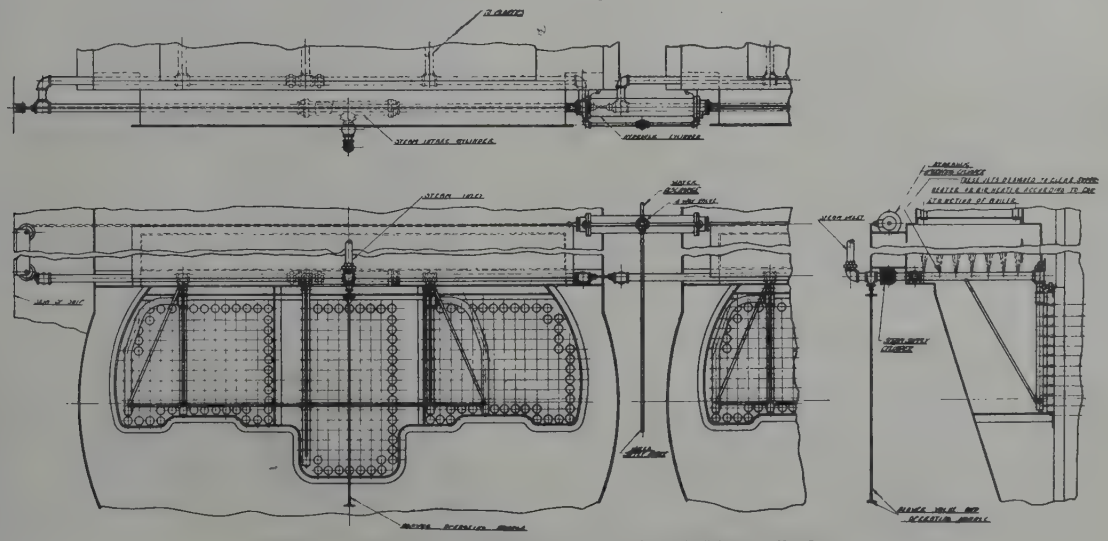
The Diamond Model "G-E" Oscillating Blower for Scotch Marine Boilers is one of the most popular of the Diamond Soot Blowers. The jets of high velocity steam, ejected from the Venturi nozzles on the four or more blower arms in each boiler, clean the uptake tubes, as well as every tube in the boiler. The blower arms are oscillating in movement, swinging about a central pivot when the operating handle is moved.

In the Diamond Automatic Sliding Blower for Scotch boilers a single valve controls all of the soot blowers in the line causing them to move slowly from left to right and back across the tube sheet. This blower effects a large saving in steam, time and labor.

The Model "B" is a rear end blower for Sotch Marine boilers. The blower is permanently fixed in the water leg. In operation dry steam is shot into each tube with the draft at a terrific velocity, sweeping and scouring the soot from the full length of the tubes.

The Service Engineers of the Diamond Company located in the principal ports on the Great Lakes, as well as on both coasts of the United States and Canada, are prepared to serve users of this equipment for either marine or land installations.

For complete information address Box 851, Detroit, or New York marine office at Room 1611, 32 Broadway.

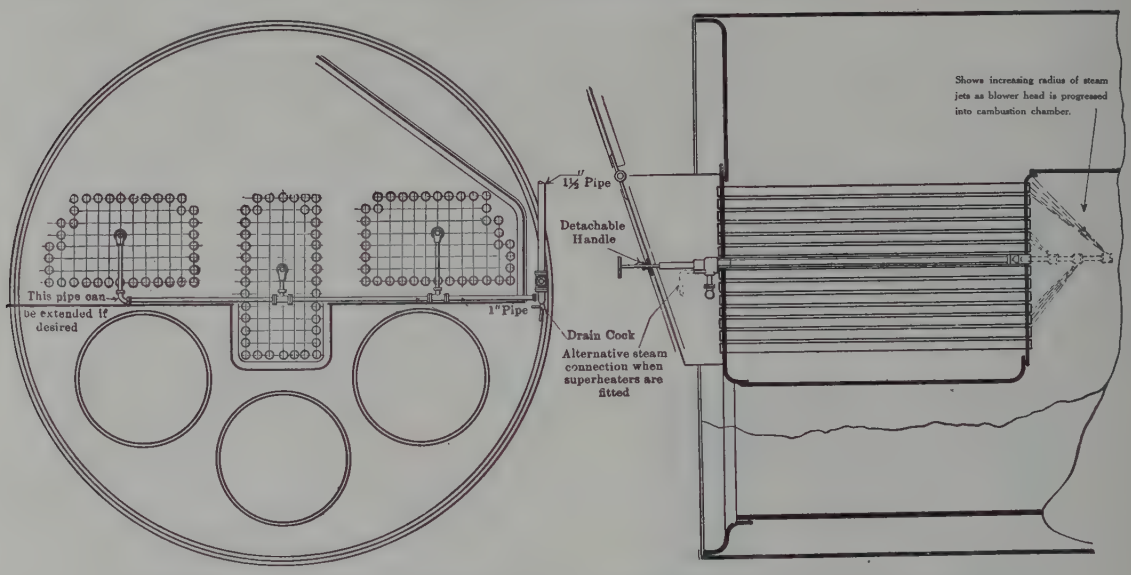


Diamond Automatic Sliding Blower for Scotch Marine Boilers

DIAMOND POWER SPECIALTY COMPANY

DETROIT, MICH.

Soot Blower


This pipe can be extended if desired
1" Pipe
1½" Pipe
Detachable Handle
Drain Cock
Alternative steam connection when superheaters are fitted
Shows increasing radius of steam jets as blower head is progressed into combustion chamber.

Showing Front and Side View of Installation of Atlas Soot Blower on Three Nests of Tubes

Purpose of Design

The Atlas Steam Soot Blower was designed for coal or oil burning Scotch Marine Boilers to meet the need for an automatic cleaner that would not only eliminate all hand cleaning of both rear plates and tubes, but at the same time do away with the danger of leaking tube ends which results from the use of wet steam.

Furthermore, the ease and simplicity of the Atlas Steam Soot Blower lends itself readily to frequent use (several times a day) thus keeping the rear plates and flues constantly free from soot and ashes, and thereby insures steady steaming and minimum coal consumption.

Important Features

1. It cleans in the logical direction, viz:—with the draft and not against it, thereby blowing the soot up the stack and not back on the rear plates.

2. It is operated from the front, always under the eye of the engineer.

3. It reaches every part with dry steam, twice. Since the Atlas Blower extends from the front to the rear of the boiler as shown in the cuts, there is no danger of leaking tube ends, as the steam is highly superheated while passing back through the Blower and across the combustion chamber before sweeping the rear plates and flues.

4. There is no reduction in pressure while using the blower as it blows with the draft and not against it, and is in use but a few minutes daily.

5. It may be quickly, easily, and economically installed, even when boiler is under full pressure.

6. There is no obstruction on the smoke box door, the handle being in position only when the blower is in use.

7. Its saving in fuel and increase in speed of vessels, has proved on official tests to amount to 10 per cent and over.

Compactness

The Atlas Blower can be quickly and easily installed in one of the tubes of each nest when boiler is under full pressure if necessary. Its installation is merely a matter of steam connecting, requiring no cutting of boiler. When not in use it telescopes into the tube (which is sealed) out of contact with the extreme heat.

Tubes Easily Cleaned Without Opening Smoke Box Door

ALBERT T. OTTO & SONS, INC.

101 PARK AVE., NEW YORK, N. Y.

Soot Blower

Simplicity of Operation

To operate the Atlas Blower it is simply necessary to open outside steam valve, place handle in position and turn to right, until checked by stop, then reverse to stop. As the rotating double nozzle is advanced and returned through the combustion chamber, two jets of dry steam are forced against the tube bank and through the tubes, effectually cleaning every nook and corner. One main steam valve controls all the blowers in a boiler, each blower being fitted with an interior valve which opens and closes automatically by the motion of the handle.

Durability

All parts of the Atlas Blower are made from the best materials for the purpose, the nozzle of cast gray iron, the seamless tubing extra heavy, other parts of steel, malleable iron and bronze, all assembled strongly and compactly. There are no parts continuously exposed to intense heat as the nozzle, pipe, steam tube, etc. are within the closed tube when not in operation.

Summary of Advantages

Steady steaming.
Minimum fuel consumption.
Maximum efficiency.
Absolute saving in labor.
Increase of speed of vessel.
Avoidance of leaking tube ends.
Increase of the useful life of your boilers.
No lowering of steam pressure.
No opening of smoke-box door while cleaning.
No temptation to put off cleaning of boiler.
Tubes and rear plates always clean.

Made in America

The Atlas Blower is made in America by Albert T. Otto & Sons., Inc., manufacturers and sole licensees in the United States.

Under the British trade name of "Improved Diamond Steam Flue Blower (Front End Type)", the Atlas has been exclusively adopted by the British Admiralty, who are using thousands of them. Included among our customers are the following great British and Continental Shipbuilders and Steam Ship Lines:—

Standard Oil Company of N. J.
Admiralty (British).
Ailsa Shipbuilding Co., Ltd., Troon, N. B.
American Petroleum Co., Rotterdam.
Amos & Smith, Ltd., Hull.
Anglo-American Petroleum Co., London.
Anglo-Saxon Petroleum Co., Ltd., London.
Atlantic Transport Line, London.
Australasian United Steam Navigation Co., Ltd., London.
Australind Steamship Co., Ltd., Melbourne.
Axel Brostom & Son, Sweden.
Barclay, Curle, & Co., Ltd., Glasgow.
Wm. Beardmore & Co., Ltd., Glasgow.
Bell Brothers & Co., Glasgow.
Blair & Co., Stockton-on-Tees.
Blow, Richards & Co., Cardiff.
Blue Star Line, London.
Blyth Shipb'ld'g & Drydocks Co., Ltd., Blyth.
Booth Line, Liverpool.
Bow McLachlan & Co., Ltd., Paisley.
Bowles Brothers, London.
British India Steam Navigation Co., Ltd., London.
John Brown & Co., Clydebank.
Bryde, G. M., Christiania.
Bucknall Steamship Lines, Ltd., London.
Burdock & Co., London.
Burns, Philip & Co., Ltd., Sydney, N. S. W.
Bullard, King, & Co., London.
Bushell, E. H., Fletcher & King, Liverpool.
Caledon Shipb'ld'g & Eng. Co., Ltd., Dundee.
Cammel Laird & Co., Ltd., Liverpool.
Campbell & Co., John, Glasgow.
Canadian Pacific Railway Co., Ocean Steamship Lines, London.
Cardiff Channel Dry Docks & Pontoon Co., Ltd., Cardiff.
Central Marine Eng. Wks., West Hartlepool.
Chambers & Co., J., Liverpool.
Chargeurs Reunis, Paris.
George Clark, Ltd., Sunderland.
Cleland's Graving Dock & Slipway Co., Ltd., Willington Quay-on-Tyne.
Clover, Clayton & Co., Ltd., Birkenhead.
Clyde Shipb'ig & Eng. Co., Ltd., Pt. Glasgow.
Commonwealth & Dominion Line, Ltd., London.
Companie General Transatlantique, Paris.
Compania Nacional de Navagacao Costeria. Brazil.
Cooper & Greig, Ltd., Dundee.
A. F. Craig & Co., Ltd., Paisley.
Cunard Steamship Co., Ltd., Liverpool.
Day, Summers & Co., Ltd., Southampton.
Denny & Co., Dumbarton.
Det Norske Amerikalinge, Copenhagen.
Det Stavangerske Dampskibsselskab, Norway.
J. Dickson & Sons, Ltd., Sunderland.
Dillon & Sons, H. W., London.
Dodwell & Co., London.
Doxford & Sons, Ltd., Sunderland.
Dudgeon & Gray, London.
Duncan & Co., J. T., Cardiff.
Dunlop, Bremner & Co., Ltd., Port Glasgow.
Dunsmuir & Jackson, Glasgow.
Earles Shipbuilding & Engineering Co., Hull.
Edwards, Hepburn & Co., Cardiff.
Elder, Dempster & Co., Ltd., Liverpool.
Ellerman-Hall Line, Liverpool.
Eriksbergs Mekaniska Verkstads A. B. Sweden.
Fawcett Preston & Co., Liverpool.
Fearnley & Eger, Norway.
Fletcher, Son & Fearnal, Ltd., Tilbury.
Fornyade Angf, A. B. Gotha, Sweden.
Fornyade, Svinska Lloyd, Sweden.
Fredriksstad Mek Verksted A. S. Norway.
Furness, Withy & Co., Ltd., London.
Furness Scheepvaart en-Agentuur Maatschappij, Rotterdam.
Gellatley, Hankey & Co., London.
General Steam Navigation Co., Ltd., London.
Grayson, Ltd., H. & C., Liverpool.
Green & Silley Weir, Ltd., London.
Gow, Harrison & Co., Ltd., Glasgow.
Groedel Bros. Steamship Co., Ltd., London.
Gunn, A. H. and E., Cardiff.
Hall Line, Liverpool.
Hall, Russell & Co., Ltd., Aberdeen.
Halvorsen Thy., Norway.
Harland & Wolff, Ltd., Belfast.
Harris & Dixon, Ltd., London.
H. & W. Hawthorn, Leslie & Co., Ltd., Newcastle-on-Tyne.
Hawthorne & Co., Ltd., Leith.
D. & W. Henderson & Co., Ltd., Glasgow.
Henderson Brothers, Glasgow.
Holland-Amerika Line, Rotterdam.
C. D. Holmes & Co., Ltd., Hull.
Holt & Co., Ltd., A., Liverpool.
Hong Kong & Whampoe Dock Co., Ltd., Japan.
Hall Central Drydock & Eng. Wks., Ltd., Hull.
Hosking & Callan, Liverpool.
Houlder, Middleton & Co., Ltd., London.
Howard Smith Co., Ltd., Melbourne.
Howden & Co., James, Glasgow.
Huddard Parker, Ltd., Melbourne.
Hugh Hogarth & Sons, Ltd., Glasgow.
Irvine's Shipbuilding & Dry Docks Co., Ltd., Hartlepool.
Kawasaki Dockyard Co., Kobe, Japan.
J. G. Kincaid & Co., Ltd., Greenock.
Koninklyike, Hollandische Lloyd, Amsterdam.
Lamport & Holt, Liverpool.
Lancashire & Yorkshire Railway, Goole.
Lawther, Latta & Co., Ltd., London.
Lester & Perkins, London.
John Lewis & Sons, Ltd., Aberdeen.
W. V. V. Lidgerwood, Coatbridge.
Lindholmen Co., Sweden.
Lindsay, Burnet & Co., Ltd., Glasgow.
Lobnitz & Co., Renfrew.
Lubricating Fuel Oil Co., Ltd.
MacIlwraith, MacEacharn & Co., Proprietary, Ltd., Melbourne.
McColl & Pollock, Ltd., Sunderland.
McKill & Co., Robert, Glasgow.
Manchester Liners, Ltd., Manchester.
Mercantile Dry Dock Co., Ltd., Jarrow-on-Tyne.
Messageries Maritimes de France.
Milburn & Co., William, London.
Mills & Sons, Grimsby.
Mitsubishi Goshi Kaisha Co., Japan.
Morrell, Mills & Co., Manchester.
Mountstuart Dry Dock Co., Ltd., Cardiff.
Muir & Houston, Glasgow.
Nautilus Steam Shipping Co., Ltd., Sunderland.
Nelson, Ltd., H. & W., London.
New Waterway Shipbuilding Co., Rotterdam.
New Zealand Shipping Co., Ltd., London.
Nicholl & Co., Edward, Cardiff.
Nippon Yusen Kabushiki Kairha, Tokio.
Nordenfjeldske Dampskibs-seiskab Trondhjem, Norway.
Norske Amerikalin, Norway.
North Coast Steam Navigation Co., Ltd., Sydney, N. S. W.
North-Eastern Marine Engineering Co., Ltd., Sunderland and Wallsend.
Nourse, Ltd., T., London.
Ocean Steamship Co., Ltd., Liverpool.
Osake Iron Works, Ltd., Japan.
Oscarshamns Mek. Verstads & Skeppsdockas A. S. Sweden.
Otto Thoresen Line, Norway.
Palmers's Shipbuilding & Iron Co., Ltd., Jarrow-on-Tyne.
P. & O. Line, London.
Paton & Hendry.
Prince Line, Newcastle.
Ramage & Ferguson, Ltd., Leith.
Rankin & Blackmore, Greenock.
Rederi A. B. Disa, Sweden.
Richardson, Westgarth & Co., Ltd., Hartlepool.
F. & W. Ritson, Sunderland.
Ross Duncan & Co., Govan, Glasgow.
Rotterdam Dry Dock Co., Rotterdam.
David Rowan & Co., Glasgow.
Royal Mail Steam Packet Co., London.
Scott & Son, J. R., Newcastle.
Scott's Shipbuilding & Engineering Co., Ltd., Greenock.
Shearman & Co., Ltd., John, Cardiff.
Wm. Simons & Co., Ltd., Renfrew.
Societe Anonyme John Cockerill, Ostend, Belgium.
Societe Anonyme des Ateliers & Chantiers de l'Havre.
Societe Anonyme John Cockerill, Seraing, Belgium.
Smith's Dock Co., Ltd., South Shields.
Speeding, Marshal & Co., Sunderland.
Stephens & Sons, Ltd., Hebburn-on-Tyne.
Stockholms Rederi A. B. Sevea, Sweden.
Swan, Hunter & Wigham Richardsons, Ltd. Wallsend-on-Tyne.
Swedish-American Mexican Line, Sweden.
Swedish East Asiatic Co., Ltd., Sweden.
Taikoo Dockyard & Engineering Co., of Hong Kong, Ltd.
Takata & Co., Japan.
W. Thomson & Co., Canada.
Transatlantic Steamship Co., Gothenberg.
Turner, Brightman & Co., Ltd., London.
Union Steamship Company of New Zealand, Dunedin, N. Z.
Wallsend Slipway and Engineering Co., Ltd., Wallsend-on-Tyne.
Watkins & Co., Wm., London.
Wiel & Amundsen, Norway.
Wilh. Wilhelmsen, Norway.
Williams & Mordey, Cardiff.
Wilsons & Furness-Leyland Line, Hull.
Wilson & Co., Hull.
Wiltons Eng. & Slipway Co., Rotterdam.
Wrangell & Co., A. S., H. M., Norway.

ALBERT T. OTTO & SONS, INC.

101 PARK AVE., NEW YORK, N. Y.

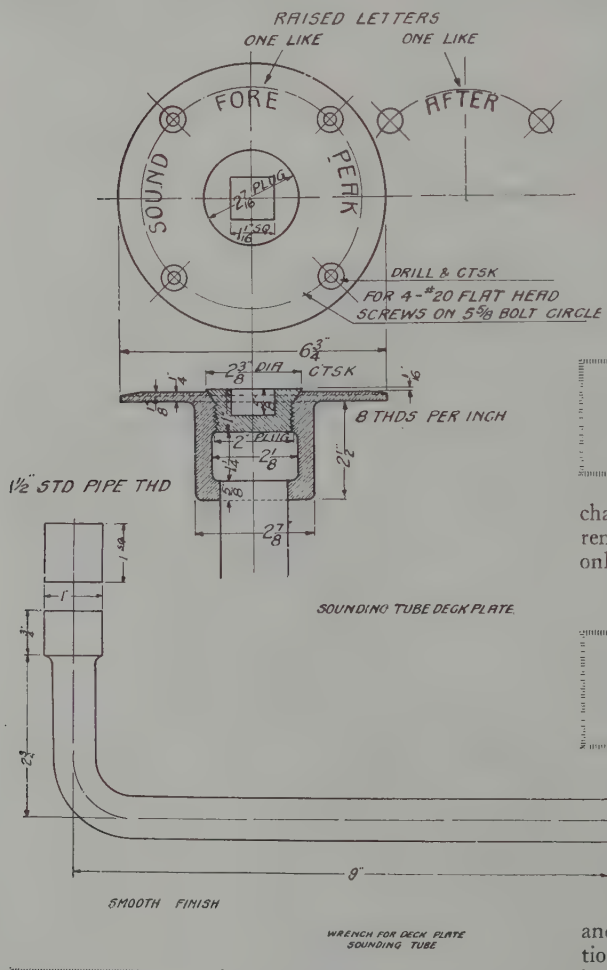
Madesco Sounding Tube Deck Plates

Scuppers and Deck Drains

Castings for Scuppers and Deck Drains must of necessity be flawless without departing from conventional practice, and such are those of the Madesco brand by virtue of experience in manufacture.

Sounding Tube Deck Plates

In finish and general workmanship the Madesco Sounding Tube Deck Plates have established a new standard of excellence. The line drawing shown below illustrates the design of the Madesco Sounding Tube Deck Plate and Wrench.



Madesco Hydraulic Ash Ejectors

Madesco Hydraulic Ash Ejectors are made in two standard sizes, 4½ inches and 6 inches. Other sizes are made on order designed to meet any conditions and specifications. The 4½ inch Ash Ejector is designed to operate on a pressure of 125 pounds per square inch and can be furnished from stock.

Six-Inch Hydraulic Ash Ejector

The Madesco Six-Inch Ash Ejector is of the Hydraulic type, designed to operate on salt water lines under a pressure of from 125 to 250 pounds per square inch. The arrangement of the complete apparatus is shown in the drawing on the opposite page.

The Madesco Ash Ejector is not an experiment but a proved asset to those whose interests require prompt, accurate and complete evacuation of ash accumulation in the boiler room.

This unit will discharge as many ashes as three men can shovel into the Hopper at one time, under a pressure of 175 pounds, and will operate down to a pressure of 125 pounds.

At a pressure of 175 pounds it will shoot ashes on a horizontal line 60 feet to the windward, thereby preventing the blowing of dust over the ship's side as is the case when the ordinary ash hoist is used. It is therefore a self-evident fact that the Madesco Ash Ejector is more economical and desirable in every way than the old-fashioned ash hoist.

The length of the pipe from the Hopper to the elbow bend can be increased or decreased as desired. We carry a stock of these units at all times so as to make immediate delivery upon receipt of orders. Prices furnished upon request.

Discharge Pipe

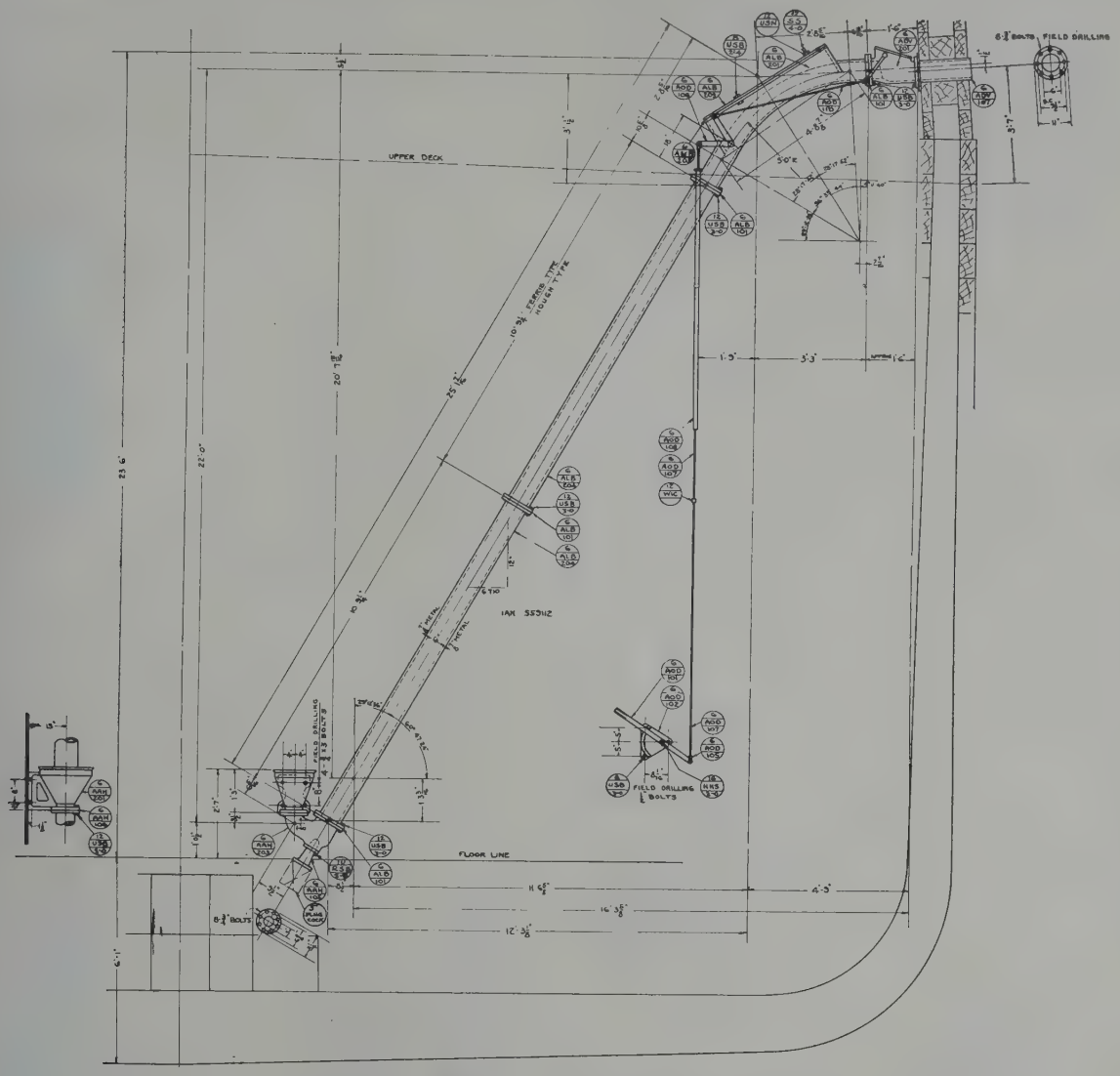
The Conveyor Pipe is six inches in internal diameter with seven-eighths inch walls. The elbow at the top of Discharge Pipe forms a long, sweeping curve, and the wear of the discharge ashes and water is taken up on two chilled iron removable Liners. These Liners are practically the only parts subject to wear and are easily replaced.

Ash Hopper and Fittings

The Hopper into which ashes are shoveled or dumped is of the same grade of cast iron as is the pipe. The opening at the bottom is so designed that clinkers which pass through it will not clog the Discharge Pipe. The cover is provided with a heavy gasket to insure water-tight construction necessary in establishing the vacuum, and the arrangement of the bolts admits of easy and rapid manipulation. A removable composition Ejector Nozzle, with a cast iron body and a three-inch American Standard Flange connection, is fitted at the bottom of the Hopper. A three-inch composition straight-away Plug Cock with flanged or flanged and screw connections is bolted to the Ejector Nozzle. The cock will easily withstand a hydraulic test of 300 pounds per square inch.

The cast iron used for pipes and fittings is of such composition and hardness as to give it maximum wearing qualities. All flanges are faced and sealed with gaskets in order to produce an absolutely tight joint. Material and workmanship are of the best quality.

Madesco Six-Inch Hydraulic Ash Ejector



Arrangement of Madesco Six-Inch Hydraulic Ash Ejector
This unit in use on over 700 sea-going vessels June 1, 1919

Discharge Valves

A Discharge Valve, with a cast iron body and a cast iron Flapper Valve to prevent the wash from backing into the boiler room, is fitted, as shown, to the flange of a pipe projecting through the side of the ship.

Handling Gear

The Handling Gear, consisting of forged levers and rods, as shown in the above drawing, is furnished ready for installation.

Method of Shipment

The efficient supervision of shipment of Ash Ejectors insures all parts being marked and crated properly for shipment.

The Ash Ejector parts are numbered consecutively in accordance with the bill of material to facilitate the checking of the parts received, and to aid in arranging the parts for installation.

The Ash Ejector and Gear are boxed or crated, and marked to designate the contents.

The pipe is marked and shipped uncrated.

Ashton Marine Pop Safety Valves

Experience Built into Ashton Products

Established in 1871, the Ashton Valve Company has specialized for almost 50 years in the manufacture of Valves and Gages.

The Ashton Marine Pop Safety Valve, for example, approved in 1872 by the United States Board of Supervising Inspectors, has been improved from time to time, keeping pace constantly with the increasing rigidness of the official requirements. Because of this long experience and development, the Ashton Valve today not only fulfills every requirement of the Board, but in almost every feature is better than called for.

Ashton Marine Pop Safety Valves

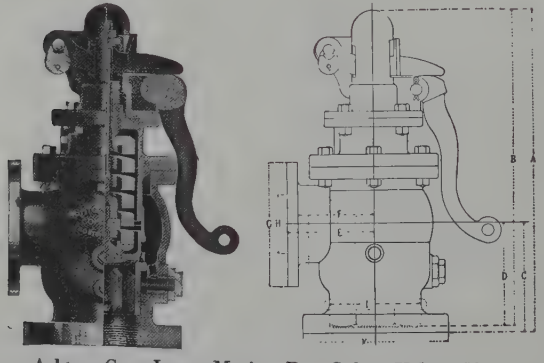
Ashton Safety Valves are made with 45 degrees bevel seats—the United States Government Standard. These seats, made of extra high quality composition metal or nickel, remain tight, have great wearing qualities, do not corrode and are easy to grind in or face off.

The Pop chamber (Patented) is of special design. It is the annular space above the seat enclosed within the patented knife edge lip. The lip wears down in proportion to the wear on the seat, thus giving steady and unvarying pop, which insures long service without adjustment or repairs.

The patent screw plug pop regulator on the outside of Ashton Safety Valves affords convenient means for regulating the pop at all times without taking valve apart, and when the steam is on the boiler.

The lock-up attachment prevents tampering with the set pressure adjustment.

With the patented Cam Lever it is easy to lift the valve from its seat one-eighth the diameter of the valve opening, by hand, regardless of the pressure in the boiler. The Cap and trip lever can be made to operate in any position regardless of the location of the valve outlet.



Ashton Cam Lever Marine Pop Safety Valve—No.16

NO. 16—DIMENSIONS IN INCHES

Sizes	A	B	C	D	E	F	G	H	I	K
2	15⅝	15⅝	5½	5½	3⅝	3	6	2	4	6½
2½	17¼	17⅝	6¼	6¼	4¼	4	7	2½	4⅜	7½
3	20⅛	20⅛	6¾	6¾	5½	4¾	7½	3	5⅛	8¼
3½	22¼	22¼	7¼	7¼	5⅛	5	8½	3½	5¼	9
4	21⅞	21⅞	7⅞	7⅞	6⅛	5¼	9	4	6¼	10
4½	23¼	23¼	7⅞	7⅞	6⅛	5½	9¼	4½	6¾	10½
5	25½	25½	8¼	8¼	8¼	5⅞	10	5	7¼	11
5½	23⅞	23⅞	8⅞	8⅞	7½	6½	11	*5½	8⅛	12½
6	24¾	24¾	9⅛	9⅛	7½	6½	11	6	9	12½

*When screw outlet is used it is cut for 5-inch pipe.

The No. 16 Ashton Marine Pop Safety Valve is especially adapted for marine service and has been extensively used for many years on marine boilers.

Ashton Safety Valves for Superheaters

These valves are made with outside spring, an arrangement adapting them particularly to superheater installations, because the spring never comes in contact with the high-temperature steam which would affect its temper. Cast steel body and solid nickel valve and seat bushing insure proper strength as well as equal expansion and contraction of parts.

These valves are of heavy construction with very strong lifting gear.

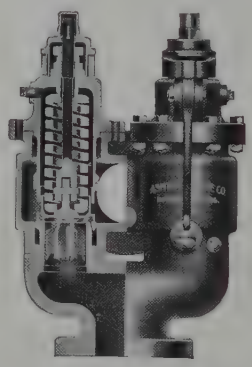
Style No. 17 B, as illustrated, can be supplied in sizes 3/4 inch to 2 inches, with either screwed or flanged connections.

Style No. 17, also for superheaters, can be supplied in sizes 2 inches to 5 inches.

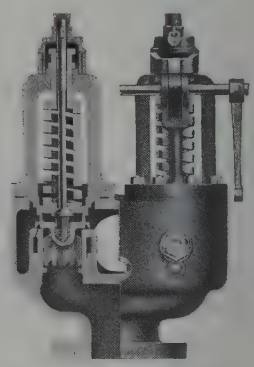
Ashton Outside Spring Steel Body Pop Safety Valve—No. 17B

Ashton Duplex Marine Pop Safety Valves

Where the capacity of two valves is required, the Ashton Duplex Cam Lever Marine Pop Safety Valve saves space and piping. It requires but one valve connection on the boiler and has a single discharge outlet, yet it has the full capacity of two valves.



No. 16A—Enclosed Spring Type



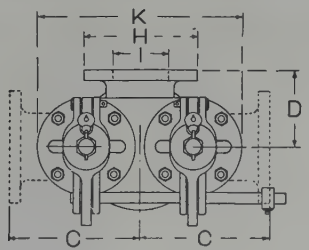
No. 16B—Outside Spring Type

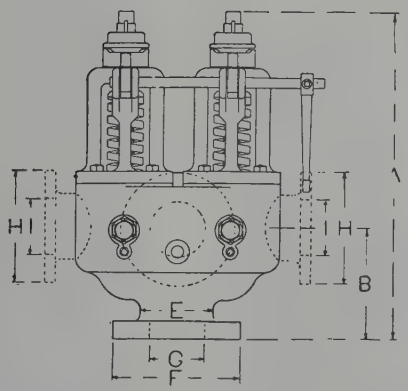
Ashton Duplex Cam Lever Marine Pop Safety Valves

This type is made under the same patents as the No. 16, and is of the same high quality throughout.

The Duplex Valves are made with cast iron or steel body, and with either independent cam levers or with rocker-shaft with single lever. When of the latter style it is customary to adjust the cams so that the valves will be lifted from their seats in succession.

These valves can be supplied with either inside or outside spring, the latter type having the advantage of greater durability of spring, which does not come in contact with the discharged steam.





Outline Drawing—Ashton Duplex Pop Safety Valves

NO. 16A—DIMENSIONS IN INCHES

Sizes	A	B	C	D	E	F	G	H	I
2	19½	8 7/16	8	4¾	4¼	8¼	2⅞	7½	2⅞
2½	20 7/16	9⅛	9 7/16	5⅜	5¼	9	3 7/16	8½	3 7/16
3	24⅞	11⅝	10½	6⅛	6	10½	4¼	0¼	4¼
3½	27½	12½	11	6¾	7	11	5	10	5
4	30	12⅝	11½	6⅝	7¾	12½	5 11/16	11	5 11/16
4½	31	13⅝	11½	6¾	8⅜	14	6⅜	12½	6¾
5	30⅞	14¼	12¾	7½	9⅛	14	7⅛	12½	7¼
5½	37⅛	15⅝	14	8	9⅞	15	7 13/16	13½	7 13/16
6	38¼	16⅞	14⅝	8	10¾	16¼	8½	15	8½

NO. 16B—DIMENSIONS IN INCHES

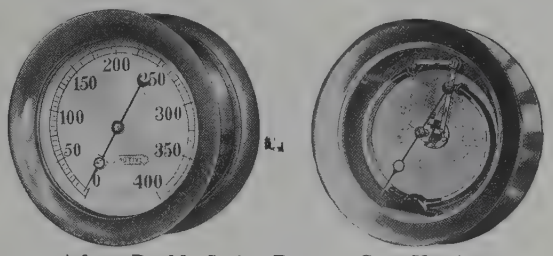
3 ..	27⅝	9⅛	6	6⅛	6	10½	4½	9¼	4½	8¼
3½ ..	30⅝	10⅛	6⅛	6 11/16	6¾	11	5	10	5	8⅞

Application of Safety Valves

Safety valves should always be applied close to the boiler or main supply of steam, on short nipples or nozzles having full inside diameter. When otherwise connected they are likely to chatter when blowing, and will not give full capacity of relief, due to restricted steam supply. Each safety valve should be applied to a separate boiler nozzle, with no other engine or auxiliary pipe line connected thereto. This will insure the valves of having a full and steady supply of steam to maintain their maximum efficiency lift without fluctuation.

Ashton Pressure and Vacuum Gages

Ashton Gages are made in many designs to meet the varied requirements of stationary and marine practice, for steam, air, water, ammonia, oxy-acetylene, hydraulic work, etc. Standard patterns include Pressure, Vacuum, Compound Pressure and Vacuum, Registering Gages, also Recording Gages.



Ashton Double Spring Pressure Gage No. 52

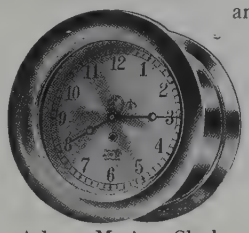
The Ashton No. 52 Double Spring Pressure Gage is particularly adapted for marine use. It is a distinct improvement over the ordinary single-spring gage. The double spring and movement reduces to a minimum the vibration of the hand. The movement, which has nickel silver pinions and arbors, is very durable.

The dial in this, as in all Ashton Gages, is hand graduated individually, insuring the accuracy of each dial to the actual movement of the hand.

Ashton Double Spring Pressure Gages are made in sizes from 4½ inch to 24 inch dials, and may be graduated to any desired maximum pressure up to 500 pounds per square inch. For most satisfactory service gages should have dials graduated to double the highest working pressure.

Ashton Marine Clocks

Ashton Engine Room Marine Clocks are furnished with either Howard, Chelsea or Seth Thomas movements, full jeweled, with chronometer balance and patent regulators.



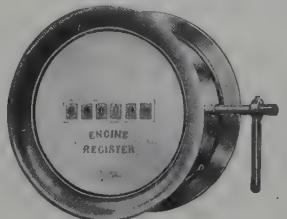
Ashton Marine Clock—No. 63

Cases are made with hinged rings and snap latch, or lock and key when desired. Standard dial sizes are from 5 to 12 inches.

Clocks with Chelsea movement are furnished in either deep or shallow cases, as desired.

Ashton Engine Registers

The Ashton No. 64 Improved Engine Registers are made for either right or left hand revolutions and reciprocating motions, and work equally well under varying lengths of stroke or revolving motions. This design of register has positive motion and is durable, accurate and reliable. Standard sizes range from 6 inches to 12 inches, with 6 or 8 wheels.



Ashton Improved Engine Register—No. 64

Rectangular Revolution Counters can also be supplied if desired.

The Ashton Valve Co. also manufactures Relief Valves, Plain and Chime Whistles, Dead Weight Gage Testers, Syphons, Cocks, and Sanitary Drinking Fountains.

Gauges, Whistles and Steam Traps

Gauges

The American Gauges are made for all indicating or recording marine purposes; in the single spring Bourdon Type for lower pressures and with double spring for severe service. The springs or tubes are solid drawn of a special bronze that has been tested out to be the best for this purpose. Special methods are employed in rolling and bending, and each tube is subjected to excess pressure tests and thorough calibration to determine its fitness. No metal liable to corrosion is used in the gauge movements which embody features for producing delicate adjustments that are distinctive in American Gauges. The dials are of sheet brass, with graduations filled with black enamel and all other portions silver finish. Other dial arrangements can also be furnished for special conditions. Special gauges are also made to Navy Specifications.

American Pressure Gauge

American Gauges are made indicating or recording for water, steam, ammonia, air, gas or oil pressures. Alarm gauges are also made, designed especially for lubricating oil systems, boilers, pipe lines, etc., where an automatic alarm is desired at either high or low pressure point, or both.

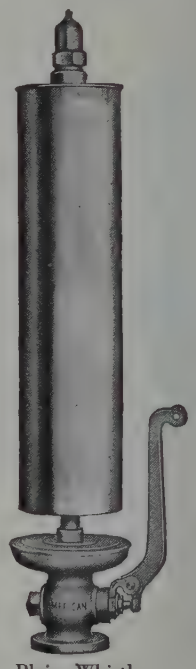
Other Indicating and Recording Instruments

Besides gauges of all types and for all purposes, many other indicating and recording instruments can be furnished, such as Round Case and Rectangular Revolution Counters for reciprocating engines or turbines, Engine Room Clocks, Temperature Recorders, Indicating Thermometers, Complete Gauge Boards, Gauge Testers, Draft Gauges, Mercury Gauges, Pyrometers, etc.

Whistles

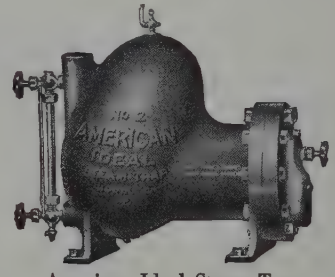
American Steam Whistles are of the very best quality, material and workmanship throughout, with seamless drawn brass tube, finished base, and adjustable lever. These whistles are furnished plain or chime, with screwed or flanged connections, and with or without plain or compound valve. Sirens are also furnished for emergency signal use.

Chime Whistle


Plain Whistle
Long Bell Type

Steam Traps

American Ideal Steam Traps are built for pressures up to 250 pounds. These traps are of the float-operated type, and have a valve with leverage so much greater than is usually found in steam traps that it is possible to use very heavy floats, thus eliminating the trouble from collapsing, common to light-weight floats. The powerful leverage also makes it possible to use a large diameter valve discharge orifice. All American Ideal Steam Traps are tested to at least 400 pounds pressure to insure tightness of joints and perfect float.


American Ideal Steam Trap

AMERICAN STEAM GAUGE & VALVE MFG. CO.

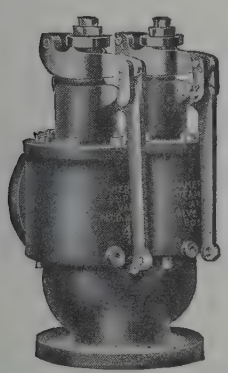
NEW YORK 208-220 CAMDEN ST., BOSTON, MASS. CHICAGO

Valves and Feed Water Filters

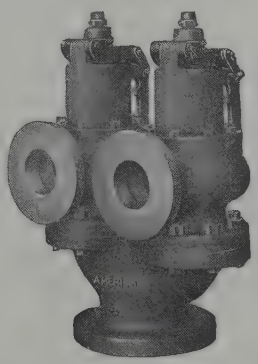
Safety Valves

American Safety Valves are all spring loaded and before shipment from the factory are tested and set to relieve at the pressure designated by the customer. These valves are characterized by simple adjustment, minimum number of parts to maintain, reliability, and mechanical superiority.

Pop Safety Valves, as shown below, are built, especially designed for Marine Service, and complying with the specifications of the U. S. Steamboat Inspection Service, Lloyd's, and other similar bureaus. These valves are built of cast iron, gun metal or cast steel, with compound levers to make lifting of valve off seat easy and to decrease bearing surface friction, and can be supplied single or duplex, and with special features as required.

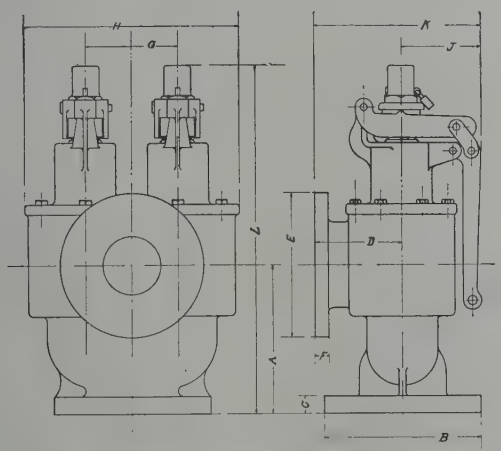


Duplex Valve



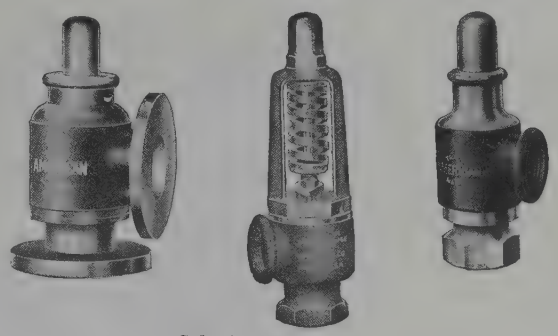
Twin Valve

TABLE OF DIMENSIONS—AMERICAN DUPLEX SAFETY VALVE



DIMENSIONS OF IRON DUPLEX VALVES—FIG. 373

Size of Valve	A	B	C	D	E	F	G	H	J	K	L
	Horiz. Dist. from Base of Valve to Center of Outlet	Diameter of Inlet Flange	Thickness of Inlet Flange	Diameter of Outlet Flange	Thickness of Outlet Flange	Center to Center of Bolts in Outlet Flange	Extreme Width	Center of Brace to Base of Lever	Extreme Depth	Extreme Height
2"	7"	8¼"	1⅛"	4¾"	7/16"	¾"	5"	10¾"	4⅝"	8⅝"	18¼"
2½"	8½"	9"	1¼"	5¼"	8¼"	1/2"	5¾"	12½"	4¾"	10¼"	21¾"
3"	9½"	10¼"	1⅜"	6"	9¼"	9/16"	6¼"	13¾"	5¼"	11¼"	23½"
3½"	10¼"	11"	1⅜"	6¼"	10"	5/8"	6⅝"	15"	5⅝"	11⅞"	25⅝"
4"	11"	12¼"	1⅜"	6½"	11"	1"	7"	15¾"	5¾"	12¼"	26½"
4½"	12½"	12½"	1⅜"	7½"	11"	1"	7¼"	17¼"	6"	13½"	28"



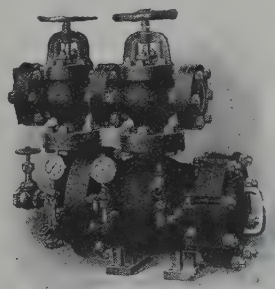
Cylinder Relief Valves

Relief Valves

American Cylinder Relief Valves, Shifting Valves, Water Relief Valves, etc., for all pressures and in many types can also be furnished to meet standard and Navy specifications.

Feed Water Filter

The American H_2O Grease Extracting Feed Water Filter is built in a number of sizes as listed below, for capacities up to 174,000 pounds of water per hour. The oil and grease are removed by filtering through linen terry cloths wrapped around cages of large area and arranged to permit quick and easy changing of cloths.



American H_2O Grease Extracting Feed Water Filter

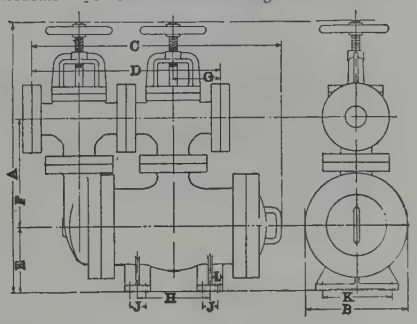
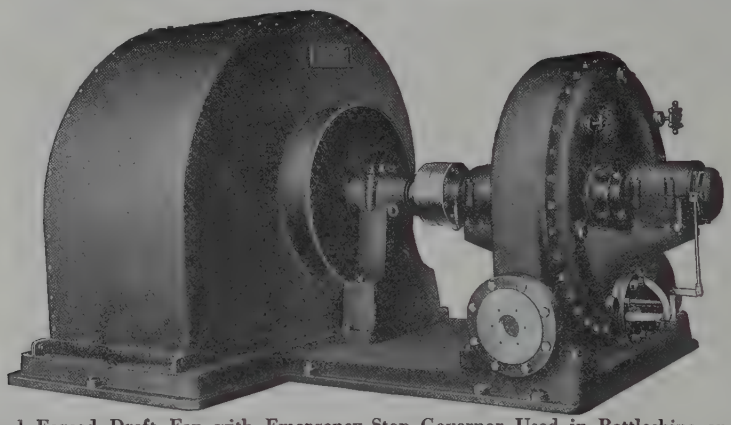


Fig. 475

TABLE OF SIZES AND DIMENSIONS

Size	A	B	C	D	E	F	G	H	I	J	K
2"	2'-1⅞"	10"	2'-0⅛"	18¼"	6¼"	10⅝"	4⅜"	7"	½"	1½"	6¾"
2½"	2'-10⅜"	14¼"	2'-3¾"	20"	8½"	13¾"	5"	7"	½"	1⅝"	8½"
3"	2'-11⅜"	14¼"	2'-7¼"	23"	8½"	14¼"	5¾"	8¾"	½"	1⅝"	8½"
3½"	3'-5¼"	18"	2'-8"	23½"	12"	16⅛"	5⅞"	8¾"	⅝"	1⅜"	10"
4"	3'-6⅛"	18"	3'-1⅞"	2'-4½"	12"	17½"	7⅛"	11"	¾"	2½"	10"

Turbine Driven Forced Draft Fans



Sturtevant Turbine and Forced Draft Fan with Emergency Stop Governor Used in Battleships and Auxiliary Ships of the U. S. Navy. Vertical Type Turbines Are Used on Destroyers.

Advantages of Design

In the use of fans for many applications, but more especially for Mechanical Draft Installations, a fan operating at speeds sufficiently high for direct connection to steam turbines and high speed electric motors is often very desirable. The problem is to secure a fan sufficiently strong to withstand the stress of the high speeds while operating at high fan efficiency. Sturtevant High Speed Mechanical Draft Fans (see illustration) accomplish the results.

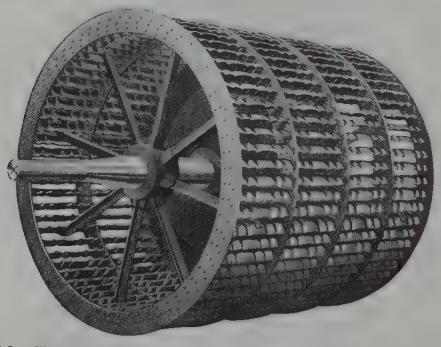
Application to Shipboard

These fans are especially adapted for use on shipboard being usually built as double width fans. They require but little head room and are exceptionally compact for the volume required. The high speed at which they may be successfully operated makes possible the use of a small steam turbine. This turbine operating at the high speed at which it is most efficient is a very small consumer of steam. There is no oil in the exhaust from a steam turbine, and this fact commends this type of unit especially for marine work.

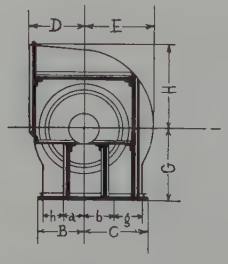
These forced draft fans are applicable not only to marine boilers but to any installation where an exceptionally compact unit is desired.

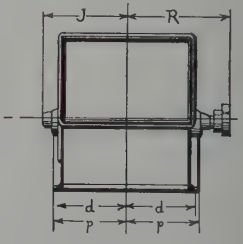
Construction

The fan wheels are of special design, rigidly constructed of heavy steel plate and very carefully balanced. The fan casing is built of heavy steel plate rigidly braced together. The shafts are accurately turned and ground to an exact size and run in large, thoroughly lubricated bearings. Every detail in their design and construction tends to especially high operating efficiency and great rigidity.



Double Width Multivane Type Forced Draft Fan Wheel





SIZES AND PRINCIPAL DIMENSIONS OF STURTEVANT DESIGN 3 DOUBLE WIDTH DOUBLE INLET MULTIVANE FORCED DRAFT FAN

Right hand, top horizontal, double width, double inlet

Size of Fan	B	C	D	E	G	H	J	p	R	a	b	d	g	h
4	10	13	12 7/8	15 1/4	15 1/4	18 1/2	20	16 3/8	23	6 1/2	9	15 1/2	—	—
5	11 3/4	15 1/2	14 3/4	17 5/8	17 1/2	21 1/2	20 7/8	19 1/4	26	7 1/4	10 1/2	18 1/8	—	—
6	13	17 1/2	17 1/8	20 3/8	19 7/8	24 1/2	25 7/8	21 5/8	29 3/4	8	12	20 1/2	—	—
6 1/4	14 1/4	19 1/2	19	22 1/8	22	27 3/4	29	24	33 1/2	8 3/4	13 1/2	22 1/8	—	—
7	15 1/2	21 1/2	20 7/8	25 1/2	24 1/4	30 3/4	31 3/4	26 3/4	36 1/2	9 1/2	15	25 1/4	—	—
8	10 1/2	26 1/4	24 5/8	30 1/2	28 3/4	36 7/8	36 5/8	31 1/8	42	13	18	30	7 1/8	4 1/8

For Turbine Dimensions Refer to 4th Page Following.

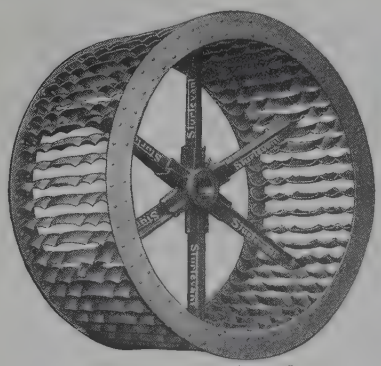
B. F. STURTEVANT COMPANY

HYDE PARK, BOSTON, MASS.

Address nearest office. For list of offices see fifth page following.

Engine Driven Forced Draft Fans

Steel Plate Forced Draft Fan Wheel



Multivane Fan Wheel

Forced and Induced Draft Application

Engine driven fans are used very largely in connection with forced or induced draft work, primarily because of their flexibility and ease of control. The possibility of using the exhaust steam for feed water heaters, and for numerous other purposes, quite frequently gives engine drive preference over motor drive in mechanical draft installations.

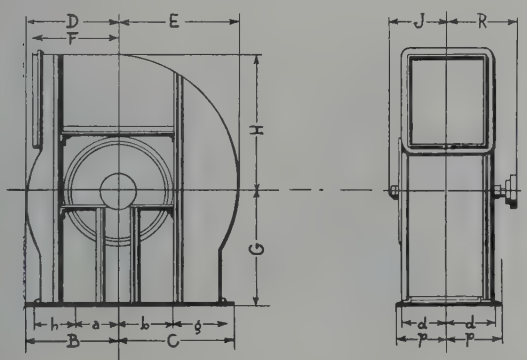
On board ship, and more particularly in navy work, the requirements of forced draft installations are unusually severe and only apparatus of proved dependability can be installed. It is significant that Sturtevant Forced Draft Fans are used more than any other make on United States Battleships, Cruisers, Destroyers and on the U. S. Merchant Marine.

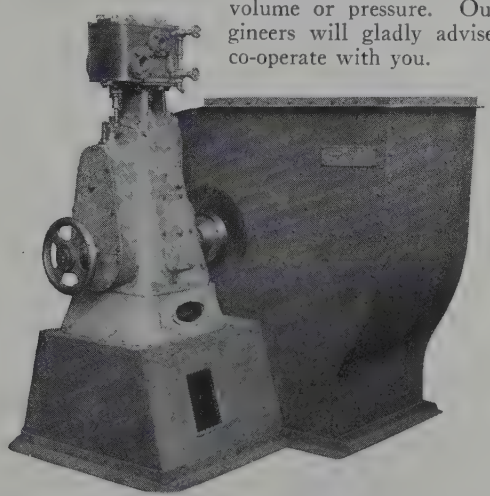
Design and Construction

All Sturtevant forced draft fans are especially designed for their work. On account of the high pressure usually necessary and in order to withstand the stresses of high speed duration, they are built exceedingly strong and heavy. All types of Sturtevant steam driven fans can be readily controlled by boiler pressure with the aid of special regulating valves.

Service

To supply adequately all needs a complete line of forced draft fans and apparatus has been developed. This enables us to meet any condition of speed, volume or pressure. Our engineers will gladly advise and co-operate with you.





Engine Driven Forced Draft Fan Used to a Great Extent with the Howden System of Forced Draft

SIZES AND PRINCIPAL DIMENSIONS OF STURTEVANT DESIGN 1 STEEL PLATE FORCED DRAFT FAN

Steel plate, right hand, top horizontal discharge, full housing, single width, double inlet

Size of Fan	B	C	D	E	F	G	H	J	p	R	a	b	d	g	h
80	31	31	31	39	30½	36½	43	20⅝	15	25⅛	24½	24½	13¼	—	—
90	34½	34½	34	44	34¼	45	49	22½	17	27½	25	25	15½	8	8
100	35½	35½	37	49	36½	50	55	24½	19	29½	27	27	17½	7	7
110	40½	40½	40½	53½	40½	50½	60	26¾	22	32	32	32	20	6½	6½
120	46	46	44	58	41½	55	65	30⅜	25½	36	34½	34½	23⅛	9¼	9¼
140	49	49	50	68	45½	64	77	33⅝	28½	40	38½	38½	26¼	8¼	8¼

For Single Width Multivane Fan Dimensions Refer to Second Page Following. For Engine Dimensions Refer to Next Page Following.

B. F. STURTEVANT COMPANY

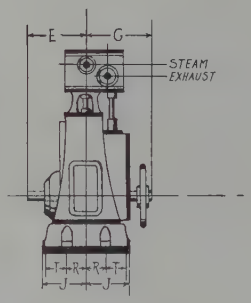
HYDE PARK, BOSTON, MASS.

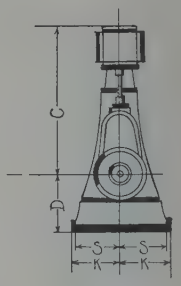
Address nearest office. For list of offices see fourth page following.

Engines and Generating Sets

Construction

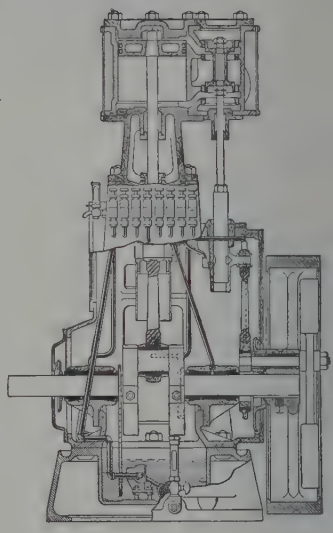
The engine is of the short-stroke high speed type, developing sufficient power at low piston speeds to carry the normal generator load on a cut-off at one-third stroke. For fractional loads the cut-off is automatically reduced, insuring economical operation and at the same time maintaining very close regulation of speed. The reciprocating parts of the engine are balanced dynamically to eliminate vibration. Gravity system of lubrication is employed with automatic return. We also manufacture this engine with forced lubrication. It is designated VS-8. Well adapted for driving main circulating pumps on merchant ships.





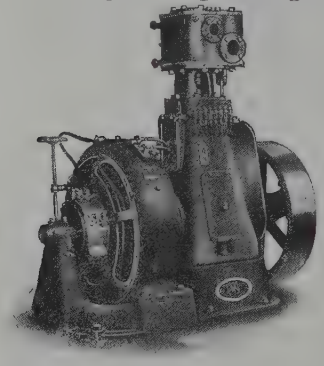
SIZES AND PRINCIPAL DIMENSIONS OF STURTEVANT VS7-VS8 ENGINES

Size of Engine	Pipes team	Pipes Exh.	C	D	E	G	J	K	R	S	T
4x5	1¼	1½	37								
5x5	1¼	1½	37								
6x5	1½	2	37	13¾	15¼	17⅝	10⅞	12¼	4⅞	11¼	—
7x5	1½	2	37								
5x6	1½	2	43 1/16								
6x6	1½	2	43 1/16								
7x6	2	2½	43 5/16	51¾	17⅝	19¾	12½	13	6	12	—
8x6	2	2½	46 5/16								
6x7	2	2½	50½								
7x7	2	2½	50½								
8x7	2½	3	50 11/16	18½	20⅛	22⅝	14	14¾	6½	13¾	6½
9x7	2½	3	50¾								
7x8	2½	3	55¾								
8x8	2½	3	55 13/16								
9x8	3	3½	55 15/16	18½	22⅜	24⅝	15¼	16	7⅛	14⅞	6¾
10x8	3	3½	55 15/16								

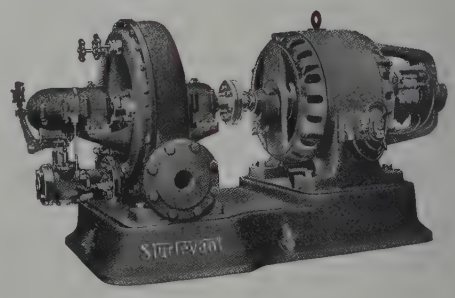


Construction of Generating Sets

Simplicity is evidenced throughout the construction of both the engine driven and turbine driven generating sets. The V. S.-7 engine driven generating set is of the three bearing type. Both the engine and generating set are mounted on a substantial sub-base permitting movement from place to place. It is designed to operate both at normal load and twenty-five per cent overload. It is further designed to carry fifty per cent overload momentarily without injury.



Engine Driven Generating Set



Turbine Driven Generating Sets

Turbine Driven Generating Sets

The turbine driven generating sets are very desirable power and lighting units many of which are being used on the U. S. Navy ships and mine sweepers. The compactness and small size of these sets recommends them for shipboard where space is usually a very important consideration.

B. F. STURTEVANT COMPANY

HYDE PARK, BOSTON, MASS.

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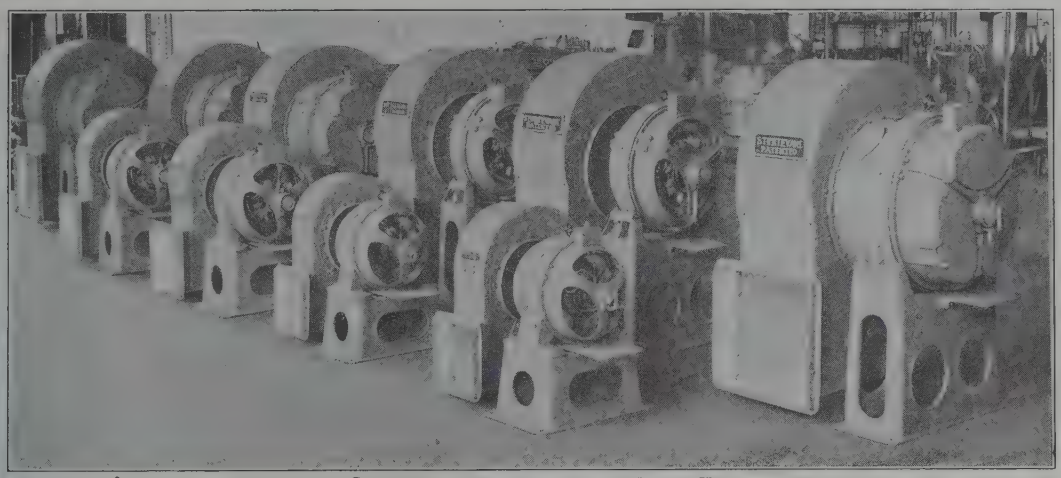
Motor Driven Ventilation Fans



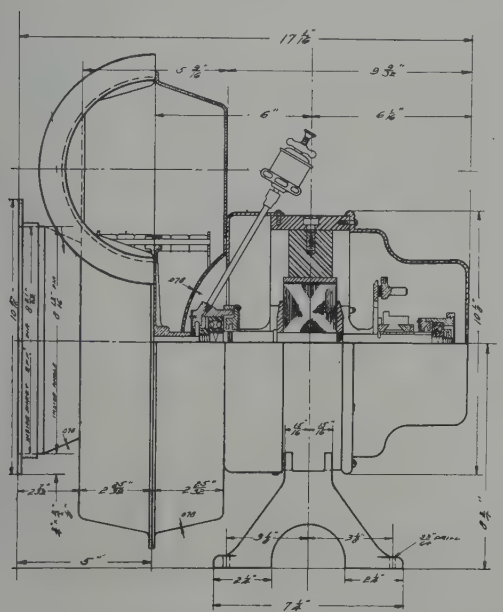
Sturtevant Motor Driven Ventilation Fans

Adaptability of the Electric Drive

Smaller Sizes of Sturtevant Motor Driven Ventilation Fans are used extensively for Submarine Battery Ventilation and Ventilation of Engine Rooms, Officers' and Crews' Quarters.

Larger sizes are used for hull ventilation on U. S. Navy ships and for ventilating passenger and cargo spaces on passenger ships. The electric drive is very satisfactory and convenient for fan work, for applications where the direct connection of the motor to the fan is possible.

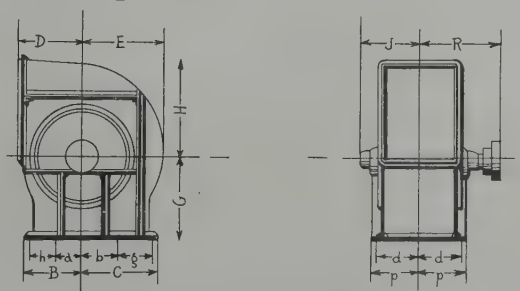
Practically any type or size of Sturtevant Fan may be equipped with direct connected electric motor unless the working conditions require speeds too high for satisfactory motor operation.



D Size Set with ¼ B Motor

Sturtevant Direct Current Motors

All Sturtevant motors are built for direct current, and for standard voltages. With direct current electric drive it is possible to control the speed of the fan by means of regulating rheostats, and any installation may be so arranged that it can be controlled from any designated place. Standard motors are supplied with Sturtevant Fans for alternating current.



SIZES AND PRINCIPAL DIMENSIONS OF STURTEVANT DESIGN 3 SINGLE WIDTH MULTI-VANE FORCED DRAFT AND VENTILATION FAN.

Right hand, Top horizontal discharge, single width, single and double inlet.

Size of Fan	B	C	D	E	G	H	J	p	R	a	b	d	g	h
2	7	9½	8⅞	10¼	10¾	12¾	11	6⅜	12¾	5	6	5¾	—	—
3	8¾	11½	10¾	12¾	13	15⅜	12⅛	8⅛	14	5¾	7½	7⅜	—	—
4	10	13	12⅞	15¼	15¼	18½	13¾	9¼	15⅜	6½	9	8⅜	—	—
5	11¼	15½	14⅝	17⅞	17½	21½	15½	10⅜	17	7¼	10½	9⅝	—	—
6	13	17½	17⅛	20⅝	19¾	24⅝	17⅛	12⅛	19¼	8	12	11	—	—
6½	14¼	19⅜	19	22⅞	22	27¾	19¼	13⅜	21½	8¾	13½	12⅛	—	—
7	15½	21½	20⅞	25½	24¼	30¾	20½	14½	22⅝	9½	15	13⅜	—	—
8	18½	26¼	24⅝	30½	28¾	36⅞	23¾	16⅞	26½	13	18	15¾	—	—
9	22½	30¼	28¾	35⅝	33¼	43	26⅞	20¼	29⅝	15	21	18¾	—	—
10	25½	34¼	32⅛	40⅝	37¾	49⅛	30⅛	22⅝	32½	11	19¾	21⅛	13	13

B. F. STURTEVANT COMPANY

HYDE PARK, BOSTON, MASS.

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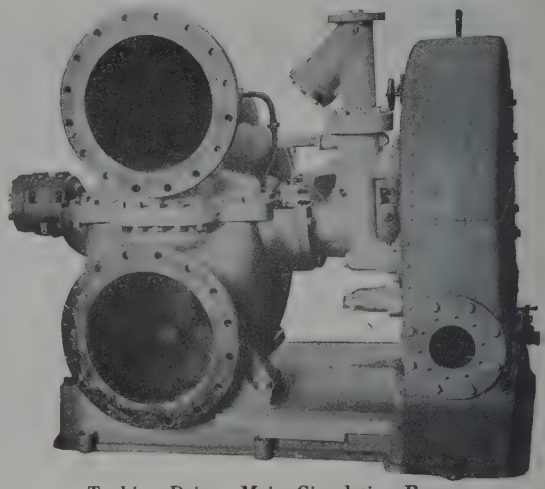
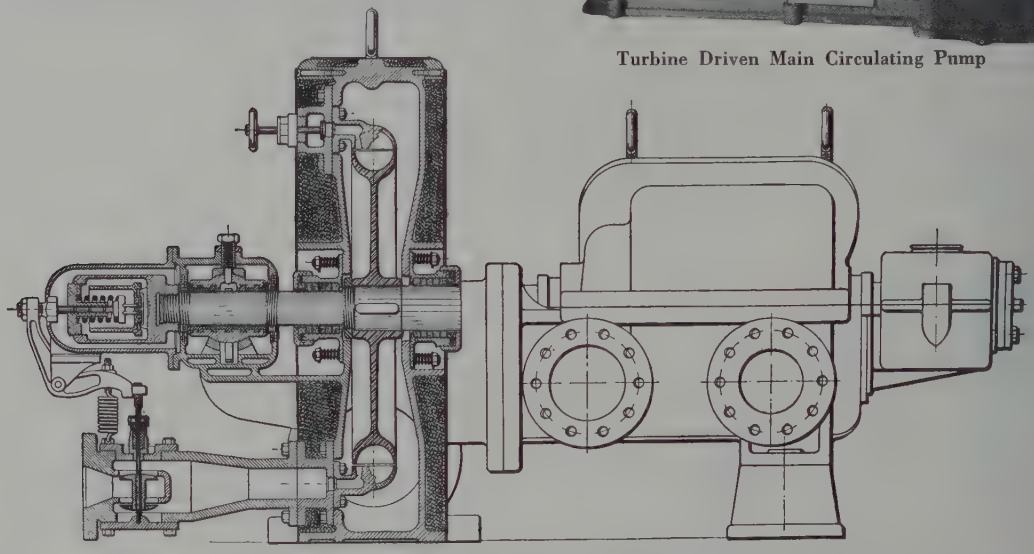
Construction

Steam Turbines are of the single stage, multi velocity type. By suitable combinations of steam pressure, size of rotor, nozzle capacity and rotative speed, a range of from one to three hundred horse power is obtainable. The refinements in design and construction account for their superiority in power, strength, operating economy, and reliable performance. Built with solid rotors having buckets milled into the rim by our own patented process. Their individually controlled nozzles with integral reverse buckets insure the most efficient absorption of the steam velocity. Unsurpassed in close speed regulation and in protection against over speed.



Turbine Driven Main Circulating Pump



SIZES AND PRINCIPAL DIMENSIONS OF STURTEVANT DESIGN 11 STEAM TURBINE

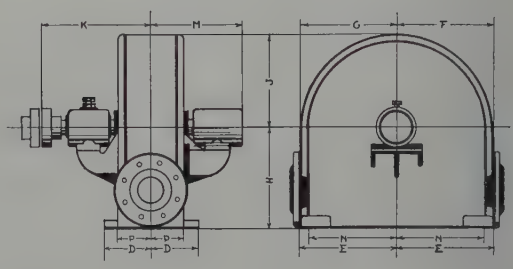
Size of Turbine	Size of Steam Pipe	Size of Exhaust Pipe	D	E	F	G	H	J	K	M	N	P
A-11	1	4	5¾	10½	10¾	10¾	10½	10¼	13¾	13¾	8½	4⅞
B-11	1½	6	6⅝	13⅝	13¾	13¾	14	14⅞	15½	15½	11¾	6
C-11	2	8	8¼	17⅝	17½	17½	18	17⅞	18⅛	17⅞	14⅝	7
D-11	2½	8	9⅛	21⅛	21	21	21¼	21⅝	21⅛	20⅛	18	7⅞
E-11	2½	10	10	24¾	24⅝	24⅝	24½	25⅜	24⅝	24	21½	8¾

Uses

1. Forced Draft—Refer to third and fourth previous pages.

2. Generating Sets—Refer to second page previous.

3. Pumps—Very compact turbine pump units have been furnished for main circulating, boiler feed, and auxiliary pumps to meet the limited space aboard ship.



B. F. STURTEVANT COMPANY
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Marine Heaters

Marine Heaters

Marine Heaters

We also manufacture various types of heaters for marine use, the detailed design being varied to suit the space available and the heat rise desired.

Sturtevant Marine Heaters are supplied with solid bases or with sectional bases, and in the latter case each section may be individually controlled. This gives flexibility and a wide range of temperatures. Still greater temperature control is made possible by the use of a damper and by-pass. Air may be obtained all cold, all hot, or may be mixed to secure any desired final temperature.

For Navy use these heaters are made of seamless drawn steel tubes expanded into steel headers. For Merchant Marine use they are made of wrought iron pipe screwed into steel headers.

Water Tight Construction

The heaters are made with casings that are both air-tight and water-tight, so that they may be placed either on deck or inside. Special attention is given to secure the foundation and lower part of the heater absolutely water-tight.

The finish of the heaters is specially designed to withstand the corrosive action of salt water and air.

These sets will stand any steam pressure up to 80 pounds and are furnished with or without fans as desired.

Service

Ever striving to improve and perfect members of the large family of air-moving and power products, trade-marked Sturtevant, a large, modernly equipped research and experimental laboratory is maintained. Collaborating with this laboratory is our engineering department, which includes the largest staff of fan and ventilating experts in the country. The services of this department are unreservedly at your disposal. Bulletins are published on every product of Sturtevant manufacture. For the convenience and help of our friends twenty-three Sales Engineering branches as listed below, are maintained in the leading business centers. Avail yourself of the resources of this unique organization.

The B. F. Sturtevant Company are the largest builders in the world of Fans, Fan Systems and Allied Products.

Atlanta	Hartford	Salt Lake City
Boston	Kansas City	Washington
Buffalo	Minneapolis	San Francisco
Chicago	New York	Seattle
Cincinnati	Philadelphia	Galt, Ont.
Cleveland	Pittsburgh	Montreal
Dallas	Rochester	Toronto
Detroit	St. Louis	

General Offices and Works of the B. F. Sturtevant Company, Hyde Park, Boston, Mass.

B. F. STURTEVANT COMPANY

HYDE PARK, BOSTON, MASS.

Address nearest office. For list of offices see above.

Forced Draught and Oil Burning Apparatus

Wellsville Plant of James Howden & Co. of America, Inc.

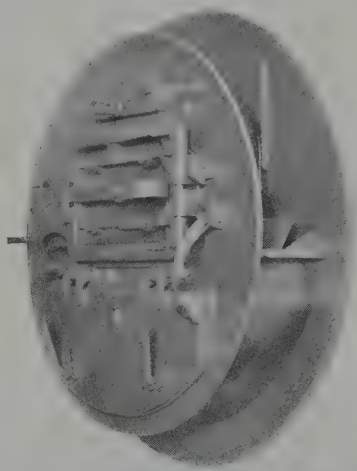
James Howden & Company

After the United States entered the Great War and the arrangements were completed by the Government whereby the United States Shipping Board undertook to build a large number of ships, one of the principal difficulties was the supply of auxiliaries for these vessels. At that time James Howden & Company, Limited, of Glasgow, Scotland, approached the representatives of the Emergency Fleet Corporation in London and proposed that in order to help supply auxiliaries in America they would be pleased to undertake the operation of an engineering plant in the United States. The proposal was warmly received by the American officials in London with the result that in 1918 James Howden & Company, Limited, purchased a suitable factory at Wellsville, New York, and the branch company was incorporated in that state as James Howden & Company of America, Inc.

The plant at Wellsville, N. Y., consists of a large foundry with machine shops and erecting shops. The head offices are located there also, as well as the drawing offices, and the whole undertaking is under the control of representatives from the Glasgow factory.

The auxiliaries manufactured in Wellsville consist of the vital fittings for the well known Howden system of Hot Air Forced Draught.

The principles on which this system of forced draught is based are (1) the supplying under pressure of hot air for combustion in quantities suited to the quality of coal or oil used and (2) the utilization of the heat in the waste gases for the purpose of raising the temperature of the air for combustion.



Howden Patent Single Action Furnace Front Arranged for Coal Burning. Furnace Fronts of the Convertible Type for Burning Coal or Oil and Furnace Fronts for Burning Oil only are also supplied by the Company.

Briefly stated, the following are the principal advantages of this method of combustion.

(1) Great increase in the steaming power of the boilers (at least 30 per cent over the best natural draught conditions and as much as 50 per cent when burning oil).

(2) Economy (from 10 to 15 per cent saving in fuel per pound of water evaporated).

(3) Reduced size and weight of boilers for a given power.

(4) Complete control of combustion under all atmospheric conditions and with different grades of fuel.

(5) Capability of burning all classes of steam coal or oil.

(6) Preservation of the boilers on account of the more uniform temperature maintained in the furnace. No cold air enters the furnace during the period of working. When the fire door is opened, air pressure in the ashpit automatically ceases and only the hot air from the upper valve passes into the furnace, first in a direction vertically downwards, thereby forming a hot screen over the furnace mouth and preventing the access of cold air. Such conditions when firing or cleaning fires are conducive to economy.

(7) Reduction of smoke due to perfect combustion.

(8) No high smoke stack required.

(9) Coolness in the boiler room and ease of working. With this system the air casing, reservoirs and furnace fronts on the boiler end effectually prevent radiation into the stokehold.

The general arrangement of the Howden system consists of a fan (driven by a steam engine or electric motor) which supplies the air for combustion, discharging it through a conduit into the air heating chambers.

Forced Draught and Oil Burning Apparatus

In these air heating chambers the air circulates around a nest of tubes through which the hot waste gases pass before entering the uptake. The air, thus heated passes to reservoirs surrounding the furnace fronts where it is admitted through valves to the ashpits and over the fire through air distributing boxes in proportions exactly suited to the kind of fuel used and the rate of combustion required, thereby insuring a very perfect combustion of fuel.

Fans

At the Wellsville factory the double inlet Howden fans of plate construction are built as well as the single cylinder double acting enclosed forced lubrication Howden engines. A photograph of one of these units, which are specially designed to operate in conjunction with the Howden System, is shown in the opposite column. Fans arranged with two engines, one on either side and each capable of driving the fan at full power while the other acts as a standby, are also built when required.

Furnace Fronts

The Wellsville plant also supplies patent "single-action" safety type furnace fronts arranged with valves which control the air for combustion, and designed specially to suit the boilers for which they are intended. These furnace fronts, which are supplied suitable for burning coal or oil only or coal and oil in conjunction, have the valves so arranged that it is impossible to open the furnace door while the air pressure is maintained in the ashpit, thus obviating any danger of flames being blown out into the stokehold.

Silley Patent Smokebox Door Fastenings

Silley Patented Smokebox Door Fastenings which form an important adjunct to the forced draught apparatus are also supplied from Wellsville. These fittings insure a thoroughly air tight smokebox and entirely obviate the trouble usually experienced with buckling, etc., in doors secured by other methods.

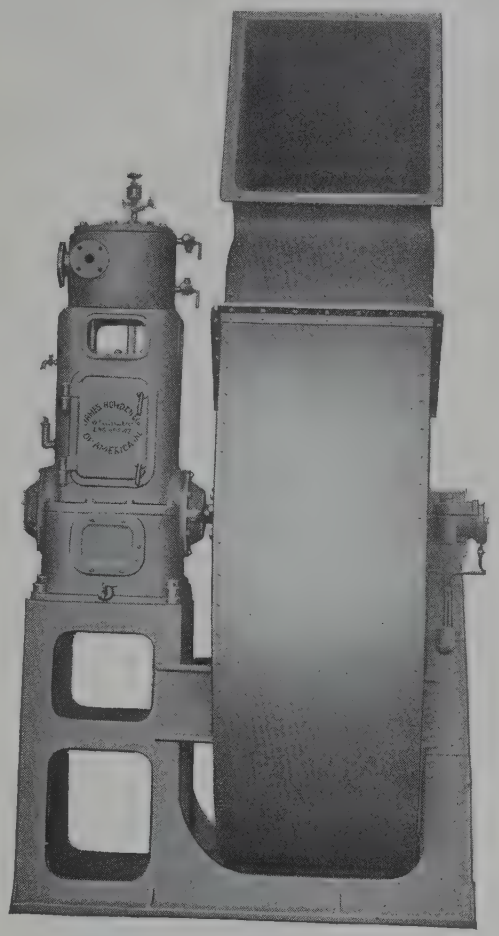
In marine boilers retarders are also fitted (one in each boiler tube). These may also be obtained from Wellsville.

23,000,000 I. H. P. Fitted

At present, the company has fitted about 6,500 vessels aggregating 23,000,000 I. H. P. with the Howden System. These vessels include the Aquitania, Mauritania, Leviathan, and other well known ships of the principal steamship companies of the world. Many warships and the principal fast channel steamers are also fitted with the System.

Oil Burning Equipment

In addition to the forced draught fittings, above described, James Howden & Company of America, Inc., also supply the Wallsend-Howden Patent Liquid Fuel Burning System which they claim to be the simplest, most efficient and most economical on the market. While this system is applicable to boilers working under closed stokehold forced draught, induced draught, or natural draught, the highest efficiency is obtained with Howden's Hot Air Closed Ashpit Forced Draught System, 16.22 lbs. of water having been evaporated (from and at 212 degrees F.) per lb. of oil burned, the calorific value of the oil being 18,770 B. T. U., giving a boiler efficiency of 83.9 per cent. This system has been fitted to more than 400 steamers of all descriptions.



Typical Howden Fan with Enclosed Forced Lubrication Engine

Other Auxiliaries

The company are also prepared to supply marine type steam driven centrifugal circulating pumps and steam driven electric generator sets for ship lighting.

Service

The company maintains a staff of skilled representatives located at various parts of the country. Shipbuilders and others interested in the above products are requested to communicate with us. Estimates and designs furnished.

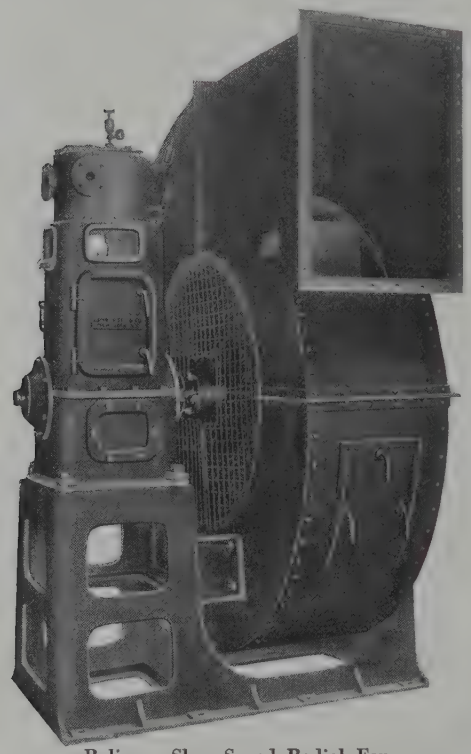
JAMES HOWDEN & CO. OF AMERICA, INC.

WELLSVILLE, N. Y.

Reliance Forced Draft Equipment

Extensive Use

When the shipping emergency developed, we determined that our best contribution towards the solution of the shipbuilding problems of the United States and their Allies would be on the line of Forced Draft Equipment. Our designs were based on the latest and best marine practice, developed through years of experience, and were made with a full appreciation of the paramount importance of reliability in service. In a very short time our equipments attracted the favorable notice of shipbuilders and marine engineers throughout the United States and Canada. Our equipments have been approved and used extensively by the engineers of the U. S. Shipping Board and the Canadian Department of Marine.



Reliance Slow Speed Radial Fan

Advantages of Forced Draft

The advantages to be derived from the application of Forced Draft, as applied to Scotch Boilers, are now so generally recognized as to render further presentation quite superfluous. Experience with steam tonnage under war conditions has justified fully every claim which has been made for Forced Draft on shipboard and revealed new possibilities of the utmost importance.

Primary Features of Forced Draft Equipment

The ultimate success of any Marine Forced Draft Equipment depends primarily on the careful design and manufacture of the four main items of each installation, viz: 1. The Furnace Front; 2. The Fan and Engine; 3. The Air Heater; 4. The Air Ducts and Passages.

The failure of any one of the above items, either through faulty design or mistakes in manufacture, may destroy the value of the whole installation and prejudice the steaming qualities of the vessel during its whole working life. Examination of defective Forced Draft installations has revealed in many cases badly designed fronts, unsuitable fans and engines, insufficient heater areas, and tortuous air passages prejudicing the efficiency of the whole installation.

The "Reliance" Equipments have been specially developed to embody all the most efficient features which long periods of operation at sea have demonstrated to be necessary.

Design of Reliance Fan Equipments

The "Reliance" Fan Equipments have been developed with the sole object of providing shipbuilders and marine engineers with a thoroughly reliable and efficient blower for marine service. The slow speed radial type was adopted as offering the best prospect in construction and capability of meeting the very onerous conditions on shipboard. After experimenting with numerous forms of fan wheel blading we advanced from a flat blade to one with a double curvature, test data from which show very high efficiency. We are therefore able to keep our fan diameters within such limits as will assist the shipbuilder when space available is limited. Revolutions for full output do not exceed 350, the average working revolutions being under 300 per minute.

For special duty such as the ventilation of cargo holds or passenger accommodation we furnish a Multibladed type of small diameter and high speed but we do not offer this type for Forced Draft work.

Specifications for 75-Inch Fan

Following is an outline specification of our standard 75″ Fan with twin Engines very largely adopted in the standard cargo vessels of the U. S. Shipping Board.

Fans: The fan wheel is built up on a wrought steel spider with cast iron center, keyed to 3″ shaft. Wheel blading is of steel plates with double curvature, edge-supported by shroud plates. All wheels are carefully tested for balance and run true in casings with minimum clearances.

Engines: Twin engines of vertical type, fully enclosed with Forced Lubrication System throughout. Of

Reliance Forced Draft Equipment

most rugged construction and specially designed for steady running over long periods at sea. One engine sufficient for full power, the second is fitted as a standby.

Fans are constructed throughout of steel plates, Fan Casing being split to allow easy access to wheel without disturbing Engines.

Fan and Engine Assembly: The Fan and Engines are direct connected and mounted on heavy cast iron stools with cast brackets supporting oil ring bearings. The Fan may be turned over between the stools to suit any required direction of discharge.

Sizes of Reliance Fan Equipments

"Reliance" Fan Equipments are manufactured in sizes varying from 51″ diameter of impeller to 105″.

Standard sizes covering any marine installation from 500 I.H.P. to 3500 I.H.P. are kept in stock for immediate shipment. Special sizes and types for any particular duty, such as induced draft or ventilation, can also be supplied at short notice.

Furnace Fronts

We manufacture any and every type suited to every condition and give below some of the types produced:—

1. Solid one-piece, coal burning.

2. Solid one-piece, coal and oil burning.

3. Solid one-piece, coal and oil burning with removable sill and firebox.

4. Oil burning only (solid one-piece) circular firebox. Suitable for adaptation of any Oil Fuel Equipment.

5. Sectional two-piece front for coal; also convertible for coal and oil burning. This is the Standard "Reliance" Front which we recommend for all purposes.

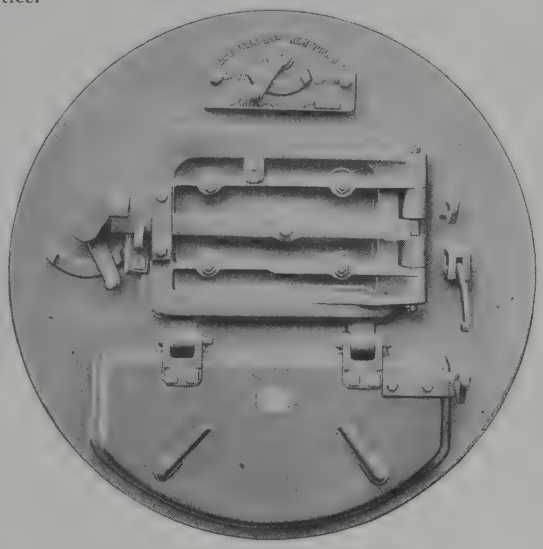
Our sectional type is built up of two or more separate sections, cast from special patterns, carefully matched and machined to template, and bolted together. The best grade gray iron is used for the main castings and all mountings are designed for reliability in service.

All Fronts are finished complete with furnace and ashpit doors, top and side valves with safety interlocking latch check if desired, and one set of air baffles to suit furnace mouth.

Furnace Fronts can also be supplied for Watertube Boilers using Forced Draft. We manufacture also a natural Draft front convertible from coal burning to oil burning.

Air Heaters and Accessories

We manufacture Forced Draft Air Heaters of standard types for all sizes of boilers, also sectional air heaters for simplicity of shipment and installation. Also for oil burning only we make a heater incorporated in the fan duct. We also manufacture the smokeboxes and doors with wedge or toggle fasteners all to latest and best forced draft practice.



Furnace Front

Retarders

Our Automatic Retarder Machines have an output of 3000 pieces per day. We carry large stocks of steel strip so as to deliver quickly for repairs and replacements.

Designs

We undertake to furnish complete plans of Fan Equipments. Air Heaters, Furnace Fronts and any feature entering into an up-to-date Marine Forced Draft Installation. We also superintend the construction and testing of such installations and advise builders and owners as to improvements in the boilering of their vessels.

Centrifugal Pumps

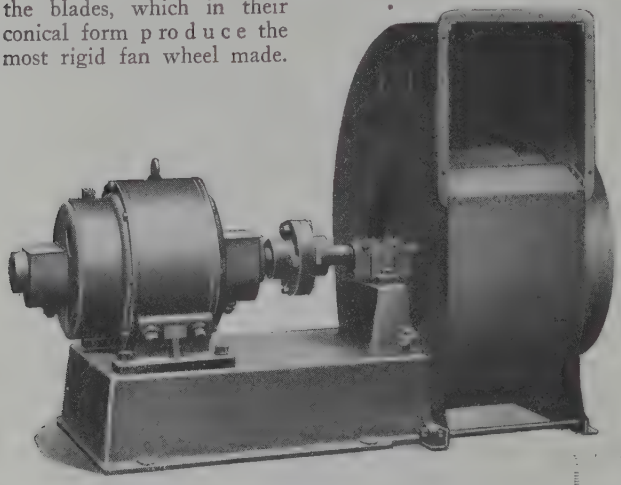
We also manufacture several standard sizes of Centrifugal Circulating Pumps with Open Engines and Sight Feed Lubrication or with Enclosed Engines with Forced Lubrication to all bearings.

Fans, Blowers and Boiler Circulators

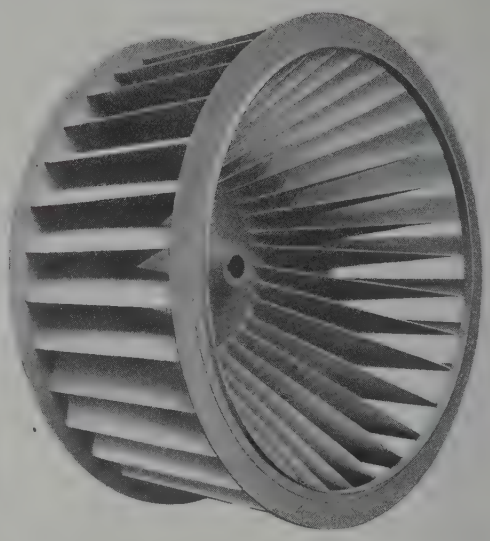
Advantages of Design

The Keith Patent Multi-Blade Fan and Blower is especially adapted for forced draft, induced draft, ventilating or heating.

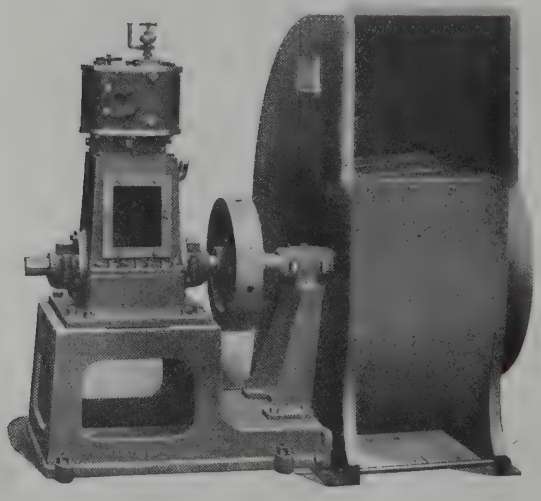
The Keith Fan stands first in efficiency, obtained largely by the peculiar shape of the blades, which in their conical form produce the most rigid fan wheel made.



Motor Driven Keith Fan
Especially Adapted for Forced Draft



Standard Keith Multiblade Runner



Engine Driven Keith Fan
Well Adapted for Induced Draft

Approved by U. S. Government

A large number of these fans have been purchased and installed by the U. S. Navy on Battleships, Cruisers and Destroyers, also by the U. S. Shipping Board. A large number have been purchased by the National Shipbuilding Co., Fabricated Ship Corp., Merrill-Stevens Shipbuilding Corp., Oscar Daniels Co. and others.

Brundrit Boiler Circulators

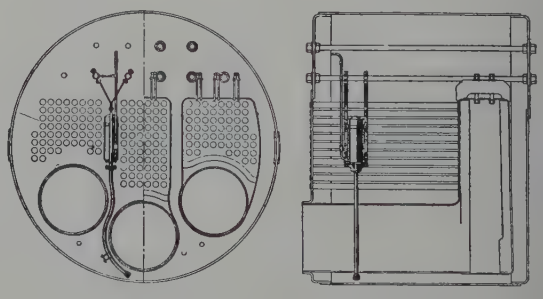
We have secured the American Rights for supplying the Brundrit Patent Temperature Balance and Automatic Circulators for Boilers.

The "Temperature Balance" is a valveless automatic apparatus for circulating the water in steam boilers. It consists of a wrought iron drum, with wrought iron suction and discharge lines connected to the drum, which is fitted in the boiler as shown below. It is unnecessary to pierce the boiler shell or to make any alteration whatever. The "Temperature Balance" can be installed in any marine boiler in an hour.

It begins to operate shortly after the fires are lighted, lifts the cold water from the bottom and delivers it above the water level.

The "Temperature Balance" also works when lying under banked fires, keeping up the temperature at the bottom of the boiler, which is of great importance.

The Brundrit Temperature Balance is used exclusively by such steamship companies as the Cunard Steamship Company; H. Hogarth & Sons, Glasgow; Lamport and Holt Lines; Prentice, Service & Henderson, Glasgow; White Star Line, and many others.



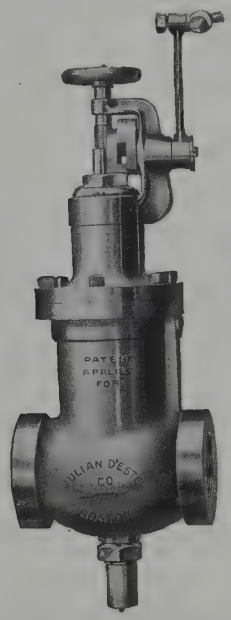
Brundrit Circulator Applied to Scotch Boiler

AMERICAN KEITH CO., INC., 26 CORTLANDT ST., N. Y. C.

Pressure Regulators—Steam Traps

Steering Engine Regulator

The Curtis Steering Engine Regulator automatically regulates the admission of steam to the steering engine for controlling the rudder. It prevents racing of the engine, and is a material aid to the pilot, as it facilitates speed and ease in steering. This regulator is of all bronze construction and is built in the following sizes: 1″, 1¼″, 1½″, and 2″.

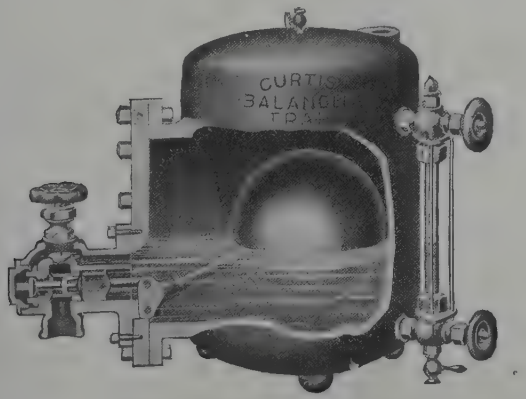


Steering Engine Regulator

Steam Trap

The Curtis Balanced Steam Trap is designed to take care of large quantities of steam line returns, delivering at a high temperature into a tank for return to the boiler. On shipboard these traps are invaluable for use on radiator returns, innerbottom, and oil tank heating system returns, etc., particularly in view of the desirability of returning all such condensation to the boiler. These traps will work against any head or back pressure less than the direct pressure in the trap, and will deliver hot water into the feed tank wherever situated.

The Curtis Trap is built in a number of sizes for capacities up to 95,000 feet of 1″ pipe and for all standard pipe sizes from ½″ to 4″.

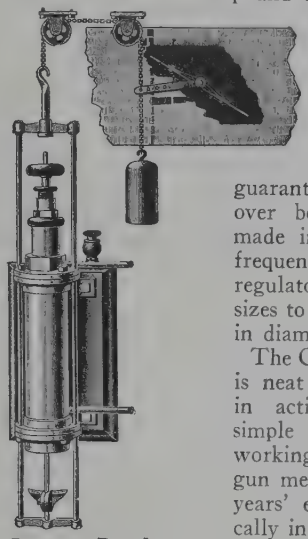


Curtis Balanced Steam Trap

Damper Regulator

The Curtis Improved Damper Regulator will maintain boiler pressure to a minimum variation, being actuated by a change in steam pressure of ½ of a pound either way from the point at which it is set to operate. It is particularly advantageous when applied to water-tube and quick steaming boilers, and while a guarantee of 10% saving of fuel over best hand regulation is made in all cases, this saving frequently reaches 15%. These regulators are made in three sizes to serve dampers up to 72″ in diameter.

The Curtis Damper Regulator is neat in appearance, positive in action, accurate, reliable, simple and durable. All the working parts are of the best gun metal bronze, found by 20 years' experience to be practically indestructible.

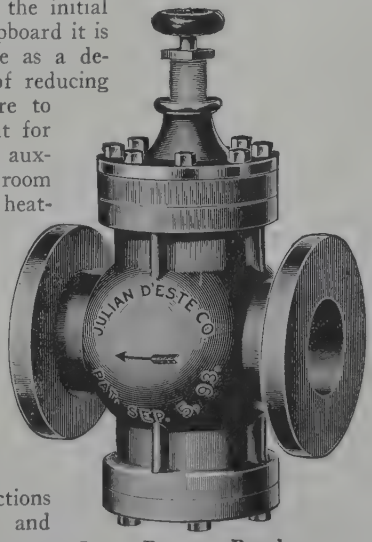


Damper Regulator

Steam Pressure Regulator

The Curtis Improved Steam Pressure Regulator is designed to reduce any varying high pressure to any constant lower pressure which may be desired, from 1 pound to within a few pounds of the initial pressure. On shipboard it is especially valuable as a dependable means of reducing the boiler pressure to the proper amount for deck machinery, auxiliary engine room machinery, steam heating systems, galley purposes, etc.

This regulator is built in all standard pipe sizes, with screwed connections from ½″ to 2″, and flanged connections from 2½″ to 8″ and larger.

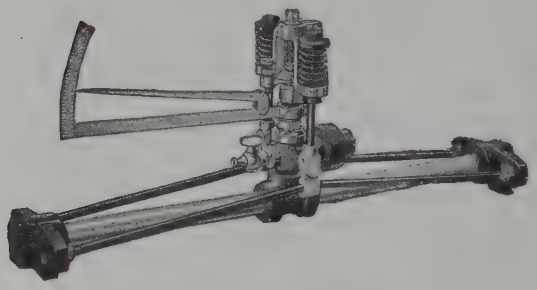


Steam Pressure Regulator

Steam Traps

Purpose

The purpose of a steam trap is to dispose of water or condensation automatically without waste of steam. The Winner Steam Trap accomplishes this to perfection. It operates automatically, and responds to the slightest change in temperature. A one degree change in temperature will cause this steam trap to operate at the proper time. It keeps all steam lines, and other apparatus that it may be connected with, clear of condensation at all times, thereby improving the efficiency of the apparatus that the trap is intended to protect and serve.



The Winner Steam Trap

Features

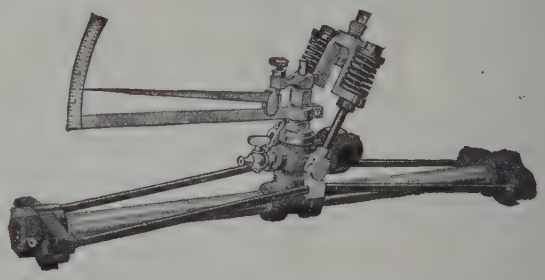
The Winner Steam Trap is the result of years of experience and experimental trials of a practical engineer who has made steam traps his life-long study and the Winner trap has been highly successful wherever installed. It is rugged in construction, fitting it for constant heavy duty. The operation of the valve movement is powerful. The simplicity of the valve will recommend it to any engineer. It is adaptable to all apparatus requiring the removal of condensation with dispatch and economy. It will remove condensation as fast as it will flow to the trap, whether a light or a heavy flow up to its capacity, providing the inlet pressure is sufficiently great to overcome the outlet pressure or head that it may have to operate against.

Repairs

The Winner Steam Trap is repaired as easily as an ordinary Globe Valve by removing the cotter pin from top spindle, and unscrewing it sufficiently to clear valve spindle, thus allowing the yoke to be laid over on one side, giving free access to the Valve Bonnet. The Bonnet, Valve Spindle and Disc can then be removed from the valve body. A new disc can be installed on the spindle, then old seat can be removed from valve body, and a new one installed. The valves are made of bronze, the discs of special metal and the seats of monel metal. The Valve Disc is made with a deflector which prevents the water from striking the walls of the valve and wearing through.

Reliability

The Winner Steam Trap is always ready for service, and can never be air bound. The valve is always open wide until dry steam fills the body or expansion tubes of the trap. Therefore, all cold water and air must pass out before the trap will close. This feature alone eliminates the necessity of bypass valves, air-valves, or other means of relieving the apparatus to obtain quick circulation. The operator of a steam trap, which has bypass valves, occasionally opens them in order to obtain quick circulation. After the valve has been opened, the operator may be called away to perform other duties and forget to close it. This practice is extremely wasteful. Air and condensation cannot remain in the body of the Winner valve. It retains steam only and will not let it pass out—no blow and no waste—and proper drainage is assured at all times. The Winner does not require an elaborate layout or great space, taking up very little more space than the pipe that it is connected to. The trap is provided with a test cock on its valve body so that an inspection can be made at any time to see that the valve is operating properly and not blowing through. It can be used outside in winter as it is impossible for the valve to freeze for the simple reason that as soon as the steam is cut off or the temperature drops, causing condensation, the trap immediately opens and discharges every bit of condensation and drains the line thoroughly before it has a chance to freeze.



The Winner Steam Trap with Yoke Thrown Back for Removal of Valve

General Use

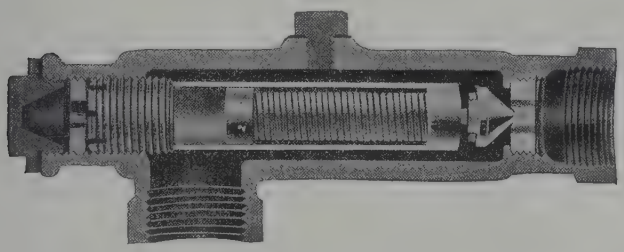
The Winner Steam Trap is for general use on high and low pressure steam. It can also be used as a Thermostat for regulating the temperature when steam is used for boiling or heating purposes; in other words it can be adjusted so as to prevent any substance that might be heated or boiled from getting beyond a certain temperature. The trap is set for a certain degree of temperature that is desired, and when this point is reached the trap automatically operates and prevents a further increase in the temperature. Its capacity is equal to, if not greater than, any other trap of same dimensions. It is built in sizes from ½" pipe connections up. Stock sizes are carried from ½" to 2". Larger connections can be built to order. The Winner Company are also manufacturers of the Winner Boiler Compound.

Steam Traps and Temperature Regulators

"Sarco" Steam Trap

The Steam Trap "Sarco" differs from every other type of steam trap, as it utilizes the pressure of a liquid, (a heavy hydro-carbon oil) hermetically sealed within a tube. When steam reaches the trap, the oil expands and compresses a spirally corrugated diaphragm, forcing out a packless piston, closing the valve.

The condensation, being of lower temperature than the steam, permits the contraction of the oil and opens the valve. Thus, whenever condensation is in the line, the valve is open but no live steam ever gets past. The action is unvarying, as the oil never fatigues, as metal does, nor deteriorates, as volatile liquids do.



Sarco Steam Trap

Lightest and Most Compact Steam Trap

The use of liquid (hydraulic expansion) permits the use of this trap not only for low pressure but also for high pressures up to 200 lbs. It needs no storage space, as required by the bucket or float traps it displacies, and it is far cheaper and the smallest, lightest, and most compact trap used for this service. A 1" high pressure trap, suitable for any given pressure up to 200 lbs., costs about $10.00, is 7¼" long and weighs only 3 lbs.

Used Extensively on Board Ship

These traps are being used by the largest shipbuilding concerns everywhere, not only for heating systems and for draining high or low pressure pipe lines, but are also the most perfect means of draining the cylinders and chests of cargo winches and other deck machinery.

For condensation the trap is always open. Live steam instantaneously closes the trap. With all condensation drained, freezing is impossible.

LIST PRICES OF STEAM TRAP SARCO
F. O. B. Bethlehem, Pa.

LOW PRESSURE, 0 TO 50 LBS.

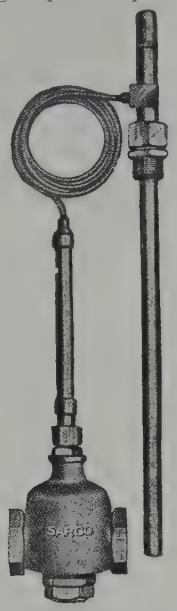
Size of Valve	⅜"	½"	¾"	1"	1¼"	1½"	2"	2½"	3"
List Prices	$6.00	6.00	9.45	11.25	24.15	30.00	38.70	51.75	60.00

HIGH PRESSURE, 50 TO 200 LBS.

Size of Valve	⅜"	½"	¾"	1"	1¼"	1½"	2"	2½"	3"
List Prices	$7.75	7.75	10.35	12.00	28.50	34.50	48.30	60.00	75.00

"Sarco" Temperature Regulators

The "Sarco" Temperature Regulator is based on the same principle as the Steam Trap "Sarco" and relies on the expansion of a liquid hermetically sealed within a tube. The tube is exposed to heat changes and the liquid expands and contracts proportionately, thereby operating a balanced valve through a packless piston.



Type TR-21
Sarco Temperature Regulator

The "Sarco" Temperature Regulator is entirely self-contained, and is self operated, not requiring electricity, compressed air, water or any other auxiliary motive power.

It is extremely compact, light in weight, and therefore particularly suitable for marine work. These regulators are being used in large numbers on United States Government and Mercantile Marine vessels. They are suitable for control of hot water service tanks, steam heated rooms, fuel oil storage tanks, isolated buildings, etc.

LIST PRICES
TYPE KR.14 SARCO TEMPERATURE REGULATOR FOR ATMOSPHERE UP TO 300° F.

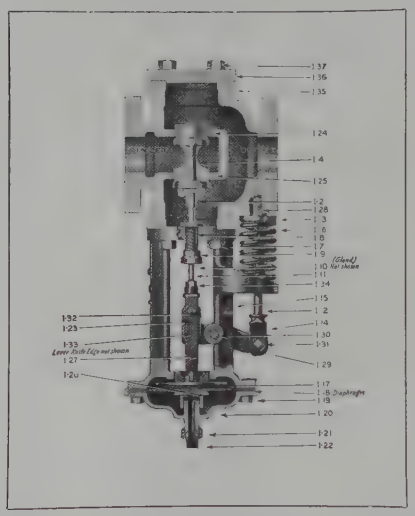
Size of Valve	½"	¾"	1"	1¼"	1½"	2"	2½"	3"	4"
List Prices	$60	$65	$70	$75	$85	$95	$110	$130	$170

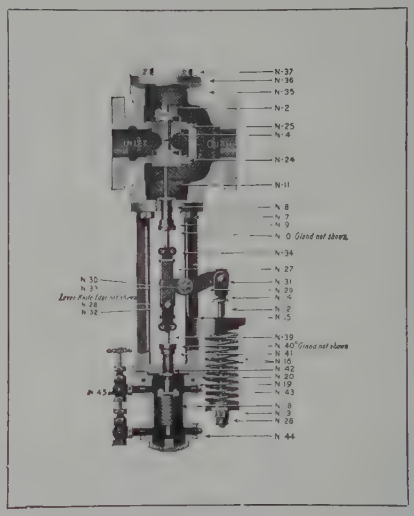
TYPE TR.-21 SARCO TEMPERATURE REGULATOR FOR LIQUIDS AND DRY KILNS.

Size Inches	Weight Pounds	List Price	Size Inches	Weight Pounds	List Price	Size Inches	Weight Pounds	List Price
½	8	$75	1½	22	$95	3	51	$135
¾	8	80	2	28	100	4	81	185
1	9	85				5	132	250
1¼	13	90	2½	37	115	6	158	300

The above prices include 6 ft. tubing between control valve and thermostat—Longer lengths subject to charge of 50c. per additional foot of armoured tubing. If lead sheathing of thermostat is necessary, there is an additional charge of $3.50 net. All prices F. O. B. Bethlehem, Pa.

Mason Pressure Regulators





Steam Reducing Valves

Mason marine type reducing valves are designed for controlling steam pressures up to 250 lbs. These valves can be installed close to the deck or bulkhead and are readily adjustable for the desired reduced pressure by means of an outside spring. Adapted for controlling steam pressures to auxiliary units, steam steering engines, heating for galley service, etc.

Materials

Furnished in sizes ½" to 1½" inclusive, bronze bodies, union connections, in sizes 2" and above, extra heavy iron bodies, flanged connections, monel mounted in all sizes.

WEIGHTS AND DIMENSIONS

Size	Center of Pipe to Top	Center of Pipe to Bottom	Net Weight Lbs.	Gross Weight Lbs.
½"	2"	13⅛"	29	59
¾"	2¼"	13 5/16"	29	59
1"	2½"	14 3/16"	32	62
1¼"	2¾"	14½"	34	64
1½"	3"	14¾"	35	65
2"	5 5/16"	16¼"	68	108
2½"	6 3/16"	20¾"	101	161
3"	7"	21 9/16"	145	185
3½"	8"	22 5/16"	150	190
4"	8⅜"	23"	237	287

Pump Regulator

Mason marine type plunger operated pump regulators are furnished in both the constant pressure and excess pressure types, for oil circulating systems, fire and bilge pumps, boiler feed pumps, etc. They have outside spring adjustment and can be installed close to the deck. Minimum of wearing parts, accessibility and quick adjustment are marked features.

Materials

Furnished in sizes ½" to 1½" inclusive, bronze bodies, union connections; sizes 2" and above extra heavy iron bodies, flanged connections, monel mounted in all sizes.

WEIGHTS AND DIMENSIONS

Size	Center Pipe to Top	Center of Pipe to Bottom	Net Weight Lbs.	Gross Weight Lbs.
½"	2 1/16"	19 1/16"	30	60
¾"	2 5/16"	19 1/4"	30	60
1"	2 5/8"	19 9/16"	31	63
1¼"	2 15/16"	19 7/8"	35	65
1½"	3 3/16"	20 1/8"	37	67
2"	5 5/16"	21 3/4"	70	110
2½"	6 3/16"	22 1/2"	103	163
3"	7"	23 5/16"	150	190
3½"	8"	24 1/4"	155	195
4"	8 3/8"	24 3/4"	240	290

Automatic Cylinder Relief Valves

Purpose

The Dew Automatic Relief Valve was designed to automatically keep steam cylinders free from condensation at all times and is of particular value when used on auxiliary deck machinery such as Windlasses, Winches, Steering Engines, Capstans, Pumps, Towing Machines, etc.

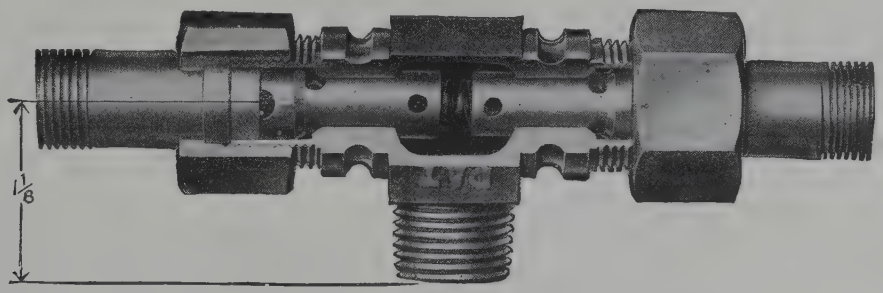
Construction

Each valve consists of a main brass casting; having two inlets for receiving the drain pipes from each end of the cylinder and one outlet for receiving the pipe for carrying the drainage to the condenser or overboard.

Inside of the main casting there are two brass valves, each with a conical seat and of sufficient length so that both valves cannot seat at the same time.

The stems of these valves are hollow, and a brass compression spring is inserted in them so as to open both sides of the cylinder to the exhaust when there is no pressure of steam on either of the valves.

In each end of the main casting there is a brass ferrule held in place by a brass hexagon nut, screwed to each end of the body casting.



The Dew Automatic Relief Valve for Draining Cylinders

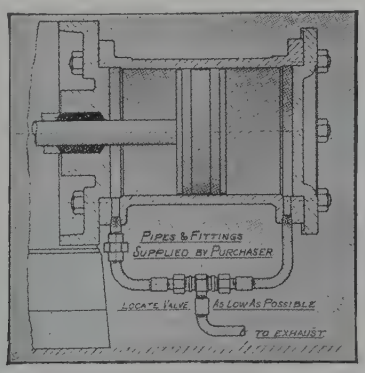
Advantages

Economy of time is secured by means of the Dew Automatic Relief Valve, as it does not require any attention whatsoever from the operator of the machine on which it is installed at any time.

Before starting the machine, warming up is unnecessary as the Dew Valve keeps the cylinders drained, preventing any possibility of bursting the cylinders or heads.

On starting, the operator is relieved from the necessity of first opening the drip cocks.

During operation, no attention whatever is required, as the Dew Valve automatically releases the condensation at every stroke.



Outline Sketch Showing Method of Connecting Up Valves to Cylinder

During shut down, freezing of water in the cylinders is prevented as the Dew Valve keeps the cylinders free of water.

Economy of all the steam admitted to the cylinder is assured because there are no open cocks on the pressure side, making it impossible to blow live steam into the drain pipes.

Economy of feed water is obtained by the use of the valve as it can be piped to the exhaust line or condenser and keeps the cylinder drains from dripping on the decks.

Operation

When there is no pressure of steam on the valves, the compression spring holds them apart and away from the valve seats so that communication from both sides of the cylinder to the valve outlet is maintained. While the machine is in operation, the steam pressure in the working end of the cylinder at any stroke forces the valve on that side against its seat, and unseats the valve on the exhaust side.

Dimensions

The dimensions below indicate the compactness of the Dew Automatic Relief Valve and the size of the pipe fittings required:

Length overall—5 9/16".

Distance from center line of steam inlets to last thread of outlet—1 1/8"

Size of steam inlets—3/8"

Size of outlet—1/2"

Other Products

The Dew Valve Company are also selling agents for the Eckliff Circulator, the Klippert Releasing Gear, the Simplex Packing Company, the Rivet Cutting Gun Company, and manufacturers of the Kinghorn Pump Valve.

DEW VALVE CO., INC., 149 BROADWAY, NEW YORK

Condensing Equipment

Tubing

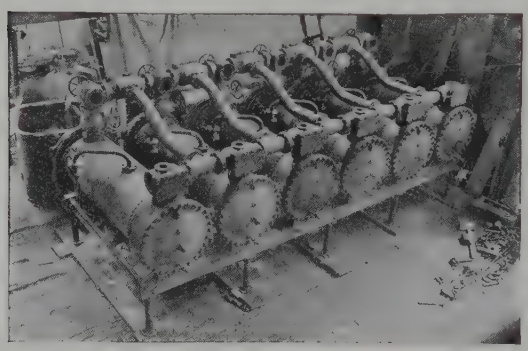
All of the 2,000,000 pounds of tubing used per year in Wheeler condensers, evaporators, heaters, reboilers, etc., is made by experts in condenser work in our own large tube mill. The tubes are of seamless drawn brass, copper or special mixture and are made in all standard sizes

and gages for various purposes. We offer you the same high quality, tough, strong, durable Crescent Brand tubing.

If your conditions are unusual our Research Department will investigate for you and will recommend the best mixture to be used.

Evaporators and Distillers

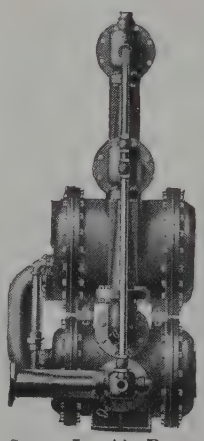
All sizes of evaporators and distillers can be furnished in single or multiple effect. We manufacture the Lillie Evaporator which possesses the distinctive advantage of reducing incrustation by being reversible. It assures higher efficiency than any other type because of mechanical circulation and 100 per cent film evaporation.



Lillie Sextuple Evaporator on Battleship

Steam Jet Air Pumps

These patented pumps cover the valuable feature of two or more steam jets working in series with condensers between the jets. They are the most efficient Steam Jet Air Pumps made and are furnished in all capacities for use on board ship.

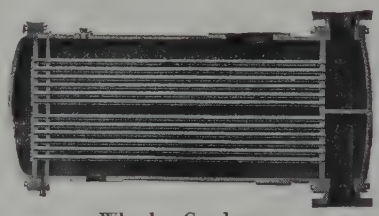


Steam Jet Air Pump

Condensers

The Wheeler Condenser & Engineering Company are pioneers in the condensing equipment business and specialize in all sizes and types of marine condensers. The illustration below shows a new type developed for the purpose of eliminating the leakage frequently experienced between tube and tube plate.

In this condenser, the tubes are tightly expanded into the right hand tube plate, eliminating the possibility of leakage at this end. At the left end the tubes are provided with standard ferrules and condenser packing. A short distance from this end is an auxiliary tube plate through which all tubes pass with a loose sliding fit.



Wheeler Condenser

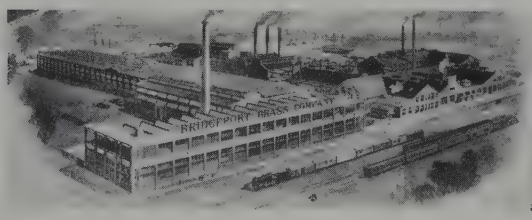
In case of leakage of circulating water through the ferrules and packing, such leakage immediately drops down to the bottom of the compartment between the two tube plates, and is then carried off by the drain shown at the bottom, to which is attached either a small direct-acting condensate pump, or a vacuum trap, depending upon conditions.

Marine Circulating Pumps

Wheeler centrifugal engine driven circulating pumps are ideal for marine service because of the small space consumed, the dependability of the operation of the engine, the elimination of upkeep troubles, and the combined high efficiency. The pumps are of the double suction horizontally split case type. An efficiency of 75% is guaranteed. Centrifugal pumps are furnished for nearly every service on board ship.

5,500 G. P. M. Engine Driven Circulating Pump

Bronze and Brass for Marine Use



Rolling Mill and Manufacturing Plants of Bridgeport Brass Company, Bridgeport, Conn.

Shipboard Applications

Bridgeport Bronze and Brass are particularly suitable for propellers and propeller shafting, fittings for rudders, stuffing boxes and struts, condenser tubes and ferrules, motor bases, sheathing, pump and valve rods, piping, bolts, nuts and other purposes requiring high-strength, toughness and non-corrodibility. It is also furnished in sheets, wire, and tubes, with physical properties as shown in the table below.

PHYSICAL PROPERTIES OF BRIDGEPORT BRONZE

Diam. or thickness in inches	Tensile Strength lb. per sq. in.	Yielding point— lb. per sq. in.	Elongation in 2 inches (per cent)
Up to 1" inclusive	62,000	31,000	25
Over 1" to 2½" inclusive	60,000	30,000	30
Over 2½" to 3½" inclusive	56,000	25,000	35
Over 3½"	54,000	22,000	40

An Electric Furnace Product

All Bridgeport Brass (as well as Bridgeport Bronze) is made in electric furnaces, insuring a uniformity and reliability of properties not otherwise commercially obtainable. For more than fifteen years this Company has worked on the development of improved methods of making brass and has developed material improvements in electric furnaces and electric furnace processes, which eliminate uncertainty from the process of melting and casting.

Part of a "Gang" of Bridgeport Electric Furnaces

Advantages of the Electric Furnace

With the Bridgeport electric process, positive control of temperature is assured at all stages of the melting process, which means that all processes occur at exactly the proper temperatures to insure the best product for the job—be it sheet, rod or tube.

Moreover the heating is under perfect control, and can be adjusted at any time to any rate desired.

There are no furnace gases to contaminate the metal in the Bridgeport electric process, thus preventing the introduction of undesirable impurities.

The charge is completely enclosed so that it does not come into contact with the atmosphere. The heat insulation is perfect, preventing waste of heat by radiation and improving the working conditions of the men who observe the process of melting and control the pouring.

Inspecting Bridgeport Condenser Tubes

The operator has perfect control of the pouring rate through a leverage mechanism permitting him to vary the pouring accurately and as slowly as he wishes without risk of molten metal cooling down in the furnace while pouring.

Condenser Tubes and Ferrules

The Bridgeport Brass Company manufactures Brass, Muntz Metal and Admiralty Seamless Condenser Tubes in the sizes listed in the table below. Condenser Ferrules to fit these tubes can also be furnished in all sizes and weights.

BRIDGEPORT SEAMLESS ADMIRALTY—BRASS AND MUNTZ METAL CONDENSER TUBES

	Sizes and Weights per Foot.				
Stubs Gauge No.	16	17	18	19	20
Thickness, inches	.065	.058	.049	.042	.035
Outside diameter in inches					
⅝	.420	.380	.326	.283	.238
¾	.514	.463	.396	.343	.289
⅞	.608	.547	.467	.404	.339
1	.70	.63	.54	.46	.39

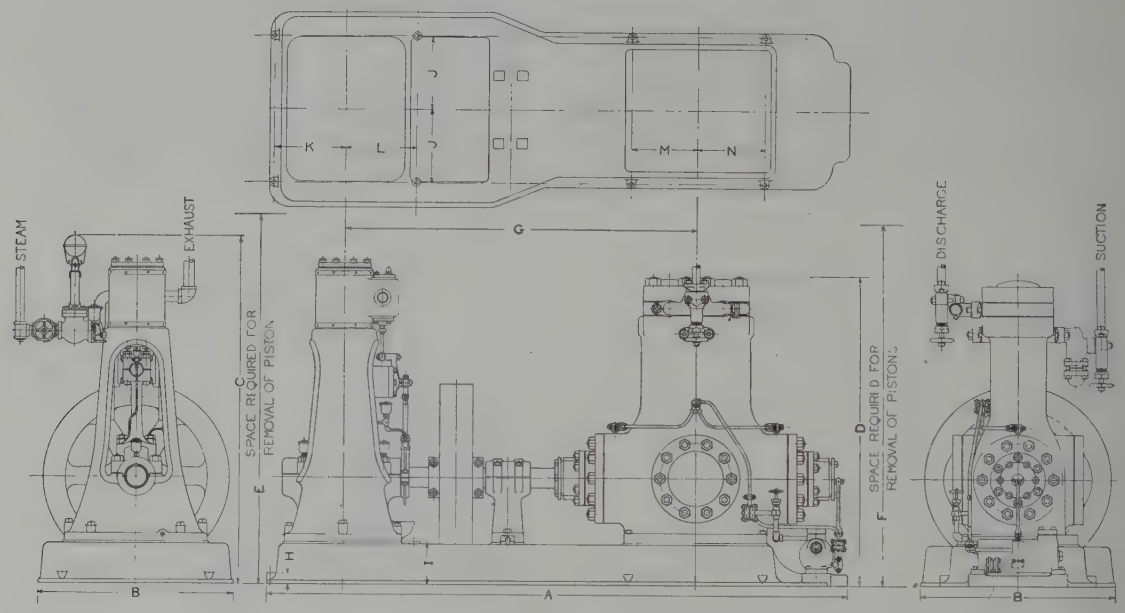
Propeller Shafting

For propeller shafting Bridgeport Bronze is decidedly preferable to steel for fresh as well as salt water, because salts and corroding elements found in sewage laden fresh water cause even greater corrosion of steel than ordinary salt water. The resistance of bronze shafts to the corrosive action of bilge water, and their low coefficient of bearing friction are other characteristics which make Bridgeport Bronze shafting so valuable.

Other Uses

Among the many other uses for Bridgeport Brass products aboard ship are motor bases for internal combustion engines, pump piston rods and valve stems, nuts and bolts for valves, cylinders, etc., salt water and feed water piping, steam piping bends to take up expansion in lines, condenser lines, etc.

BRIDGEPORT BRASS CO., BRIDGEPORT, CONN.



Marine Type CO_2 Compressor

Products

The York Manufacturing Company manufactures Ice Making and Refrigerating Machinery of both the CO_2 and Ammonia Systems including Gas Compressors, Ice Making Plants, Refrigerating Plants, Valves, Fittings, Condensers, Brine Coolers and all the accessories needed for a complete plant operating with either CO_2 or Ammonia as a refrigerant.

Facilities

The Plant of the York Manufacturing Company has, in its various departments, all the facilities necessary for the manufacture, from raw material, of any article pertaining to the trade, and maintains an extensive engineering and designing department for the purpose of rendering specifications for all problems in refrigeration.

Description

Economy in space is an important factor aboard ship. This problem has induced our Engineering Department to pay particular attention to compactness of design. Enclosed Type Compressors are particularly adapted for installation on board ships. The space required for York machines has been reduced to a minimum, and as all parts can be removed on the base of a compressor, no additional space is required for dissembling.

Either standard commercial enclosed type engines with automatic lubrication, or open type engines of conventional marine design throughout, are built for driving the compressors.

York CO_2 Compressors

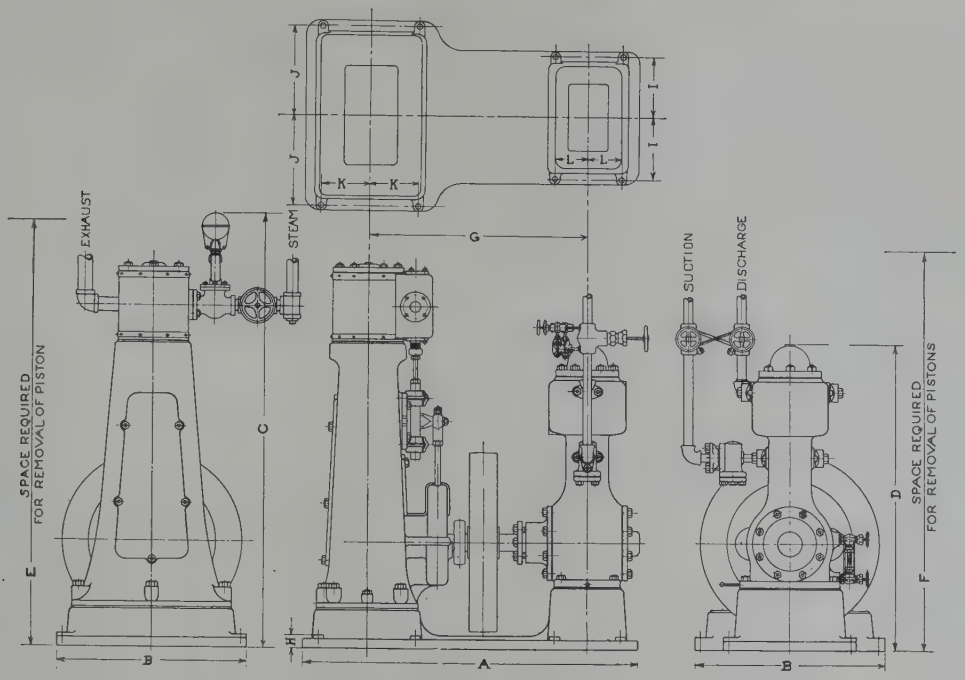
Particular attention is called to the York Enclosed CO_2 Compressor, as shown in the outline drawings on this page. The compressor is made in the sizes listed in the table below. The table also includes technical information such as the sizes of pipe fittings and anchor bolts, and the important dimensions designated on the outline drawings.

Prompt deliveries can be made of Compressors of the sizes tabulated.

The York Manufacturing Company also specializes in CO_2 Compressors of the Horizontal Double Acting Type for capacities of 20 tons and upwards.

MARINE TYPE CO_2 COMPRESSOR

Commercial Rating	A	B	C	D	E	F	G	H	I	J	K	L	M	N	Anch. Bolts	Sizes of Pipes Suct.	Disch	Stea.	Exh.	
¼ to 1 Ton	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	Motor Driv.
1 to 4 "	5′8″	2′8″	5′6″	4′0″	6′0″	5′2″	3′4″	2½″	2½″	15″	5½″	18½″	21½″	2½″	¾″	¾″	¾″	1¼″	1½″	Single Cyl.
4½ to 8 "	8′0″	3′0″	6′1″	4′0″	6′6″	5′0″	5′0″	2½″	8″	12¾″	12¾″	12¾″	8¼″	8¼″	¾″	To suit capacity.				Double "
10 to 30 "	10′9″	3′8″	6′8″	5′9″	6′11	6′9″	6′7″	2½″	9½″	16½″	16″	16″	15″	15″	¾″	To suit capacity.				" "



Marine Type Ammonia Compressor

York Ammonia Compressors

The York Ammonia Compressor, as shown in the outline drawings on this page, is made in the sizes listed in the table below which includes technical information such as the sizes of pipe fittings and anchor bolts, and the important dimensions designated on the outline drawings.

Prompt deliveries can be made of Compressors of the sizes tabluated.

The York Manufacturing Company also specializes in Ammonia Compressors of the Horizontal Double Acting Type for capacities of 20 tons and upwards.

Branch Offices

For information and recommendations regarding equipment for your particular needs, address the nearest Branch Office. The Branch Offices of the York Manufacturing Company are located, as follows:—

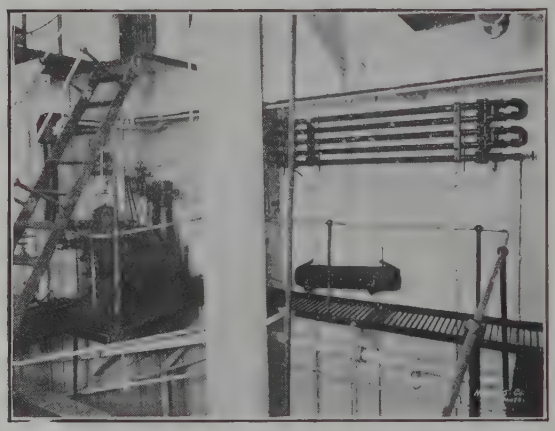
Boston, Mass.—88 Broad Street.
Brooklyn, N. Y.—Shipley Building.
Philadelphia, Pa.—2222-28 Arch Street.
Pittsburgh, Pa.—47 Terminal Way, S. S.
Cleveland, Ohio—1106-08 Woodland Ave.
Atlanta, Ga.—116-18 Central Ave.
Chicago, Ill.—26-28 North Clinton St.
Omaha, Neb.—1213-17 Jackson St.
St. Louis, Mo.—117-19 South 11th St.
Denver, Colo.—2121-31 Market St.
Houston, Texas—2201 Texas Ave.
New Orleans, La.—619 Baronne St.
San Francisco, Cal.—832-38 Folsom St.
Los Angeles, Cal.—306-08 Boyd St.
Seattle, Wash.—508 Terry Ave., North.
Toronto, Can.—Eastern Harbor Terminals, Villiers and Munition Sts.

MARINE TYPE AMMONIA COMPRESSOR

Commercial Rating.	A	B	C	D	E	F	G	H	I	J	K	L	Anch Bolts	Sizes of Pipes				
														Suct.	Disch	Stea.	Exh.	
¼ Ton..	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	Motor Driv.
½ "	3′ 4″	1′ 8″	4′ 3″	3′ 1″	4′ 0″	3′ 10″	2′ 2⅝″	2¼″	7¼″	9¼″	5″	3¼″	⅝″	½″	½″	¾″	1″	Single Cyl.
1 "	3′ 11″	2′ 1″	4′ 7″	3′ 6″	4′ 6″	4′ 6″	2′ 7″	2¼″	9″	11⅜″	7″	4″	⅝″	¾″	¾″	¾″	1″	" "
2 "	4′ 2″	2′ 5″	5′ 4″	3′ 11″	5′ 4″	5′ 0″	2′ 9″	2″	9¼″	13½″	7¼″	5″	⅝″	1″	1″	1″	1¼″	" "
4 "	5′ 4″	2′ 6″	6′ 3″	4′ 1″	5′ 6″	5′ 2″	3′ 5¾″	3¼″	11″	14″	7½″	9″	¾″	1¼″	1¼″	1¼″	1½″	Double Cyl.
6 "	6′ 0″	3′ 0″	6′ 7″	5′ 0″	6′ 8″	6′ 5″	3′ 10¼″	2¾″	11½″	17″	9½″	9½″	¾″	1¼″	1¼″	1¼″	1½″	" "
8 "	6′ 2″	3′ 0″	7′ 2″	5′ 2″	6′ 8″	6′ 8″	3′ 11½″	4¼″	13″	17″	9½″	10″	¾″	1¼″	1¼″	1½″	2″	" "
12 "	7′ 1″	3′ 6″	8′ 6″	5′ 10″	8′ 0″	7′ 8″	4′ 6″	4¼″	14″	20″	12″	12″	¾″	1½″	1½″	1½″	2″	" "
15 "	7′ 11″	3′ 7″	8′ 11″	6′ 6″	8′ 10″	8′ 6″	5′ 2″	3¼″	16¼″	20″	9″	11¼″	⅞″	2″	1¼″	2″	2¼″	" "
20 "	8′ 6″	3′ 8″	9′ 3″	7′ 2″	9′ 3″	9′ 3″	5′ 7″	3¼″	17½″	20¼″	9″	13¼″	⅞″	2″	2″	2″	3″	" "

Frick Equipment

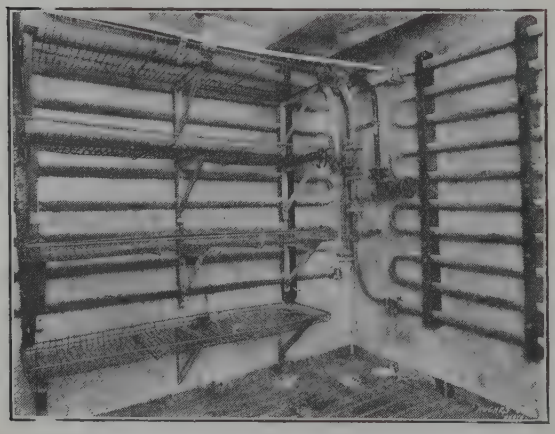
For refrigerating duty on board ships Frick Equipment consists of Vertical Single-Acting Ammonia Compressors with Vertical Engine, Horizontal Double-Acting Ammonia Compressors with Uniflow Engine, CO_2 machines of the straight line tandem type, wherein the compressor is placed behind and in tandem to the steam cylinders of a tandem compound steam engine. Gas Condensers of the Double Pipe and Shell and Coil type, Brine and Ammonia Piping, Steel Brine Tanks, Welded Double Coils, etc.



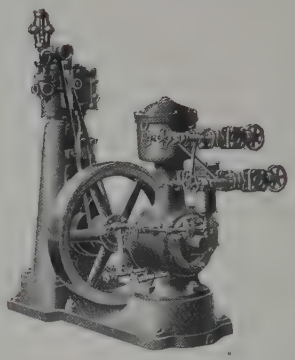
Frick Small Ammonia Machine and Equipment Installed in Ship

Capacity

Frick Refrigerating Machines are built in units of size to suit requirements from ½ ton to 1,000 tons. A statement of conditions addressed to our Engineering Department will enable us to submit an intelligent estimate and machine capacity required.



Corner of Small Ship's Provision Storage Room Showing Refrigerator Coils



Frick Vertical Type Ammonia Machine—Engine Driven

Design

The design of Frick machines is to give the maximum and most efficient service under all operating conditions. Frick Refrigerating machines are the ultimate development of a specialized engineering and manufacturing experience covering a period of more than 37 years. They embody every improvement that adds efficiency and durability and are adapted to any available power. Durably constructed of high grade materials, Frick Machines do withstand the most severe usage and overloads with very low maintenance cost.

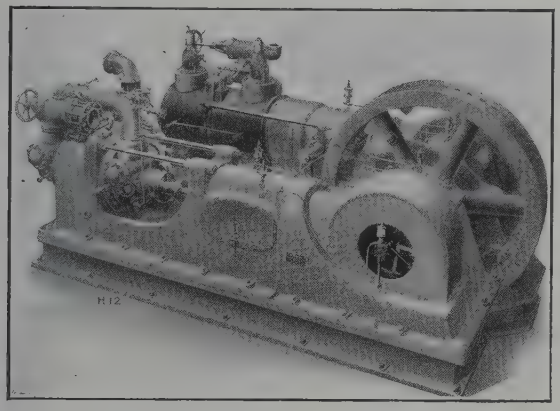
Lower Hold of Ship Showing Brine Coils and Battens Installed

Installations

The accompanying illustrations with captions beneath are of installations and show the application of Frick Refrigerating Ship Equipment.

On the preceding page two views are shown of refrigerating outfit for taking care of provisions for use on board ship; the one showing Vertical Ammonia Compressor and Engine room; the other a corner of refrigerating compartment provided with necessary cooling coils, etc.

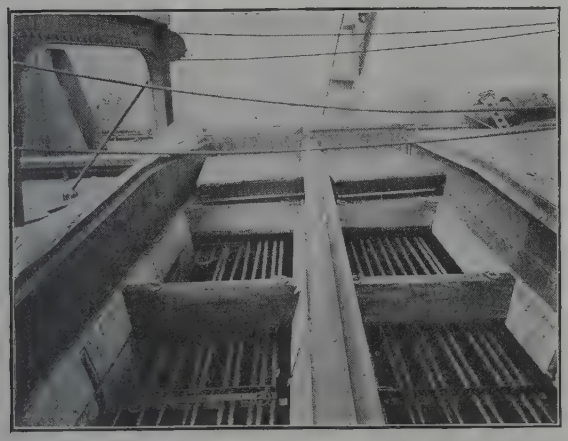
The large view on the preceding page shows method of arranging and supporting brine coils in the Lower Hold of large ship.



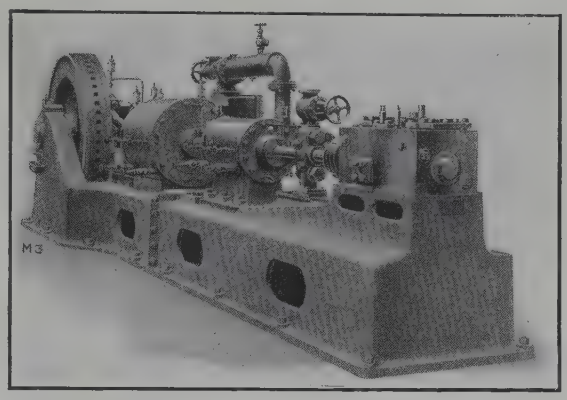
Frick Ammonia Machine with Uniflow Engine

Ammonia Machine and Uniflow Engine

The Frick Ammonia Machine with Uniflow Engine is designed with frames of the heavy duty type, every part of the machine being constructed for durability and efficient service, and to insure absolute rigidity. A heavy cast iron base is provided for adequate stiffness without relying on the vessel's deck.



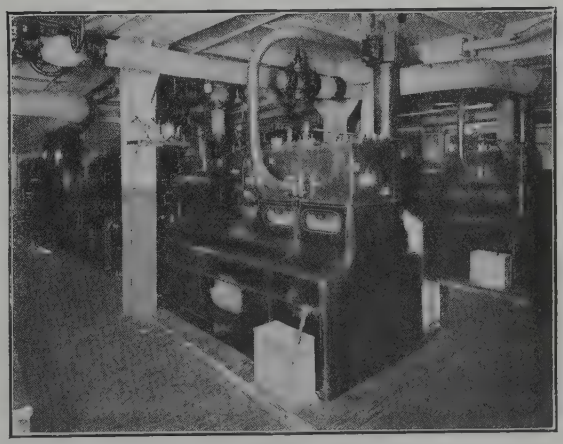
Main Hatch Partly Exposed
Showing Refrigerator Coils Installed



Frick CO_2 Refrigerating Machine

CO_2 Compressor

The above picture of Frick CO_2 machine will give a better idea of the design than the view below which shows two of these machines installed in Ship Engine Room. The crank shaft is of the double bearing, single throw type, with fly-wheel mounted between the bearings, provision being made for removal of bearings without necessity of removing crank shaft. The compressor of the CO_2 machine is made from a solid block of nickel steel bored true, and ground perfectly smooth through the working barrel, and is fitted with nickel steel valves working in nickel steel cages. Complete specifications covering refrigerating equipment for ship storage will be gladly furnished on receipt of sufficient data on proposed installation.



Ship Engine Room
Showing Two CO_2 Machines Installed

Metallic Packing

Advantages

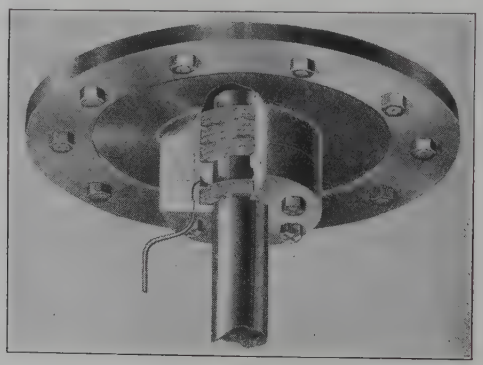
The Holmes Metallic Packing which is made of the same material as the piston rings and cylinders of your engine will last and will not wear the rod or stem as it hugs the rod and partakes of its motion. This packing does not cut or score the rod and when the engine is inactive it will not blister or rust the rod or stem. It can be placed in the stuffing box without removing the rod, and is easily removed from the box and taken apart when necessary.

Due to the fact that the Holmes Metallic Packing offers less friction on the rod than fibrous packing, it saves the rod and makes an appreciable saving in the coal used. It saves oil as we do not require the rod to be deluged with oil. It saves the continual cost and trouble of installing fibrous packing, for when Holmes Metallic Packing is once packed it is good for many years.

The Holmes Metallic Packing is steam and air tight due to the fact that the Holmes Metallic Ring, which is made of three or more sections, according to size of rod, is so arranged that when it is expanded or contracted the sections will move in or out radially—equal distances from the center of the rod—thus maintaining a perfect steam tight joint.

Marine Metallic Packing

The Holmes Marine Metallic Packing, which is our Patent Water-Pocket Packing, is designed especially for Marine work, and for conditions where there is excessive condensation. It is particularly adapted for Piston Rods, Valve Stems of Main Engines, Dynamo Engines, Steering Engines, Refrigerating Machines, Pumps and Steam Winches.



Cut Showing Marine Type Installed

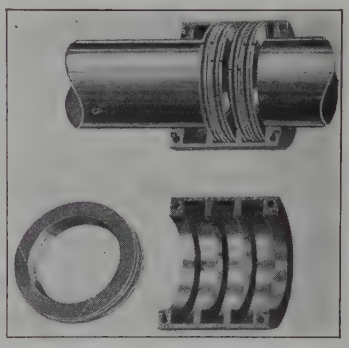
In addition to being steam and air tight, this Patent Water Pocket Packing is so arranged as to collect and remove the excess condensation. (See Cut.)

A few of the Holmes Marine Metallic Packing Installations are as follows:

U. S. Ships Montana, Tallahassee, Gresham, Panama, Mars, Rondo, Camden, Seminole, Onondago, Tahoma, Isthmian, Yamacraw, Hydrographer.

Plain Type Packing

The Holmes Plain Type Metallic Packing, shown in the cut, consists of six Holmes Rings placed in pairs in three separate grooves in the outer case. The outer metal case, which is made to fit your stuffing box, is made in two parts, thus making it easily removed.



Plain Type Packing

Other Types of Packing

The following is a partial list of different styles of metallic packing we make to suit the various conditions where the ordinary metallic packing cannot be used:

Style No. 2—Designed for use with a screw flange for either rods or valve stems.

Style No. 3—Designed for shallow stuffing boxes—outside packing. We make either round or oval gland.

Style No. 4—Designed to be used where only part of our packing can go into the stuffing box.

Style No. 6—Designed for outside packing to take the place of the screw gland.

Style No. 12—Water Pocket Packing bolted to stuffing box.

Style No. 16—Outside type Packing, where stuffing box is too shallow, either round or oval gland.

Style No. 31 G—Designed for gas packing. Guaranteed against 1500 lbs. pressure and 2500° Fahrenheit.

Guarantee

Holmes Metallic Packings are sold on thirty days' trial, if satisfactory, to be then paid for. If not satisfactory to be returned at the expense of the Holmes Metallic Packing Co.

Every Metallic Packing is guaranteed to give satisfaction, unless there is some fault with the engine or rod foreign to the Packing itself. Holmes Metallic Packings have records of from 15 to 20 years' service. The only part that ever wears at all is the rings which can be replaced at half the cost of the original packing. The Packing cage lasts indefinitely.

The Holmes Metallic Packing Company are originators of Water Pocket and Split or Divided Case Packings. 23 Patents. 22 Years' Experience.

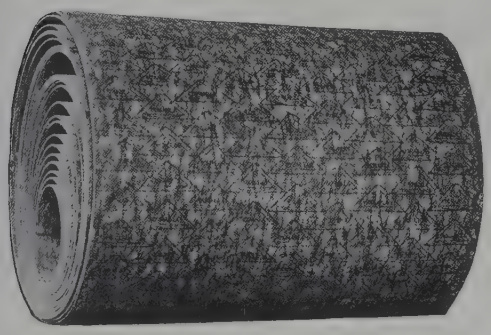
Packing Materials, Valve Discs and Gauge Glass

Durabla Compressed Asbestos Sheet

Durabla compressed asbestos sheet is a guaranteed product that can be used as a standard for all gasket work.

Durabla gaskets make tight joints on steam, water, air, oil, ammonia, and acids at all temperatures and pressures. Joints packed with Durabla can be broken without injury to the gaskets.

Vibration or condensation does not affect Durabla.



It will not burn out, blow out, or pulp at the joints and requires no following up.

Durabla sheet can be rolled and unrolled; never dries out or opens up. It does not deteriorate.

Durabla compressed asbestos sheet is packed to meet all conditions of shipping and storage.

The following sizes are carried in stock:

36 in. wide x 144 in. in length
47 in. wide x 144 in. in length
63 in. wide x 144 in. in length

In thicknesses of 1/64, 1/32, 1/16, 3/32, 1/8 in.

Durabla Rod Packing

Durabla rod packing is a semi-metallic packing, one of the patented features of which is the construction of the metal wearing surface which comes in contact with the rod. This feature prevents damage to the rod or to the packing when excessive pressure is caused by the gland being "pulled up" too tight.

Durabla rod packing is made in twelve-foot lengths, in sizes of 1/16" from 3/8" upwards and in spiral form only. Durabla rod packing is flexible, which permits cutting rings of any size.

Excellent service is being given by Durabla Rod Packing on steam hammers, hot and cold distillates, chemicals, oil and water.

Durabla High Pressure Gauge Glass

Durabla high pressure gauge glass is a metallic glass possessing elastic properties necessary to withstand the most sudden and radical changes of temperature and highest steam pressures.

Durabla gauge glass will not erode under chemical action, remains clear and transparent and will contract and expand without breaking.

Durabla gauge glass tests as follows:

Temperature: Not affected after 18 two-minute submersions in oil at 380 degrees F., then in water at 40 degrees F.

Erosion: No trace of erosion, and perfectly clear after live steam at 100 pounds pressure had passed through the glass for 96 hours.

Tensile Strength: Remained unbroken under hydraulic pressure of over 2,000 pounds per square inch for 2 minutes.

Service: Under continuous operating conditions with pressure of 225 pounds, performance equaled in every respect the best service ever obtained by any foreign glass.

Durabla gauge glasses with fused ends are carried in stock in all regular sizes ready for immediate shipment.

Durabla Gaskets

Ring gaskets for standard and extra heavy flanges cut from Durabla compressed asbestos sheet 1/16" thick are carried in stock at all times.

Quotations made on gaskets of any shape or thickness. Orders are promptly filled.

Durabla Valve Discs

Durabla valve discs make a faultless seat, wear evenly and have the strength and durability required by modern conditions.

Durabla discs will not chip or crack. They are not affected by any fluid.

Durabla valve discs can be placed in valves with the assurance that they will do the work expected of them.

Jenkins Valves, Standard Pattern

Jenkins Valves of this type contain a disc holder of brass or other suitable metal, and a removable disc of softer material, preferably Jenkins composition disc. This disc in service presents a slightly yielding surface to the valve seat and is flexible enough to adapt itself to any slight inequalities in the seat, insuring perfect contact. Should the disc be injured, it is only necessary to remove it and replace with a new one, which can be done by any mechanic.

Jenkins valves have full opening. They are made of a special high grade steam metal and contain, besides the Jenkins disc, other features found only in the genuine Jenkins valves.

Jenkins Brass Globe, Angle and Cross Valves

Screwed or flanged, are regularly furnished with Jenkins No. 119 discs, suitable for 150 lbs. working steam pressure. When specified for cold water, valves are fitted with No. 93 discs, suitable for working water pressure up to 250 lbs. Regular sizes ⅛ to 3 ins. Larger sizes in brass made from iron body patterns.

Fig. 110 Cross

Fig. 106 Globe

Fig. 108 Angle

Fig. 114 Hose Angle

Brass Valves, Standard Pattern

Jenkins Brass Check Valves, Standard Pattern

Jenkins brass horizontal, angle and vertical check valves correspond to same standard as the standard pattern globe and angle valves. Regularly furnished with Jenkins disc of semi-hard composition which will soften slightly under the action of hot water as required for boiler feed lines. When specified for cold water, air or gas, a softer and more flexible rubber disc is supplied, usually Jenkins No. 93 composition. Suitable for 150 lbs. working pressure. Sizes ⅛ to 3 ins., screwed or flanged.

Jenkins brass swing check valves, standard pattern, are made with globe shaped bodies, adapted for either horizontal or vertical installation; have renewable disc feature same as the horizontal pattern; and are suitable for same working pressures. Sizes ⅛ to 3 ins., screwed or flanged.

Fig. 117 Horizontal

Fig. 118 Angle

Fig. 119 Vertical

Fig. 352 Swing Check

Brass Check Valves, Standard Pattern

Jenkins Iron Body Valves, Standard Pattern

These are heavier and stronger than the average iron body valves. They have renewable seat rings and Jenkins discs; and are suitable for same working pressures as the standard pattern brass valves. Globe and angle valves made in sizes 2 to 24 ins., inclusive; cross valves up to 8 ins. Flanges A. S. M. E. standard dimensions.

Jenkins iron body horizontal, angle, vertical and swing check valves made in sizes 2 to 10 ins.; suitable for working pressures up to 150 lbs.

Fig. 142 Globe

Fig. 143 Angle

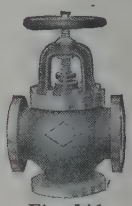


Fig. 146 Cross

Iron Body Valves, Standard Pattern

Jenkins Brass Valves, Extra Heavy Pattern

The extra heavy pattern brass globe, angle, cross and Y valves are suitable for working steam pressures up to and including 300 lbs., or for water and air pressures up to 500 lbs. Sizes ¼ to 3 ins.

Regularly fitted with renewable steam metal discs for use in steam. When ordered for cold water or air service, they are fitted with renewable Jenkins discs of flexible rubber composition. For superheated steam they can be supplied with monel metal discs and seat rings.

The stuffing boxes are fitted with glands or followers, and are so arranged that they can be repacked when valves are wide open and under pressure. The large spindles are made of manganese bronze and have powerful acme standard threads.

The extra heavy horizontal, angle and swing check valves are equally heavy in design, and are guaranteed for 300 lbs. working pressure. Swing check valves can be installed in horizontal or vertical position. Sizes ½ to 3 ins.

Fig. 128 Brass Globe

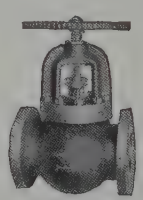


Fig. 162 Iron Body Globe

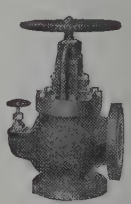


Fig. 164c Angle with By-Pass

Extra Heavy Globe and Angle Valves

Iron Body—Extra heavy pattern iron body globe, angle, cross and Y valves are suitable for 250 lbs. working steam pressure, or 400 lbs. working water pressure.

The bodies, yokes and disc holders are high grade cast iron; the spindles are of manganese bronze; the renewable seat rings and discs of durable steam metal composition.

Jenkins Valves

All flanged valves have 1/16 in. raised faces inside of bolt holes, and flange dimensions are in accordance with the American extra heavy standard. When drilling is ordered, it will also be in accordance with the American extra heavy standard, unless otherwise ordered.

Jenkins Gate Valves

All Jenkins gate valves are of the solid wedge, double face type. The bodies are globe shaped, a design which secures great strength, good proportion and neat appearance. All patterns are made with inside screw stationary spindle, or outside screw and yoke, rising spindle. The latter are particularly recommended for the higher pressures, as the spindle is more easily lubricated, increasing its durability. The traveling spindle also serves as an indicator, by means of which it can be seen at a glance whether the valve is open or closed. All the valves can be repacked under pressure when wide open, and all parts are renewable and interchangeable. The iron body and cast steel valves in the larger sizes are made with or without by-pass.

Valves can also be furnished with hub ends and square head stem, with spur, bevel or special styles of gearing, with floor stands or indicator posts, and various other operating mechanisms.

Standard Pattern—Brass, sizes ¼ to 3 ins. Iron body, sizes 2 to 30 ins. For working pressures 125 lbs. steam, 175 lbs. water. All-iron—sizes ½ to 30 ins.

Medium Pressure Pattern—Brass, sizes ¼ to 3 ins. Iron body, sizes 2 to 18 ins. For working pressures 175 lbs. steam, 250 lbs. water.

Extra Heavy Pattern—Brass, sizes ½ to 3 ins. Iron body, sizes 1½ to 24 ins. For working pressures 250 lbs. steam, 400 lbs. water.

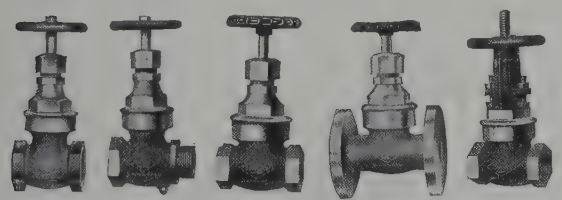


Fig. 370 Fig. 372 Standard Pattern — Fig. 280 Fig. 281 Fig. 282 Extra Heavy Pattern

Brass Gate Valves

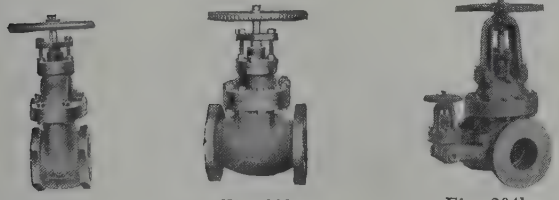


Fig. 325 Inside Screw Standard Iron Body Gate Valve — Fig. 203 Inside Screw — Fig. 204b O. S. and Y. with By-Pass

Extra Heavy Iron Body Gate Valves

Jenkins Y Valves

Besides their extensive use for blow-off service, they are particularly desirable for handling muddy or gritty water. Jenkins Y or blow-off valves are made in brass, standard and extra heavy; iron body, standard and extra heavy patterns.

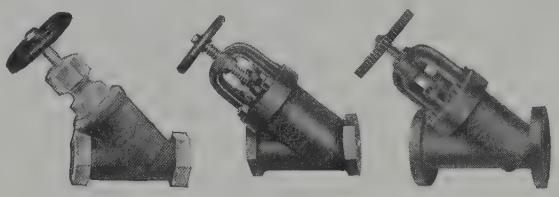


Fig. 124 Brass Y Valve — Fig. 296 Iron Body Y Valve Standard Pattern — Fig. 337 Iron Body Y Valve Extra Heavy Pattern

Jenkins Cast Steel Valves

To meet the requirements of high pressure superheated steam and hydraulic service, Jenkins Bros. manufacture a line of cast steel valves, globe, angle, gate check and automatic equalizing stop and check valves suitable for working steam pressure up to 350 lbs., and total temperature of 800° Fahr.

Mechanical Rubber Goods

Jenarco is a vulcanized red sheeting. It is very tough and pliable, equally suitable for steam, hot or cold water, and other joints. Jenkins Compressed Asbestos Jointing for superheated steam.

Jenkins Pump Valves

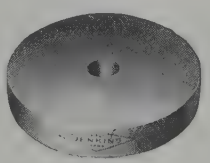


Fig. 227 Pump Valve

Made from various compounds. They are of hard compositions, particularly adapted for hot water, and for oils, acids, and other destructive fluids; the semi-hard valves for high pressure cold water service, medium soft for cold water, very soft and flexible for low pressure cold water and air.

STORES AND WAREHOUSES

80 White St.,—New York
646 Washington Blvd.,—Chicago
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133 No. Seventh St.,—Philadelphia
103 St. Remi St.,—Montreal
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JENKINS BROS.

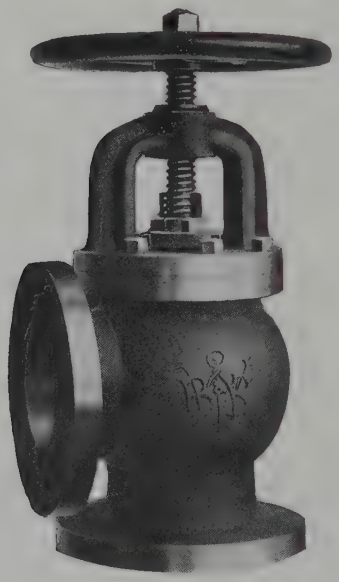
Address Nearest Office or Store.

Buckeye Products

The iron and brass valves and fittings manufactured by the Buckeye Iron and Brass Works are of the highest possible grade and represent the result of 30 years' experience in furnishing the very best that careful design, good material, accurate tools, and skilled workmen could devise and produce. Each individual product is tested to considerably beyond the working pressure at which it is designed to be used, and is guaranteed in workmanship and material. Buckeye Products have been used for many years by the U. S. Navy and have been sold in large quantities to the Emergency Fleet Corporation and to shipyards throughout the country.

Iron Body Valves

Buckeye Iron Body Globe Valves are suitably constructed for both high and moderate pressure service, and in an unusually large variety of sizes and types to meet all requirements.



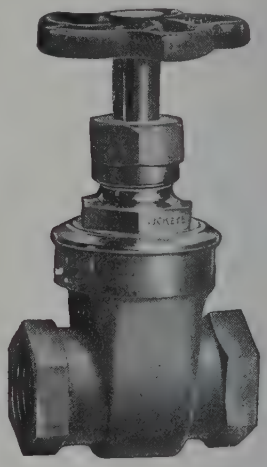
Iron Body Angle Valve

For moderate pressures, these valves are made with screwed or flanged pipe connections, with brass screwed stuffing box or with yoke and bolted stuffing box, and either straightway or angle, in standard pipe sizes.

For high pressures we make Iron Body Semi-Steel and Steel Valves. These valves are made of specially heavy construction in a large variety of standard and special sizes and types, and may be furnished straightway or angle, with or without bypass, for all types of pipe connections, and with screwed or bolted stuffing box with or without yoke.

Iron Body Check Valves

Buckeye Iron Body Check Valves are made for standard pipe sizes, either straightway or angle, and for screwed or flanged pipe connections. These check valves are brass mounted, of the best construction throughout, and of proved dependability.

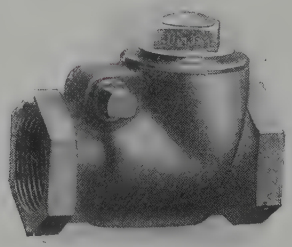


Standard Brass Angle Valve High Pressure Gate Valve

Brass Valves

Buckeye Brass Body Valves are made in standard pipe sizes for male or female screwed or flanged pipe connections. These valves are furnished either straightway, angle, or cross, with all brass liquid contact and either iron or brass wheel, and arranged with standard disc, regrinding disc, or Jenkins disc.

Brass gate valves with iron wheels are also furnished for high pressure service, arranged for screwed pipe connections in standard sizes.



Swinging Horizontal Check Valve

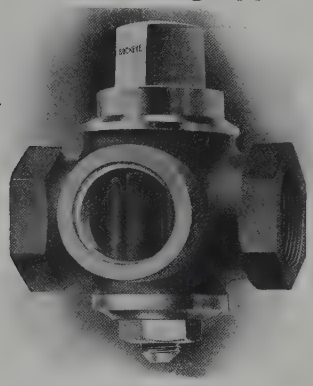
Brass Check Valves

Buckeye Brass Check Valves are made for male or female screwed, or flanged pipe connections on horizontal lines, and are arranged with standard disc, regrinding disc, Jenkins disc, or swing disc, with or without drip cock, and for moderate, heavy or extra heavy pressures.

Vertical and angle check valves may also be furnished for screwed pipe connections.

Brass Steam Cocks

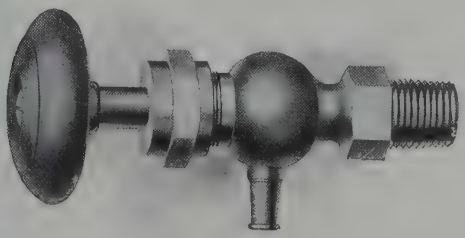
Buckeye Brass Steam Cocks are furnished either two-way or three-way, flat or square head, with or without iron handle, and for male or female screwed, or flanged pipe connections.



Standard Brass Three Way Cock

Brass Compression Gauge Cocks

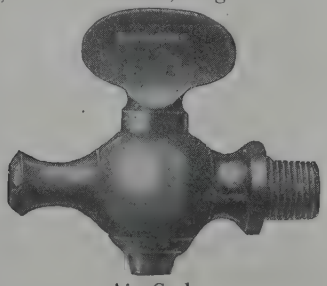
Buckeye Compression Gauge Cocks are made up to ¾ inch size with or without stuffing box for moderate pressures, without stuffing box for heavy service, and with stuffing box for extra heavy service. Mississippi type compression gauge cocks are also furnished with or without spring.



Compression Gauge Cock

Cocks

Air Cocks, Steam Gauge Cocks, and Cylinder Cocks are furnished in all sizes and types for standard and special service, and with tee, lever, or connecting handle, standard or long shank, male or female, single or double screwed,



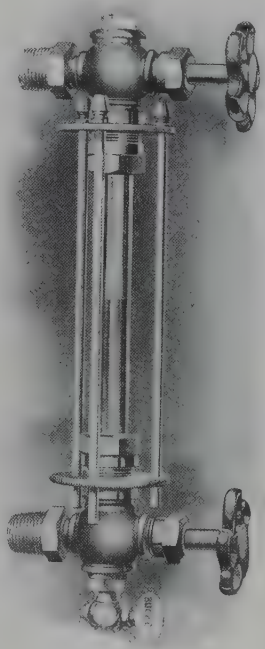
Air Cock

ends, straight or bent union connections, and with other special features for all purposes.

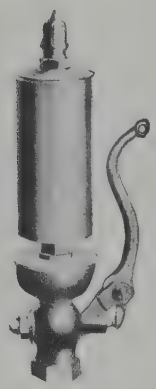
Water Columns and Gauges

Buckeye Water Columns are arranged either plain or fluted, and can be furnished with or without water gauge, gauge cocks, and air cocks in three types.

Buckeye Water Gauges are furnished with or without valve, with 2, 3 or 4 guard rods, iron or rosewood wheels, painted or finished brass or bronze body and with glass up to 60 inches in length.



Standard Water Gauge



Whistle

Brass Whistles

Buckeye Brass Whistles are furnished up to 3-inch pipe size, and 12-inch diameter bell, with or without stationary lever and valve, and suitable for air or steam. These whistles have single long bell with or without chime, and are particularly efficient, giving maximum sound or far-carrying pitch with small steam or air consumption. All brass and iron base whistle valves are also furnished.

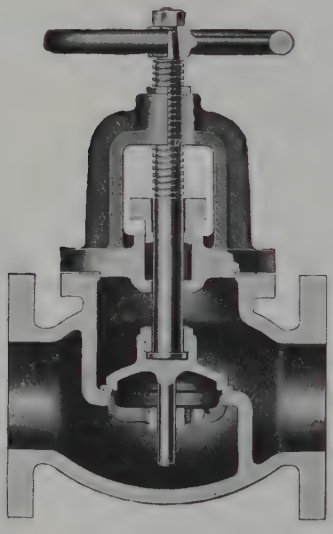
Other Products

The Buckeye Iron and Brass Works also manufacture a large variety of other iron and brass fittings including brass ground joint unions, fusible plugs, blow-off valves, quick-opening throttle valves, safety valves, butterfly valves, radiator valves, lubricators, oil cups, hose couplings, etc.

Globe and Angle Valves

Specially Adapted for Ships

Pratt and Cady Globe and Angle Valves for all pressures and in all sizes are particularly adaptable to shipbuilding work. The face to face and end to end dimensions are of the standard used in shipbuilding work, and, throughout, meet all requirements called for by the United States Steamboat Inspection Service.



Valves for 125 Lbs. Pressure

Pratt and Cady Iron Body Valves shown above have a 45° seat and are brass trimmed. They are guaranteed for 125 pounds working steam or 175 pounds of water, gas or oil pressure at a temperature not exceeding 80° F. They are tested to 150 pounds, under disc, with shell test of 350 lbs.

Among the special features of design is the solid bronze disc unit used for all sizes. It has a machined surface on its upper face, which, in contact with the machined surface on the under side of the yoke, makes a steam-tight joint and permits the valve to be packed under pressure when wide open. The seat ring is made of bronze and screwed into the body. It can be renewed whenever necessary without removing valves from the line.

Valves for 200 Lbs. Pressure

Pratt and Cady Valves for high steam pressures are of the bronze union bonnet type with long easy body curves offering the least possible resistance to the flow, and commensurate with good commercial practice. The metal used is of the highest grade bronze made to a special formula for this class of work.

The stem on all sizes is of cast manganese bronze, having the same tensile strength as mild steel. The handwheels are of a non-heating type and made of malleable iron.

The disc is of the swivel regrinding type with a ball plug type seating surface. The valves can be packed while under pressure when wide open, a tight joint being made between the stem and the bonnet by means of a bevel on the stem which engages with a corresponding seat on the bonnet. The bevel is on the inside of the valve, in a place where results in commercial machine-shop practice can easily be governed. The discs are both renewable and replaceable in an instant while the valves remain in the pipe lines.

Valves for 300 Lbs. Pressure

The Pratt and Cady Valve for 300 lbs. steam working pressure is similar in general design to the 200 lbs. pressure valve with additional features to meet the severe service due to the higher pressures. The cutting of steam is very severe under the high pressure for which these valves are used, and when employed for throttling purposes, the ordinary type of union bonnet valve has soon to be re-

ground or replaced, due to the cutting action on the seat.

When this valve is used for throttling purposes, the special deep spiral lip projecting below the seating surface of the disc allows for very delicate adjustments and at the same time prevents the steam cutting action to a very great extent, due to the fact that the disc is well off its seat before the steam is allowed to pass through. There is absolutely no other valve on the market which offers this delicate throttling action, with the added advantage of the anti-steam-cutting action of this valve.

The metal in the body is of special composition and is suitable for superheat steam work.

These valves will be furnished with renewable seat rings at an added cost when required.

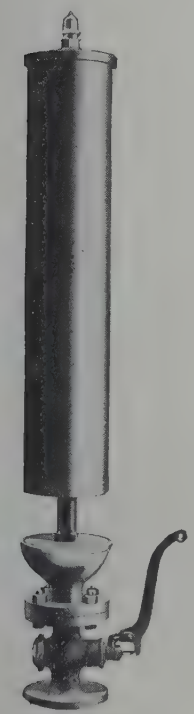
Capitol Marine Specialties

Marine Castings

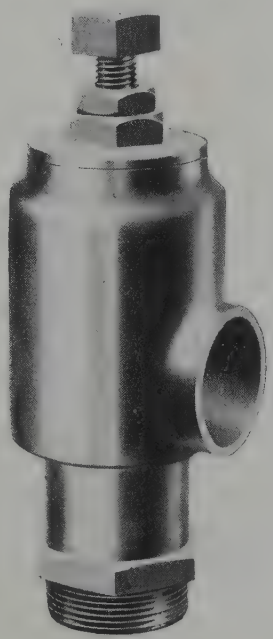
The Capitol Brass Works specializes in bronze marine castings made to any metal analysis required. These articles have been made for use on lake and ocean going vessels for a number of years and have met with universal favor.

Steam Whistles

The steam whistles manufactured by the Capitol Brass Works have a hammered copper bell and a steel stem. The whistles made for ocean going vessels are equipped with brass bases whereas the whistles which are to be used for lake service are provided with iron bases.



Steam Whistle



Relief Valve

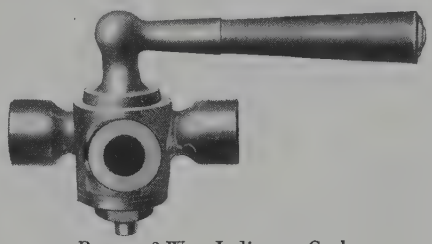
The tone of these whistles may be changed by raising or lowering the bell. Bells of any size can be furnished to order.

The following table indicates the size valve which is recommended and which will give the best results for the bell diameter indicated.

Diameter and Height of Bell	Diameter at Flanged Base	Valve
6″x30″	6″	1½″
8″x30″	6½″	2″
10″x30″	7½″	2½″
10″x36″	7½″	2½″
10″x48″	7½″	2½″
12″x36″	8¼″	3″

Bronze 3-Way Indicator Cock

This Bronze 3-Way Indicator Cock is made in two sizes—1/2″ and 3/4″—and manufactured of special bronze composition. It is designed to withstand high pressures and is fitted to the engine cylinders and connected to the indicator gear when it is necessary to ascertain the amount of horse power developed by an engine.



Bronze 3-Way Indicator Cock

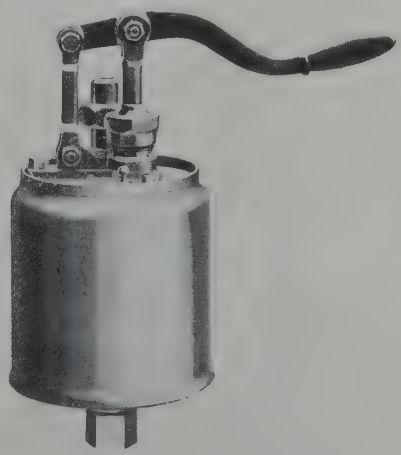
Bronze Screwed Cylinder Relief Valve

The Bronze Screwed Cylinder Relief Valve, as shown in the opposite column, is of an extra heavy pattern. It is cast of superior bronze composition and is recommended for use on cylinders where prompt and efficient relief is required. The spring is made of the best quality steel. This valve can be set to relieve any pressure specified.

The following sizes are carried in stock:
3/4″, 1″, 1 1/2″, 2″ and 2 1/2″.

Lever Handle Oil Pump

The Lever Handle Oil Pump is an emergency feed pump and is used extensively in engine rooms as auxiliary equipment to supplement the regular oiling system. The oiling is positive as all oil pumped is forced to the most remote parts of the engine which requires lubrication. This pump is made in the 1/2 gallon size only.



Lever Handle Oil Pump

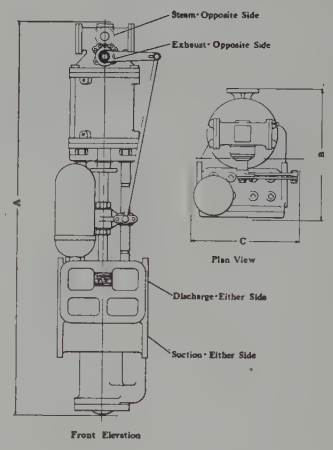
Davidson Marine Pumps

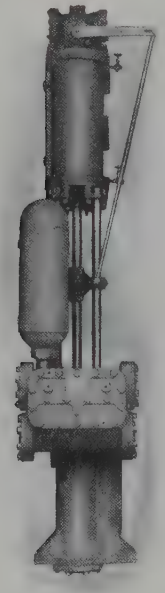
Steam Pumps for Marine Service

"Davidson" pumps have maintained the highest standard in marine service for forty years. The improved valve gear of the "Davidson" pump will operate positively under any steam pressure without internal lubrication.

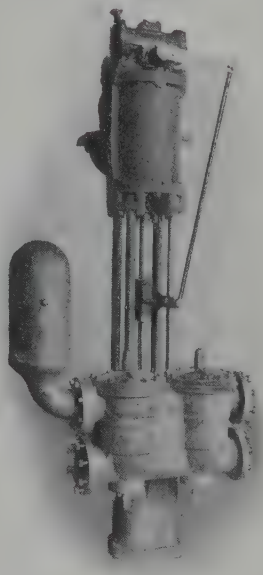
Among the various types of "Davidson" marine pumps are:—Boiler Feed Pumps, Tank Pumps, Bilge Pumps, Fire Pumps, Air Pumps, Combined Pumps and Condensers, Etc.

The vertical sizes of the Vertical Feed and Fire Pumps, and the Vertical Tank, Bilge and Ballast Pumps are listed in the tables in the opposite column. The dimensions A, B & C in both tables refer to the outline drawing above the tables.

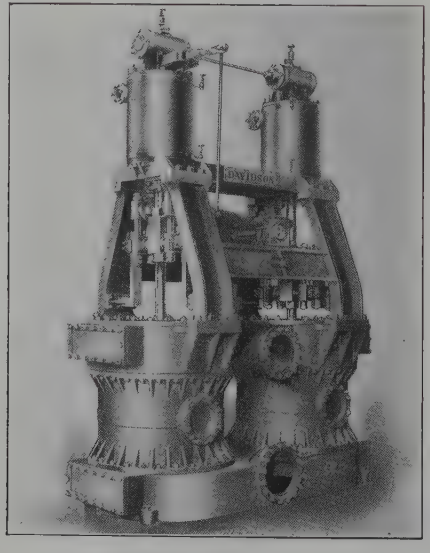




Open Front Type



Pot Valve Type



"Davidson" Twin Beam Air Pump

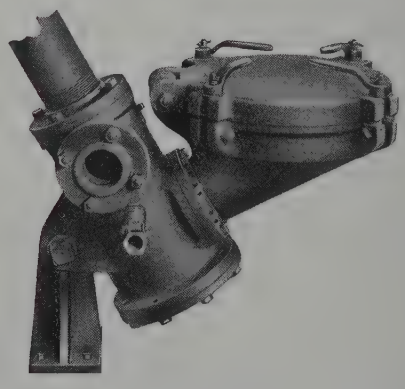
TABLE OF DIMENSIONS

VERTICAL FEED AND FIRE PUMPS

Steam Cyl.	Water Cyl.	Stroke	Steam Pipe	Exhaust Pipe	Suction Pipe	Disch. Pipe	A	B	C
8"	5"	12"	1"	1¼"	3"	2"	6' 8"	22"	19"
8"	5"	16"	1"	1¼"	3"	2"	8' 0"	22"	19"
9"	6"	12"	1"	1¼"	4"	3"	6' 10"	27"	22"
9"	6"	18"	1"	1¼"	4"	3"	8' 8"	27"	22"
10"	7"	12"	1"	1½"	5"	4"	7' 4"	31"	24"
10"	7"	18"	1"	1½"	5"	4"	9' 0"	31"	24"
10"	7"	24"	1"	1½"	5"	4"	10' 10"	31"	24"
12"	8"	18"	1½"	2"	6"	5"	9' 9"	33"	28"
12"	8"	24"	1½"	2"	6"	5"	11' 6"	33"	28"
13"	9"	18"	1½"	2"	7"	6"	10' 0"	34"	30"
13"	9"	24"	1½"	2"	7"	6"	11' 10"	34"	30"
14"	10"	24"	2"	2½"	8"	6"	12' 2"	37"	54"

VERTICAL TANK, BILGE AND BALLAST PUMPS

6"	5"	12"	¾"	1"	3½"	3½"	5' 10"	18¼"	18"
6"	5"	18"	¾"	1"	3½"	3½"	7' 4"	18¼"	18"
6"	6"	12"	¾"	1"	4"	4"	6' 4"	22"	15½"
6"	6"	18"	¾"	1"	4"	4"	7' 10"	22"	15½"
7"	7"	12"	¾"	1"	5"	5"	6' 7"	25"	17¾"
7"	7"	18"	¾"	1"	5"	5"	8' 3"	25"	17¾"
8"	8"	12"	1"	1¼"	6"	6"	7' 0"	28"	21"
8"	8"	18"	1"	1¼"	6"	6"	8' 8"	28"	21"
9"	9"	12"	1"	1¼"	6"	6"	7' 4"	31"	30"
9"	9"	18"	1"	1¼"	6"	6"	8' 10"	31"	30"
10"	10"	12"	1"	1½"	6"	6"	7' 6"	33"	32"
10"	10"	18"	1"	1½"	6"	6"	9' 0"	33"	32"
12"	12"	12"	1½"	2"	8"	8"	7' 11"	36"	32"
12"	12"	18"	1½"	2"	8	8"	9' 8"	36"	32"
14"	14"	12"	1½"	2"	10"	10"	9' 0"	41"	41½"
14"	14"	18"	1½"	2"	10"	10"	10' 6"	41"	41½"
14"	14"	24"	1½"	2"	10"	10"	12' 0"	41"	41½"

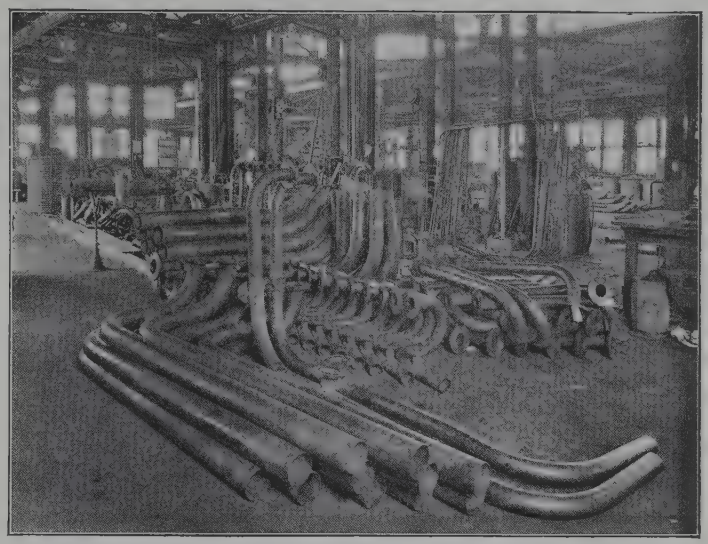


"Davidson" Hydraulic Ash Ejector. Sizes 4½" and 6".

M. T. DAVIDSON COMPANY
154 NASSAU STREET, NEW YORK

Marine Piping

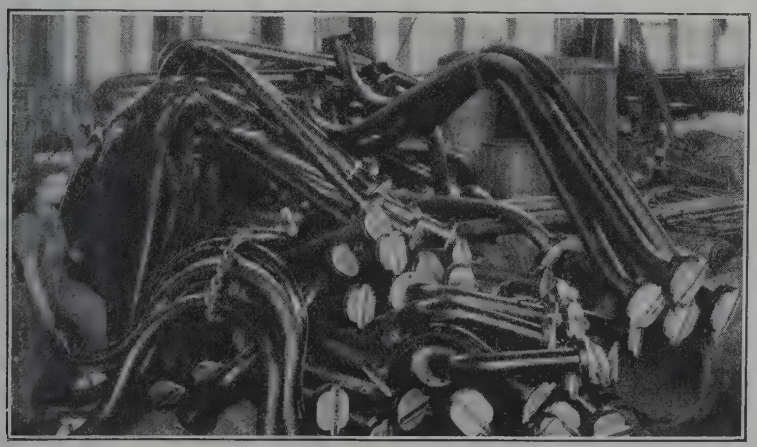
The Whitlock Coil Pipe Company furnishes high pressure flanged and bent piping for superheated and saturated steam, bent and flanged ballast and bilge piping, Van Stone and Whitlock reinforced lap piping joints, welded pipe work, and bends of steel and copper pipe and tubing for all purposes.



Portion of Orders for Bent Piping for Emergency Fleet Corp.

Recommendations for Joints and Bends

For low pressure work and where initial cost is a deciding factor, screwed flange joints are used. This is the cheapest joint of the rigid type; that is, where the flange is fixed to the pipe end and cannot be rotated, the packing lying between the flanges and not between the pipe ends.



Portion of Orders for Bent Piping for Emergency Fleet Corp.

On medium pressure lines, the joint should ordinarily be of the Van Stone type with extra heavy cast iron or standard rolled steel flanges. This type of joint is made by flaring out the pipe end into a single lap and providing a separate swiveling flange which can be rotated to align the bolt holes. This type facilitates erection, eliminates strains, and prevents leaks between pipe and flange.

For high pressures or steam lines with superheat, the Whitlock double lap joint is especially suitable. In this type of joint the pipe is rolled out and then in again forming what is actually a double lap from the original metal of the pipe itself. This doubling of the metal in the lap insures the lap being more than half again as thick as the wall of the pipe, which adds more than 50 per cent to the strength against a dishing strain over any of the Van Stone joints. This joint has proved to be perfectly satisfactory in use under the most trying conditions.

Recommendations for bending dimensions are given in the table below.

The Whitlock Coil Pipe Company also manufactures Welded Steam Headers, Marine Feed Water Heaters, Evaporators, Distillers, Surface Condensers, Fuel Oil Heaters and Oil Coolers.

Correspondence on these products is solicited and all details of types, sizes and recommendations will be sent on request.

DIMENSIONS FOR PIPE BENDS IN IRON OR STEEL PIPE

Nominal Size of Pipe—inches	3	3½	4	4½	5	6	7	8	9	10	12	14	16	18	20	22	24
Smallest Advisable Radius—inches	12	13	15	17	20	23	26	30	36	42	48	60	70	80	90	100	110
Developed Length of 90° Bend on above Radius—inches	19	20½	23½	27	31½	36	41	47½	57	66	75½	94½	110	126	142	157	173
Smallest advisable Radius for Expansion Bends—inches	18	21	24	27	30	36	48	54	60	72	84	112	128	144	.....	.....	.....
Developed Length of 90° Bend on above Radius—inches	28½	33	38	42½	47½	57	75½	85	94½	114	133	177	202	227	.....	.....	.....
Shortest length ends for flanging—ins.	3	3½	3½	4	4	4	5	5	5	6	6	7	7	7	8	8	8

NOTES—The radii given are to the center of the pipe.
Radii can be reduced below those given by the use of extra heavy pipe.
Under usual circumstances steel can be bent to a smaller radius than iron pipe.

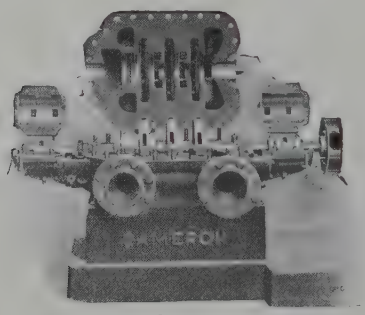
Centrifugal and Reciprocating Pumps

Centrifugal Pumps, General

Cameron Centrifugal Pumps are manufactured in many styles and a wide range of sizes and it is possible to select a pump to suit nearly every requirement and for any class of service. Every operation in the Cameron System, from the temperature test of metals to packing for shipment, is performed with that degree of thoughful attention to detail and mechanical precision which has given Cameron Service its enviable reputation.

Features of Design

Kingsbury Thrust Bearings or special hydraulic balancing devices are a standard part of the equipment of all multistage pumps and act as a perfect counter to all shaft thrust. Double suction single stage pumps are regularly furnished with self aligning bearings of approved design, and the larger sizes, working against high pressures, can be fitted upon special order with the Kingsbury Bearing. Double wearing rings around the impeller hubs give assurance of a tight joint at all times and they are easily and cheaply renewable.



Multi-stage Centrifugal Pump, Showing Casing Open

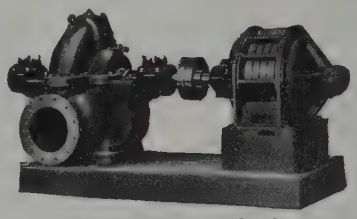
Description

Class DV Pumps—Horizontal, single stage, double suction volute, centrifugal pumps arranged for electric motor, steam engine, steam turbine or other form of direct drive and with pulley for belt drive. Capacities 88 to 20600 G.P.M. against heads from 10 to 230 feet.

Class FV Pumps—Horizontal, single stage, double suction volute, centrifugal pumps arranged for electric motor, steam engine, steam turbine or other form of direct drive and with pulley for belt drive. Capacities from 605 to 20800 G.P.M. against heads from 10 to 150 feet.

Class SV Pumps—Horizontal, single stage, single suction, open impeller, volute pumps arranged for belt drive. Capacities from 15 to 6200 G.P.M. against heads from 10 to 70 feet.

Class MT Pumps — Horizontal, single suction, multistage, turbine pumps, arranged for electric motor, steam engines, steam turbine or other form of direct drive and with pulley for belt drive. Capacities from 125 to 2425 G.P.M. against heads from 45 to 230 feet per stage. Built in two to five stages inclusive.



Double Suction, Single Stage Centrifugal Pump, Motor Driven

Class ST Pumps—Horizontal, single suction, multistage turbine pumps arranged for electric motor, steam engine, steam turbine or other forms of direct drive and with pulley for belt drive. Capacities from 125 to 2425 G.P.M. against heads from 45 to 230 feet per stage. Built in two to five stages inclusive.

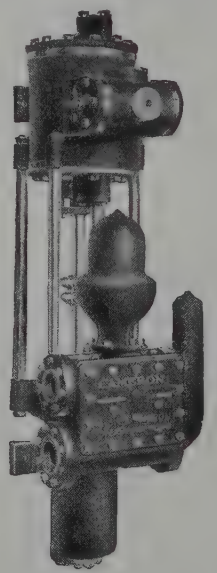
Class BT Pumps—Horizontal, single suction, three and four stage turbine pumps for direct connection to steam turbine, electric motor or other high speed drivers. Capacities 400 to 550 G.P.M. against heads from 150 to 250 lbs. per sq. in.

Reciprocating Marine Pump

These pumps are manufactured for either light service or boiler feed service and have capacities from 18 to 700 G.P.M. They are very simply designed, with no outside valve gear and extremely few parts and exhibit exceptional strength and rigidity in service.

Send for the following bulletins:

7204—Cameron Reciprocating Pumps.
7250—Cameron Double Suction Volute Pumps.
7152—Cameron Single Suction Volute Pumps.
7205—Cameron Marine Pumps.
7351—Cameron Multi-stage Pumps.

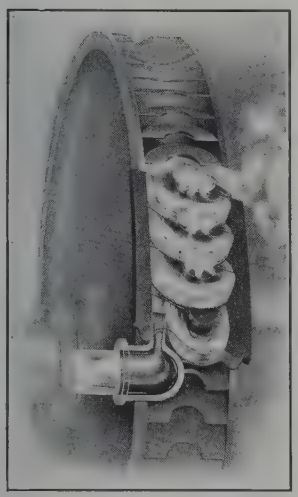


Vertical Reciprocating Marine Pump

Steam Turbines

Principle of Operation of Terry Turbine

The Terry principle of operation makes use of but a single solid wheel with internal protected integral buckets. The steam enters an expanding nozzle, as shown in the illustration below, from which it issues at high velocity, striking the side of the wheel bucket, in which its direction is reversed 180 degrees. It is then caught by the reversing chamber and returned again and again to the wheel until all of the available energy is exhausted. As bucket erosion does not alter the angle at which steam enters or leaves the wheel, this type of turbine will maintain its original efficiency for a great many years.



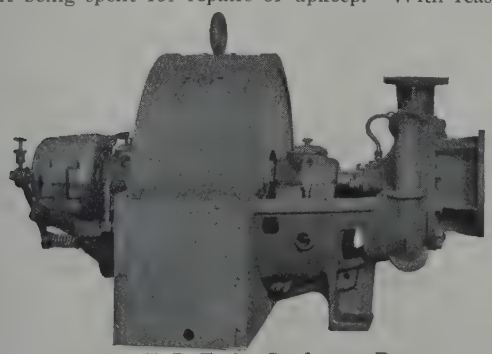
Action of Steam in Terry Wheel

Advantages of Terry Turbine Drive

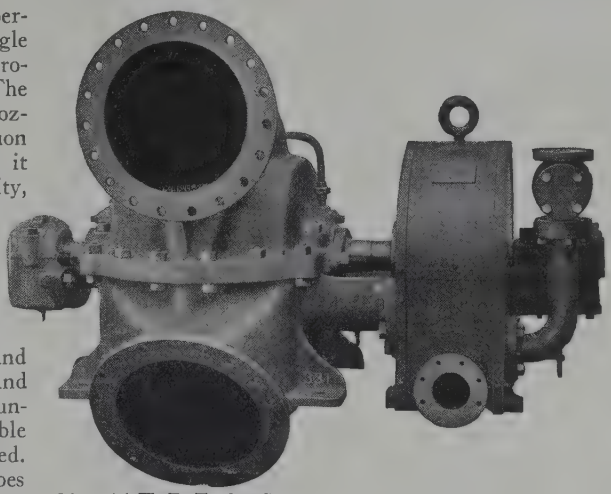
In marine service particularly, dependability, simplicity and light but rugged construction are prime requisites for satisfactory and efficient operation. The many distinctive features and advantages of Terry turbines assure their meeting these requirements to an exceptional degree.

Alignment is maintained by sturdy design of casing and supporting feet, low location of pipe connections, small temperature changes as the casing is subject to exhaust pressures and temperatures only, and operating speeds well below critical speeds.

Accessibility is obtained by the horizontally split casing, bearing, glands, etc., permitting inspection and repair without disturbing steam or exhaust connections which are located on the lower half. Economical operation at partial loads is obtained by individual nozzle control. The low upkeep cost of Terry Turbines has been proved by their records both at land and sea. Many Terrys have operated for years without one cent being spent for repairs or upkeep. With reasonable attention to lubrication there is practically no deteriorating wear. The few parts which are subject to wear are made interchanegable and kept in stock for immediate shipment.



3 to 25 H. P. Turbo Condensate Pump

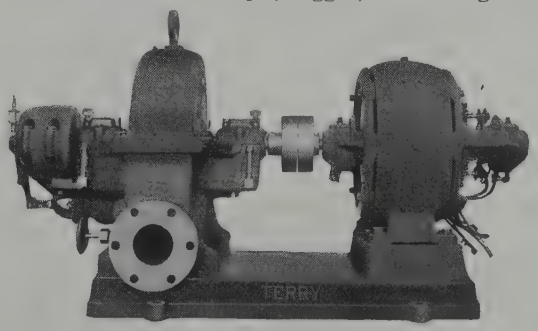


25 to 75 H. P. Turbo Condenser Circulating Pump Used on Destroyers of the United States Navy

Wide Applications in Marine Service

Because of its intrinsic values the Terry Turbine is admirably adapted for a variety of marine services.

For condensate pump drive. Built in many sizes especially for marine work. A simple, rugged, two-bearing unit with three-point support, with all parts readily accessible.



Terry Turbo Generator

For lighting and power on ships and shipyards. Terry Turbo Generators are built in sizes up to 750 kw. Geared or direct connected, A. C. or D. C.

The special advantages are: It occupies small space, is free from vibration permitting installation on light foundations, requires very little attention, it does not require packing, and uses very little oil. High superheat is beneficial to its operation and its exhaust steam is clean.

For condenser circulation. Built in all sizes required for marine work. Geared or direct connected.

Other Uses: Terry turbine drive is also adaptable to other marine services, such as ballast pumps, dredging pumps, blowers for forced draft or ventilation, etc.

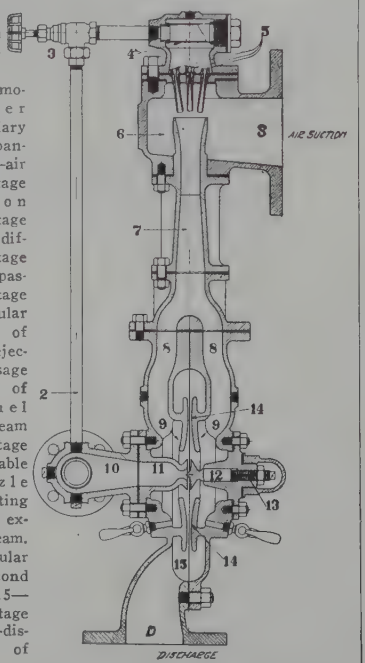
Condensing Equipment

Marine Engineering Service

During a long, practical experience in the manufacturing of condensing equipments for marine service, the C. H. Wheeler Manufacturing Company, Philadelphia, Pa., have developed a complete range of condensers and pumps, noted for reliability in service, and economy of space and weight demanded for this service. The plant of the C. H. Wheeler Manufacturing Company is equipped with the most up-to-date machine tools and facilities, permitting the largest size condensers and pumps to be machined, assembled and tested within the Works. Offices conveniently located in Philadelphia, New York, Boston, Chicago, Pittsburgh, Seattle, Charlotte, San Francisco and New Orleans are prepared to offer prompt service in solving marine condensing equipment problems of any nature.

Radojet Air Ejector Advantages

The Radojet Air Pump represents the highest development in vacuum producing apparatus. It has no moving parts, its weight and space are particularly small, requiring no foundation, and its efficiency is high and does not change after long periods of operation. It does not require lubrication or attention during operation, and its mechanical simplicity and ruggedness make it an ideal adjunct to any condenser installation. It is, moreover, quick in starting, and noiseless and safe in operation.

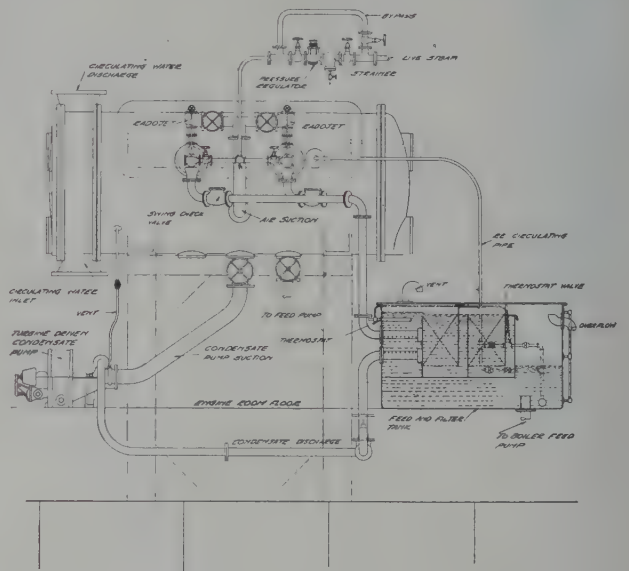


2—steam pipe to auxiliary steam nozzle. 3—auxiliary steam valve. 4—auxiliary steam monel metal strainer screen. 5—auxiliary steam bronze expansion nozzles. S—air suction to first stage ejector. 6—suction chamber of first stage ejector. 7—bronze diffuser from first stage ejector. 8—double passage to second stage of ejector. 9—annular suction chamber of second stage of ejector. 10—steam passage to second stage of ejector. 11—monel metal annular steam nozzle at second stage ejector. 12—adjustable special steel nozzle point. 13—adjusting screw to change expansion ratio of steam. 14—bronze annular diffuser from second stage of ejector. 15—casing of second stage of ejector. D—discharge opening of ejector.

Cross-section of Radojet

Radojet Air Ejector Design

The principal characteristic of the Radojet is the use of steam jets for the removal of air, and its particular feature is the special arrangement of the second stage in which a radial jet is used with a nozzle that may be adjusted from the outside. These special features, shown in the cross sectional view below, provide better efficiencies by increasing the penetrating force and entrainment surface of the jet, and by making possible the adjustment of the expansion ratio of the live steam without changing the steam consumption.



Typical Arrangement of Radojet Installation

Radojet Air Ejector Installations

Complete Radojet installations may be furnished with either centrifugal or direct acting duplex condensate pumps, and for either turbine or reciprocating propelling units. A typical arrangement is shown above with C. H. Wheeler marine type surface condenser, Radojet Vacuum Pump, and Centrifugal Condensate Pump. The many special features include pressure regulator on the steam line to the Radojet, check valve on Radojet discharge line, vent pipe from condensate pump to condenser, and re-circulating pipe controlled by thermostatic valve preventing the boiling of the feed water.

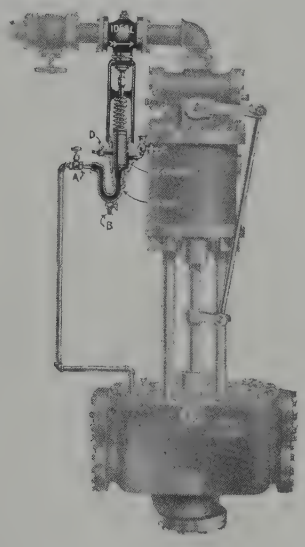
Other Engine Room Equipment

Besides the complete Radojet Condensing equipments described above for use with "wet and dry" systems, the C. H. Wheeler Manufacturing Company furnish complete condensing equipment with Rotrex positive displacement pumps for "wet" systems, jet condensing equipment for use on vessels to be used in fresh water, complete auxiliary condenser sets with combined circulating and vacuum pumps, and specially designed turbine, motor or engine driven circulating pumps, turbine or motor driven or duplex condensate pumps, automatic temperature and steam pressure regulators and steam strainers.

The "Ideal" Automatic Governor

The "Ideal" Automatic Governor is an oil-controlled, piston-actuated pressure controlling valve for governing pumps for salt or fresh water, oil, ammonia, air, etc. It is made in several styles for use both where the pressure desired from the pump is fixed, and where it is necessary that the pressure be variable. The material used in the construction of these governors for high duty service is Navy Composition Bronze or steel. For less exacting service steam composition or cast iron may be used.

The governor is extremely sensitive, with a patented exclusive feature of an oil body in the hydraulic pressure cylinder, against the lower head of the hydraulic pressure actuated piston. This body of oil prevents the liquid being pumped, from reaching the hydraulic pressure cylinder, and thus prevents any sticking of the piston due to corrosion, or to sediment in the liquid being pumped. The oil constantly bathes the cylinder walls, piston and packing in lubricant.

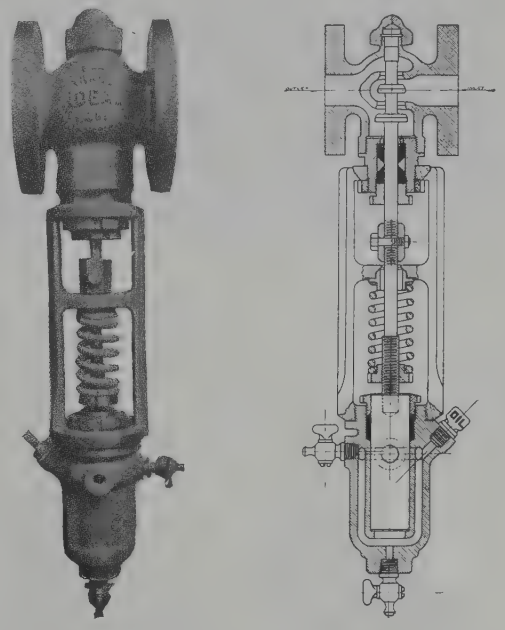


Style "A" Ideal Automatic Pump Governor Installed

Installation and Operation

The illustration shows the correct method of installing a Style A (fixed pressure) "Ideal" Automatic Pump Governor. The governor is placed in the steam line between the throttle and the pump, as close to the pump steam chest as possible, with the arrow following the direction of flow of steam to the pump. The governor must invariably hang vertically, with steam valve up, and pressure cylinder, oil trap, etc., down.

To charge oil trap and cylinder: shut cut-off valve A, open drain cock B, oil cup C, and vent cock D. When trap is drained, shut drain cock B, fill with heavy bodied mineral cylinder oil through oil cup C until oil shows at vent cock D, close vent cock D, oil cup C, open cut-off valve A and the governor is in working order.



Style "A" Ideal Automatic Governor

Style A "Ideal" Automatic

Style A "Ideal" Automatic Governor is of the constant pressure type, and is suitable for controlling pumps for salt and fresh water, oil, ammonia, air and other liquids and gases. It has been approved and adopted by the National Board of Supervising Inspectors of Steam Vessels, and by the United States Navy. On board ship it may be used on salt water fire pumps, salt water sanitary pumps, boiler feed water pumps, clutch pumps, bulkhead collision door pumps, fresh water pumps, hydraulic pumps, ash pumps, forced feed lubricating pumps, ammonia compressors, air compressors, etc., etc. For shipyard use, it is adapted to the control of automatic fire sprinkling system pumps, turbine step-bearing pumps, hydraulic pumps, fire engines, ammonia, gas, and air compressors, hydraulic rams, or in fact any apparatus requiring sensitive, reliable automatic pressure control of water, steam or pneumatic power.

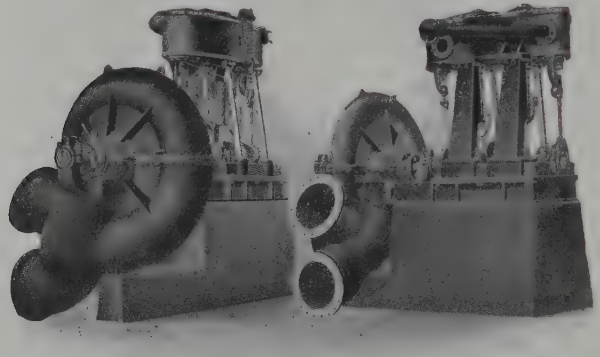
IDEAL AUTOMATIC GOVERNOR COMPANY, INC.

164 EMMET STREET, NEWARK, N. J.

The Morris Circulating Pump Erecting Shop

Engine Driven Circulating Pumping Units

Morris Engine Driven Circulating Pumps are particularly well adapted for use in circulating water through condensers on board ship as they are self-contained, take up little space, and are economical. These pump units can be furnished in any quantity for any duty requirements, and



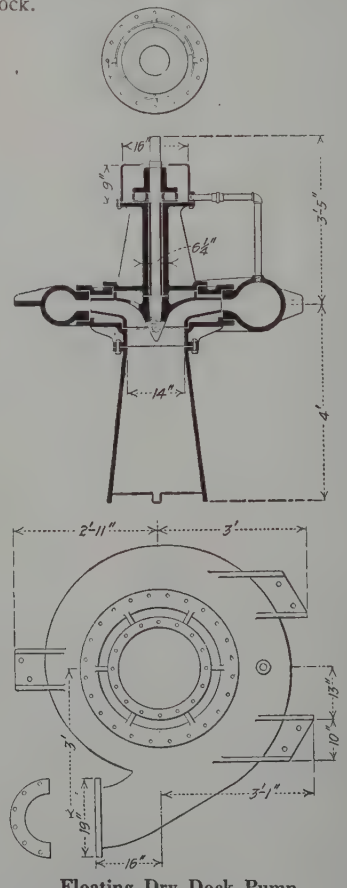
20″ Bronze Double Suction Circulating Pumps direct connected to 10 & 20 x 10 Compound Engines

include both pump and engine, the pump being either side or double suction, horizontally or vertically split, and the engine single cylinder, compound or triple expansion. All necessary equipment furnished.

Morris Circulating Pumps have been supplied to shipyards all over the country, one prominent shipbuilder having bought 75-14 inch double suction 12 x 10 units.

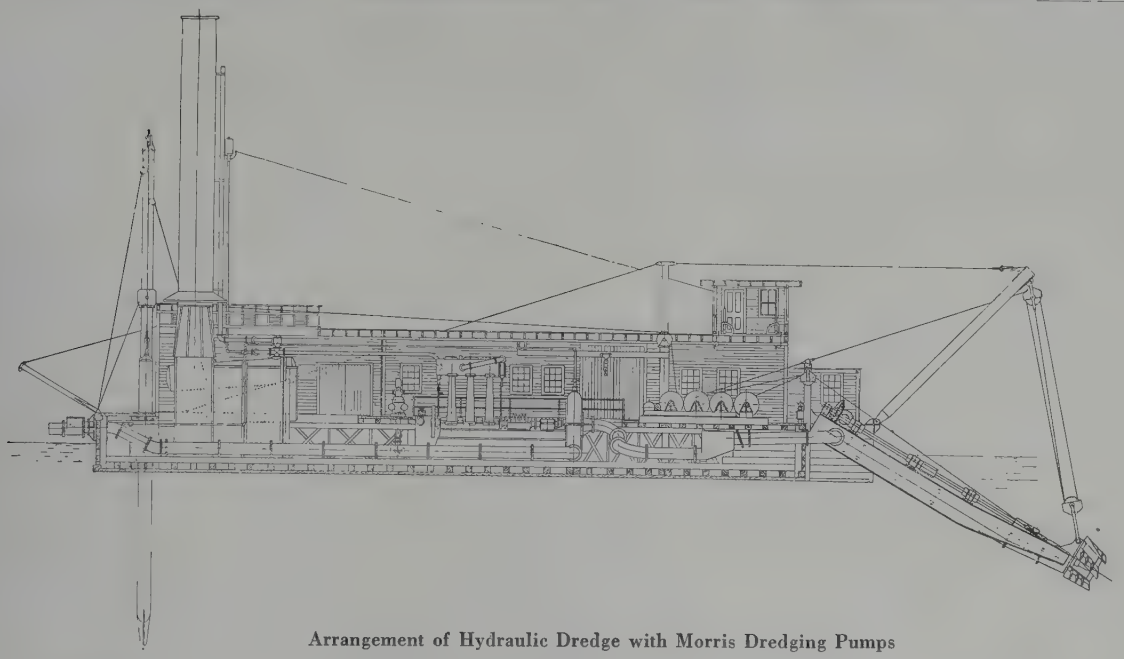
Dry Dock Pumps

Morris Vertical Centrifugal Pumps for Dry Dock service can be furnished to meet any special requirements, and a long and extremely varied experience in building pumps of this type assures the successful handling of drydock pumping problems. The Morris Machine Works have furnished the pumping equipment for the Emergency Fleet Docks at Savannah, Charleston, Beaumont and Jacksonville, the Bethlehem Dock at Sparrow's Point, and numerous other docks including the famous Dewey Floating Dock.



Floating Dry Dock Pump

Dredges, Dredging Pumps, Marine Engines



Arrangement of Hydraulic Dredge with Morris Dredging Pumps

Dredges and Dredging Pumps

Morris Dredges and Dredging Pumps are standard throughout the country and have conclusively demonstrated their complete fitness for the exceptionally severe service required of equipment of this type. The pumps are usually furnished in 12 inch, 15 inch, 18 inch or 20 inch sizes, and will handle 10 to 15 per cent solids in average dredging, delivering the material to be deposited at distances upwards of a mile away. By using pumps in relays, it is possible to deliver the material at any distance or elevation. They can be arranged for either steam, electric or belt drive as desired, and complete dredges, including the hull and all machinery, can be furnished.

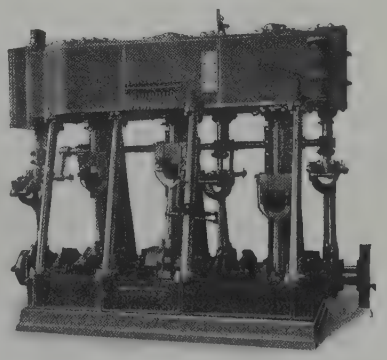
Advantages

Morris Dredging Pumps have proved to be most economical in handling sand, gravel, silt, mud, clay, loam, etc.: in fact they can be used in all classes of material except solid rock.

In contrast to other types of dredges, the hydraulic dredge, equipped with centrifugal pumps, not only dredges the material, but also delivers it to the exact point desired as regards distance and height, all in one operation. Dredges of this type can also be built in capacities far exceeding those of any other kind, and Morris Dredging Pumps have handled over 3000 cubic yards of material per hour on Government dredges in the Mississippi River.

Features of Construction

The Morris Dredging Pump is properly designed and built to stand the wear due to the material passing through, and at the same time have a good efficiency. The pump casing is particularly heavy, with extra metal provided in such parts as are most subject to wear. Cast iron, manganese or carbon steel is used, lined or unlined as best suited to the material handled. The impeller is of the enclosed type for efficiency, and is provided with ample spaces between vanes to permit handling stones. Stuffing boxes are protected from the action of the material handled by water seal and many other distinctive features combine to make a durable and efficient unit.



800 H.P. Triple Expansion Marine Engine

Marine Engines

The Morris Machine Works also builds steam engines for all purposes in sizes from 1 1/2 H. P. to 1000 H. P. These can be furnished simple, compound or triple expansion for either stationary or marine use. Morris Marine Engines are of the best construction throughout, properly designed and carefully built, and are furnished complete with all necessary fittings.

MORRIS MACHINE WORKS, BALDWINSVILLE, N. Y.

Rotating Plunger Pumps

Applications

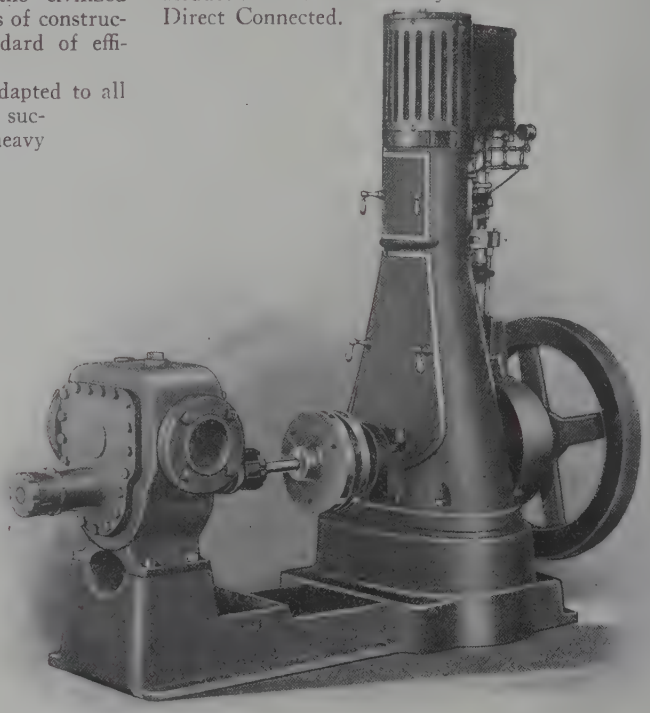
The Kinney rotating plunger pump is manufactured by the Kinney Manufacturing Company of Boston, Massachusetts. It is protected by letters patent in all parts of the civilized world. It has been perfected in all details of construction, resulting in the present high standard of efficiency.

Due to its great range of speed, it is adapted to all kinds of drive. It is extensively and successfully used in pumping all grades of heavy viscous material, such as molasses, asphalts, heavy Mexican crude oils, glucose, soap stocks, as well as the lightest and most volatile liquids. Owing to its flexibility in speed, as well as the variety of materials it is adapted to handle, it is particularly adapted for marine use, for fuel oil burners, in lubricating oil systems, and also for cargo pumps. It has been successfully tried out under most trying conditions on all the above mentioned liquids.

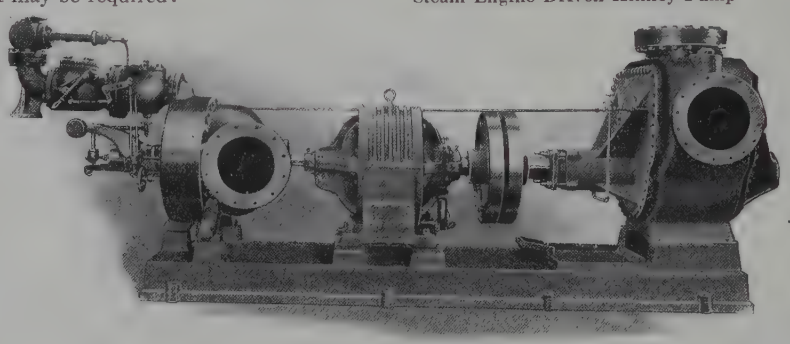
Capacities and Methods of Drive

It can be directly coupled to any type of prime mover as shown in the accompanying illustrations, providing the same operates at the correct speed for the pump which may also be driven through gears. The pump may be built in sizes that may be required: at the present time the sizes range from 1 GPM to 5,000 GPM.

Technical data such as the capacities, net weights, dimensions, etc., are shown on these pages for the Kinney Turbine Driven Pump with Turbo Type Speed Reduction and the Kinney Turbine Driven Pump Direct Connected.

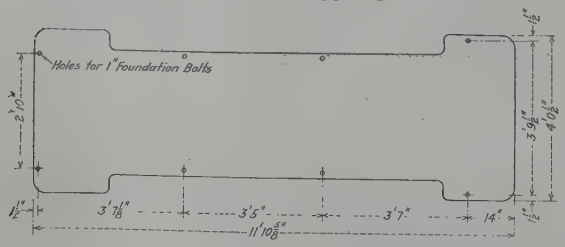


Steam Engine Driven Kinney Pump



Turbine Driven Kinney Pump-Turbo Type Speed Reduction

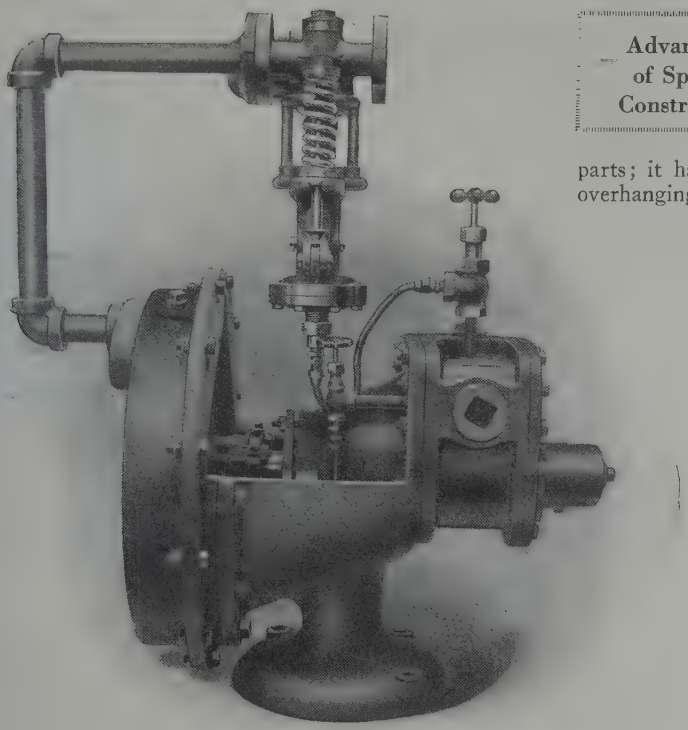
PLAN OF BEDPLATE
Turbine Driven Pump-Turbo Type Speed Reduction.



DATA TABLE
Turbine Driven Pump-Turbo Type Speed Reduction.

Size Number	25-13-22
Capacity	4000 GPM
Net Weight	21700 Pounds
Size of Pump Inlet	14 Inches
Size of Pump Outlet	3½ Inches
Size of Steam Inlet	3½ Inches
Size of Steam Outlet	12 Inches
Overall Length	14 Feet, 7 Inches
Overall Height	5 Feet, 10 Inches

Rotating Plunger Pumps



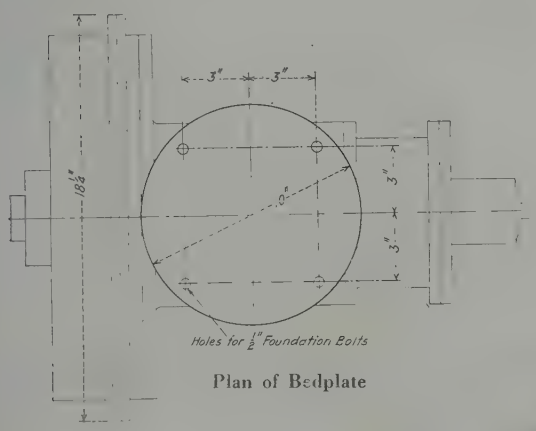
Kinney Turbine Driven Pump—Direct Connected

Advantages of Special Construction

One of the most important features of the Kinney Pump is its supreme simplicity of construction and directness of operation. The pump consists of a cylinder and four working parts; it has no valves, lobes, gears, internal springs, overhanging valves, intermeshing cogs, or other complicated parts. The Kinney Pump is distinctly different from any other type of pump in its principle of construction.

Its action is positive and direct, both as to suction and discharge. The action being positive, the pump does not depend on high speed for its successful results.

The standard of efficiency of the Kinney pump is very high, both volumetric and mechanical. Its efficiency is further demonstrated by its high vacuum capacity and by its capability of discharging against high pressures and high temperatures. Its action is free from pulsation, unevenness or reversal of flow and consequent impulse losses. It is provided with liberal size port openings, making it particularly desirable for pumping viscous materials.



Plan of Bedplate

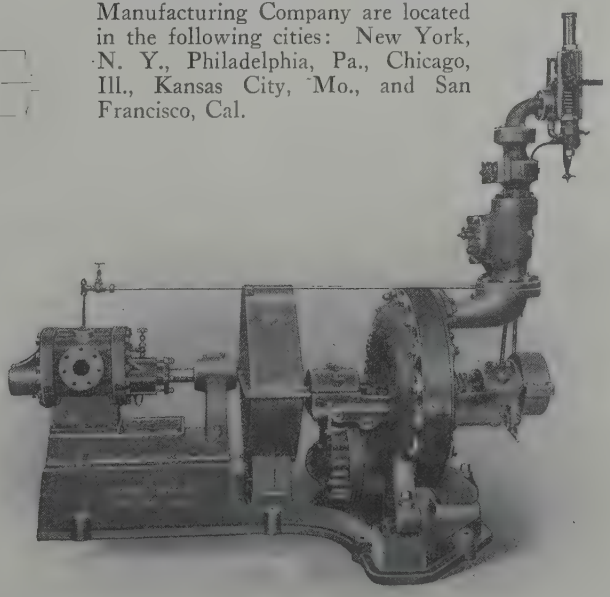
Products

The products of the Kinney Manufacturing Company are Rotating Plunger Type Steam Jacketed Pumps, Turbine Driven Pumps, Gasoline Engine Driven Pumps, Electrically Driven Pumps, Belt Driven Pumps and Strainers.

Branch offices of The Kinney Manufacturing Company are located in the following cities: New York, N. Y., Philadelphia, Pa., Chicago, Ill., Kansas City, Mo., and San Francisco, Cal.

DATA TABLE.
Turbine Driven Pump-Direct Connected.

Size Number	411
Capacity	4000 G.P.M.
Net Weight	275 Pounds
Size of Pump Inlet	1 Inch
Size of Pump Outlet	1 Inch
Size of Steam Inlet	¾ Inch
Size of Steam Outlet	2 inches
Overall Length	26½ Inches
Overall Height	30½ Inches



Kinney Turbine Drive Pump—Gear Connected

THE KINNEY MANUFACTURING CO.

3529-3541 WASHINGTON ST., JAMAICA PLAIN STATION, BOSTON, MASS.

Products

Hand and power pumps for all uses, including single and double acting triplex and horizontal power pumps for various services; deep well power working heads; artesian well cylinders; complete hydro-pneumatic water systems; tank pumps; bilge pumps; rotary pumps; hydraulic rams; spray pumps, nozzles and accessories.

Agencies

Complete stocks are carried by distributing houses in the principal cities of the country. A partial list containing the names of the distributors in the leading shipping centers follows:

Chicago: Henion and Hubbell.
Pittsburgh: Harris Pump & Supply Co.
New York: Ralph B. Carter Co., 152 Chambers St.
Boston: Charles J. Jager Co., 15 Custom House St.
Providence House, 33 Canal St.
Philadelphia: W. P. Dallett Co., 922-924 Sansom St.
Buffalo: Root, Neal & Co., 178 Main St.
Detroit: Kerr Machinery Corporation.
New Orleans: Stauffer, Eshleman & Co.
San Francisco: Crane Co., 301 Brannan St.
Los Angeles: R. W. Sparling

Information Required for Estimate

Compiled with especial reference to our triplex power pumps and power deep well working heads.

1. For what purpose the pump is to be used. 2. The maximum quantity to be pumped per minute, hour or day of 24 hours. 3. To what height the liquid is to be lifted by suction and the diameter and length of the suction pipe. 4. The height or pressure against which the liquid is to be discharged. 5. Diameter and length of the discharge pipe. 6. Whether the liquid to be pumped is hot or cold, salt or fresh, acid or clear, thick or gritty. 7. Power available for driving the pump. 8. If electric motor, state whether current is direct or altenating; if direct, give voltage; if alternating, state voltage, cycle and phase. 9. Advise if pump is to be driven by belt from motor, or to have same direct connected by gearing or otherwise.

All Deming Pumps are guaranteed to perform the duty for which they are rated. We hold ourselves to supply free any part of our power pumps and working heads, breaking within one year from date of shipment, when such breakage bears unmistakable evidence of faulty material or workmanship.

Catalogs and Bulletins

General Catalog No. 26—Descriptive of our general line of hand, windmill and small power pumps. 256 pages.

Individual Bulletins — Descriptive of our triplex power pumps, deep well working heads, etc. 24 to 48 pages, each.

Catalog of Complete Hydro-Pneumatic Water Systems. 48 pages.

Catalog of Spray Pumps, Nozzles and Accessories. 40 Pages.

Deming Hand Tank Fire Protector, Fig. 1668

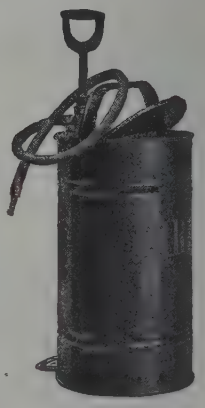


Fig. 1668

Many thousands of these Deming Hand Tank Fire Protectors were supplied to the U. S. Government. The outfit consists of a substantial, all brass, double acting pump, mounted on a five gallon galvanized iron tank. The outside of the tank is protected by two coats of red paint, and the inside by a special, non-corrosive enamel, according to Government specifications. Tank has hinged cover and handle for carrying. Three minutes of rapid pumping will empty tank. Pump is securely fastened to tank but may be easily removed.

Three feet of ⅜" hose and brass fire nozzle for throwing solid stream are regularly supplied. Weight, boxed, 25 pounds.

Deming "Triumph" "Handy Billy" Pumps

Fig. 602

Deming "Triumph" "Handy Billy" Pumps are particularly adapted for use on vessels, in pumping hot, cold, acid or salt water. Have brass lined cylinder; brass valves and seat, and brass piston rod. Fig. 601 is fitted with a single malleable lever. Fig. 602 has two levers. The No. 4 size has a displacement in excess of 100 cubic inches, thereby more than meeting the requirements of the U. S. Steamboat Inspection Service which calls for one pump of 100 cubic inches capacity on vessels of 200 tons or less and two pumps on vessels over 200 tons. Extreme suction lift should not exceed 25 feet.

Deming "Marine" Bilge Pump, Fig. 470

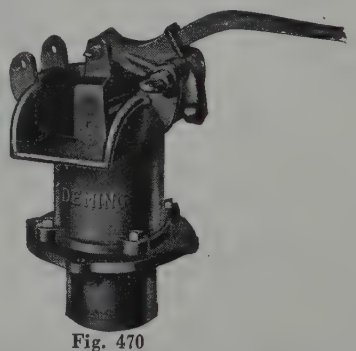


Fig. 470

For raising large quantities of water by hand from the bilge well of vessels, when the water is not over 20 feet vertically from the pump.

Lever is adjustable to any one of three positions. Valves are rubber faced and are extra large to provide ample water way. They may be easily removed for examination or repair.

Deming Triplex Plunger Pump, Fig. 50

The Deming Triplex Plunger Pump, Fig. 50, is an exceptionally good pump for medium service and for general water supply. This pump may be operated by electric motor, gasoline or steam engine, either belt driven or direct connected to driver. It frequently affects a saving of two-thirds the cost of operating direct acting steam pumps.

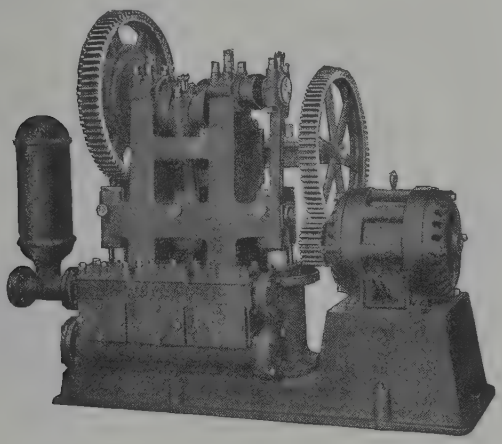


Fig. 50, Size 5½x8 with Type "B" Drive

Type "B" drive consists of intermediate pump gear, rawhide or fibre, motor pinion, and bedplate under both pump and motor, except in the larger sizes which have a separate motor bedplate bolted to the pump base. This type is recommended where the space available for installation is limited, and where some noise due to high speed gearing is not objectionable.

The Frame of the large sizes is made in one casting with guides and crankshaft bearings lined with anti-friction metal. In sizes 4 x 4 and smaller, the frame and cylinder are cast in one piece. Gearing is machine cut, double in sizes 9 x 10 and larger. The Pinion shaft is made of steel running in anti-friction metal bolted to the main housing.

SIZES, CAPACITIES, ETC.

Plungers		Capacity		Maximum working pressure, lbs.	Diam. of Pipes		*Tight and loose pulleys
Diam., inches	Stroke inches	Usual revs. per min.	Gals. per min.		Suction inches	Disch. inches	
2	2	70	5.67	150	1½	1	8x 2
2½	2	70	8.89	150	1½	1	10x 2
2½	3	60	11.4	150	2	1½	12 x3
3	3	60	16.2	150	2	1½	14x 3
3½	3	60	22.	150	2	1½	16x3
3½	4	60	30.	150	2½	2	16x 4
4	4	60	39.	150	2½	2	18x 4
4	6	60	59.	160	2½	2	20x 5
4½	6	60	74.	150	3	2½	20x5
5	6	60	91.	150	3	2½	24x5
5½	8	60	147.	150	4	3	28x 6
6	8	55	161.	140	4	3	30x 6
7	8	55	220.	150	5	4	30x 8
8	8	55	287.	150	5	4	36x 8
8½	8	55	324.	140	6	5	36x 8
9	10	50	413.	160	8	6	42x10
10	10	45	459.	150	8	6	42x12
11	12	42	622.	160	10	8	48x14
12	12	42	740.	150	10	8	48x16
12	14	40	820.	150	12	10	48x18
13	14	40	964.	140	12	10	48x20

*NOTE—Sizes 9 by 10 and larger regularly furnished with tight pulley only.

High Presure Triplex Pump, Fig. 84

High Pressure Triplex Pump, Fig. 84, is built especially for high speed service. The various pressure ratings are given in the table below.

The frame consists of two standards and includes crosshead guides and main crank shaft bearings. The bearings are lined with the best anti-friction metal. The Crank Shaft is made of the best open hearth steel casting in one piece. Gearing is machine cut, and is double in 10-inch stroke and larger sizes. Pinion Shaft is of polished steel, running in bearings lined with best anti-friction metal and bolted to the main frame. Connecting Rods have marine type boxes at the crank end, and bronze boxes with wedge and screw adjustment at the crosshead end.

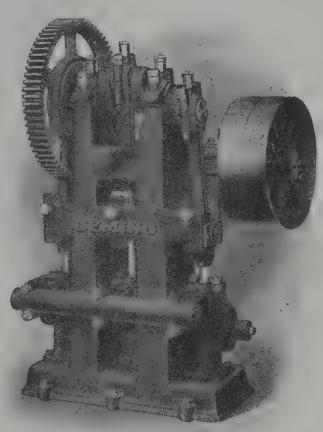


Fig. 84, Sizes 1¼x6 to 2½x6

Type "B" drive is described under Deming Triplex Plunger Pump, Fig. 50, in the opposite column.

FIG. 84. SIZES, CAPACITIES, ETC.

Plungers		Capacity		Maximum working pressure lbs*	Diam. of Pipes		*Tight and loose pulleys
Diam. inches	Stroke inches	Usual revs. per min.	Gals. per min.		Suction inches	Dischg. inches	
⅞	6	50	2.35	5000	1	¾	24x 5
1¼	6	50	4.80	2000	1¼	1	24x 5
1½	6	50	6.90	1500	1¼	1	24x 5
2	6	50	12.25	900	2	1½	24x 5
2¼	6	50	19.15	600	2	1½	24x 5
1	8	45	3.70	5000	1¼	1	28x 6
2	8	45	14.67	1200	2	1½	28x 6
2	8	45	14.67	2500	2	1½	36x 8
2½	8	45	22.95	800	2½	2	28x 6
2½	8	45	22.95	1500	2½	2	36x 8
3	8	45	33.03	500	2½	2	28x 6
3	8	45	33.03	1000	2½	2	36x 8
4	8	45	58.77	600	3	2½	36x 8
5	8	45	91.80	400	4	3	36x 8
1½	10	42	9.70	5000	1½	1¼	42x10
2	10	42	17.13	3750	2½	2	42x10
2½	10	42	26.83	2400	2½	2	42x10
3	10	42	38.55	1500	2½	2	42x10
4	10	42	68.54	900	3	2½	42x10
5	10	42	107.10	600	4	3	42x10
2	12	40	19.60	5500	2½	2	48x14
3	12	40	44.08	2500	3	2½	48x14
4	12	40	78.32	1400	4	3	48x14
5	12	40	122.40	900	5	4	48x14
6	12	40	176.00	600	5	4	48x14
2	14	38	21.66	5500	2½	2	48x10
3	14	38	48.79	2500	4	3	48x16
4	14	38	86.86	1400	4	3	48x16
5	14	38	135.66	900	5	4	48x16
6	14	38	195.39	600	5	4	48x16

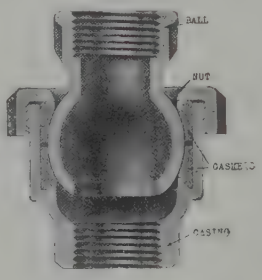
*NOTE—All 10-inch stroke and larger pumps are regularly furnished with tight pulley only.

Barco Flexible Joints

General Description

Barco Flexible Joints — which afford decided advantages for Marine Service — consist of three metallic parts and two non-metallic gaskets which surround the ball and prevent it from coming in contact with the metallic cap and casing.

These gaskets offer a firm resisting seal, somewhat softer than the ball, yet hard enough to keep perfect shape without disintegration, and being softer than the ball conform to its surface, thus assuring absolute tightness under all conditions, while their self lubricating feature insures free and easy movement with minimum wear. The gaskets are renewable at small cost making the joint practically new, or, if as may sometimes happen in Marine Service, new gaskets are not at hand, the bottom gasket may be interchanged with the top one to make the joint tight.



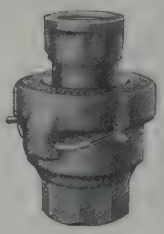
Correct in Principle, Simple and Durable

The construction of the Barco Joint as described above, is mechanically correct in principle, while the marked success of these joints—since their introduction—years ago—in service wherever a flexible connection is demanded for air, steam, oil or water, under pressure or suction, is ample proof of the tightness of the gasket. The "Barco" having been put to every possible test so many times and with such success, they can be put to the severest Marine service with confidence that they will give the utmost satisfaction.

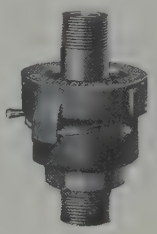
Some Marine Uses of the Barco Joint

Many uses in Marine work for a dependable flexible joint suggest themselves, for example in steamships and engine rooms to take up expansion or vibration in steam lines; for repairing with the use of compressed air where the air line connection must provide for tide, etc.; for loading and unloading oil lighters and barges; for expansion joints in steam lines, and on the steam outlet from the boilers, the Barco is used advantageously due to the vibration of the ship.

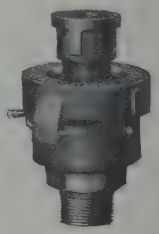
Such are a few of the Marine uses of the Barco Joint. Another is when a ship is out of commission, or being outfitted, or when the fires are out, or the boilers are being repaired and it is desired to heat her from a plant on shore, as in such cases the Barco proves its worth in the steam connection to take care of the tide and the warping.



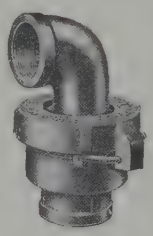
7-8
Straight Joint
Female Ends



7C-8C
Male Joint

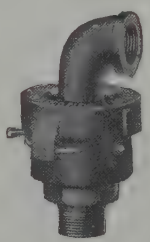


7C-8
Male Hexagon
Female Ball



7-8B
Female Joint
90° Ball

7A-8
Angle Joint

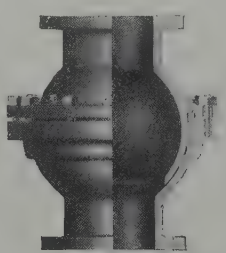


7C-8B
Male Joint
90° Ball

7B-8
Flange Angle
Joint

7A-8B
Angle Joint
Angle Both Ends

7H-8
Square Flange
Joint
Female Ball



Joint 7F

Advantages

Barco Flexible Joints solve the problem of making pipe flexible in Marine work, solve it in the most economical and satisfactory way, as they never leak, and require little or no attention or repair.

Joints are made in all sizes and styles ¼"—36" pipe. Malleable iron (to 4") and Bronze (to 2") are carried in stock regularly. Made for steam pressure of 150 lbs. Price lists, parts lists, dimensions sheets and full particulars about any installation furnished on request.

BARCO MFG. CO., 212 WEST ILLINOIS ST., CHICAGO, ILL.

Ships Ventilators

Ship Ventilators

The usual types of ship ventilators are the "spoon" and "mushroom". In the "spoon" type, the air is caught and forced by the movement of the vessel or the velocity of the wind, into the interior spaces which are to be ventilated. In the "mushroom" type, the air is sucked in.

All types of ventilators in common use are ineffective against the admission of spray, rain or seas under certain conditions. Accordingly various means are adopted for closing off the air duct. These comprise unshipping the ventilator stack, covering the opening with plates, etc.

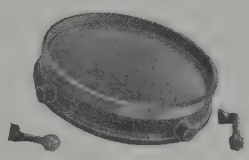
Under these circumstances, spaces designed to be supplied with fresh air are often practically sealed for a long period of time, and the conditions below decks become intolerable. In order to shorten the period during which the ventilated spaces must be sealed, there is a tendency to defer closing off ventilators until such time as to make the storm-swept weather deck a most dangerous place to send seamen to unship stacks and fit covers or hatches.

These operations have often been attended with casualties and the loss of fittings, which leave openings, endangering the safety of the vessel. In order to provide a remedy, covers are sometimes fitted to the duct inside the vessel. Such covers are wet and troublesome, dripping water while in place and deluging the room when opened. They also tend to change the direction and otherwise reduce the air efficiency.

Improved Draft Controlling Ventilator

The Improved Draft Controlling Ventilator catches the air and forces it into the ventilated space. It is a Self-Draining form of ventilator duct cover which is always ready for instant use. It can remain open until conditions become such that it must be closed. It can be opened as soon as weather stress abates. It can be instantly operated from within the vessel. It forms no effective obstruction to air currents, as it stands in a vertical plane when open. Whenever open it is perfectly dry, shedding water into drain above the deck line. It provides an effective catch for air with ventilator stack removed, and a watertight cover for the opening in case the stack is carried away.

Fully Opened

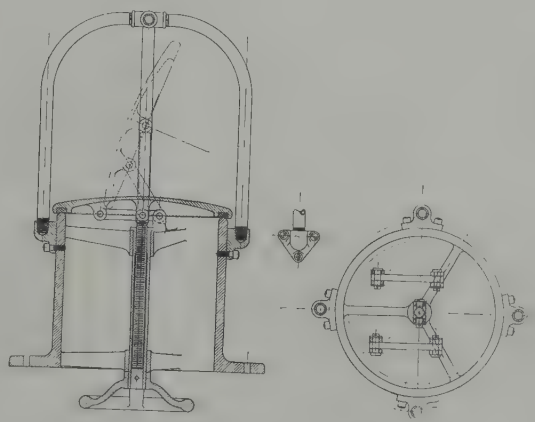


Closed Against Weather
Improved Draft Controlling Ventilator

Partly Opened

Merchant Type Controlling Ventilator

The Merchant Type Improved Draft Controlling Ventilator, as shown in the cross section and plan view, is practically the same in construction and operation as the other types, but it is designed for use without a cowl. The cover can be turned in any direction and at any angle to catch the wind.



Cross Section and Plan View of the Merchant Type
Improved Draft Controlling Ventilator

Standard and Special Sizes

The Improved Draft Controlling Ventilator is made in all the standard sizes of ventilator openings. Special sizes can be made to order. This ventilator can be made in composition and other metals, and fitted to old work as well as new.

AUXILIARY EQUIPMENT COMPANY, INC.
164 EMMET ST., NEWARK, N. J.

Swartwout Standard Cowls

Swartwout Standard Cowl Advantages

Common practice is to turn the metal over wire at the mouth. In the "Swartwout" heavy pipe, slotted and welded into an endless ring, is forced over the cowl-mouth and securely welded. Arched construction and fewer segments make a more rigid and handsome cowl.

The shape of the opening varies little in any section from inlet to neck. Due to care in forming the curves, skin friction is small. Delivery of air is very close to intake, resulting in high efficiency. The elliptical inlet requires minimum room on the ship's deck.

All lap seams are painted before assembling, and the cowl receives one coat of paint before shipping.

There is a great variation in the ideas of designers as to connections of the cowls and the coamings. We have standardized the Cowl Tube which is riveted to the neck of the cowl so as to take a length of coaming tube equal to 1-1/2 times its diameter. This limits the Cowl Tube to a short length, making hand operation easy, as wind resistance is practically eliminated. Handles and locking screw are attached through a band riveted and welded to lower end of the Cowl Tube. This band usually rests on a similar band riveted or welded on the coaming.

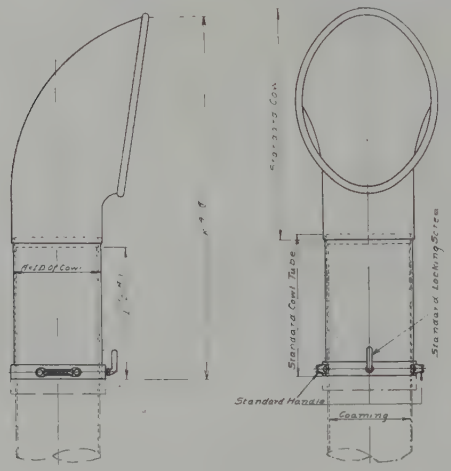
Where the Cowl is necessarily high above the deck, the handles are reached from the top of deck alongside or a ladder is riveted on the coaming.

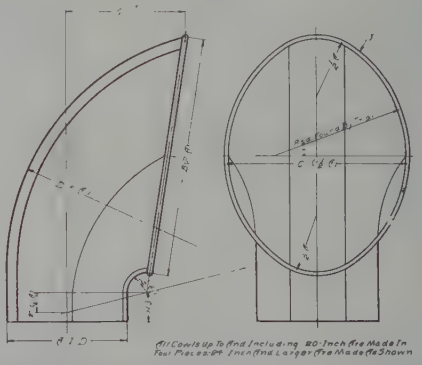
Tubes are riveted or spot-welded to the cowl and band, are made with lap joints, and painted to match the cowl.

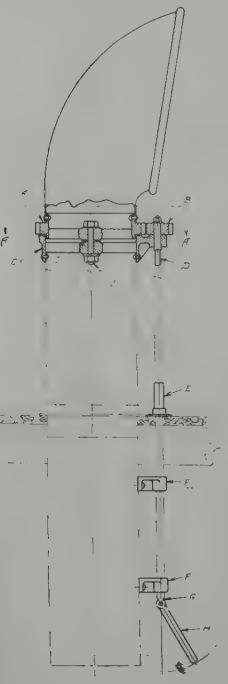
When turning gears are used the Cowl-neck is riveted to upper or gear ring of the gear, and coaming is riveted to lower ring, all parts being machined to fit.

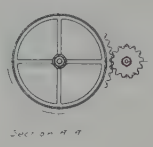
Our engineers studied all the approved designs and, we believe, succeeded in combining all desirable points. Our gears have been approved by the U. S. Shipping Board.

Gears are shipped with pinion shaft, brackets and handle only, leaving pipe shaft (a plain pipe) to be supplied at the place of launching. Ashbucket lift equipment furnished if desired.









PARTS FURNISHED WITH TURNING GEAR

Mark	Name of Parts
A	Inner Ring
B	Pinion
C	Outer Ring
D	Upper Shaft End, Nut, Key and Washer
E	Deck Flange and Coaming Tube
F	Pipe Brackets
G	Lower Pipe Shaft End
H	Handle with Bolt and Nut
I	Bronze Bearing Washer
J	Finished Bolt with Nut and Pin

DIMENSIONS OF SWARTWOUT STANDARD COWLS

A	B	C	D	E	F	G	H	J	K	L	M	U.S.S.
8	16	12	16	1⅜	1⅜	8	12⅝	¼	32	12	9	18
10	20	15	20	1¾	1¾	10	16¼	¼	40	15	11¼	18
12	24	18	24	2	2	12	20	¼	48	18	13½	18
15	30	22½	30	2½	2½	15	25½	⅜	60	22½	16⅞	18
16	32	24	32	2¾	2¾	16	27¼	⅜	64	24	18	18
18	36	27	36	3	3	18	31	1¼	72	27	20¼	18
20	40	30	40	3⅜	3⅜	20	34⅝	½	80	30	22½	18
21	42	31½	42	3½	3½	21	36½	½	84	31½	23⅝	18
24	48	36	48	4	4	24	42½	¾	96	36	27	16
30	60	45	60	5	5	30	53⅛	¾	120	45	33¾	16
36	72	54	72	6	6	36	64¼	1	144	54	40½	14
42	84	63	84	7	7	42	75¼	1¼	168	63	47¼	14
48	96	72	96	8	8	48	86¼	1¼	192	72	54	14

PROPORTION OF PARTS TO SIZE OF COWL

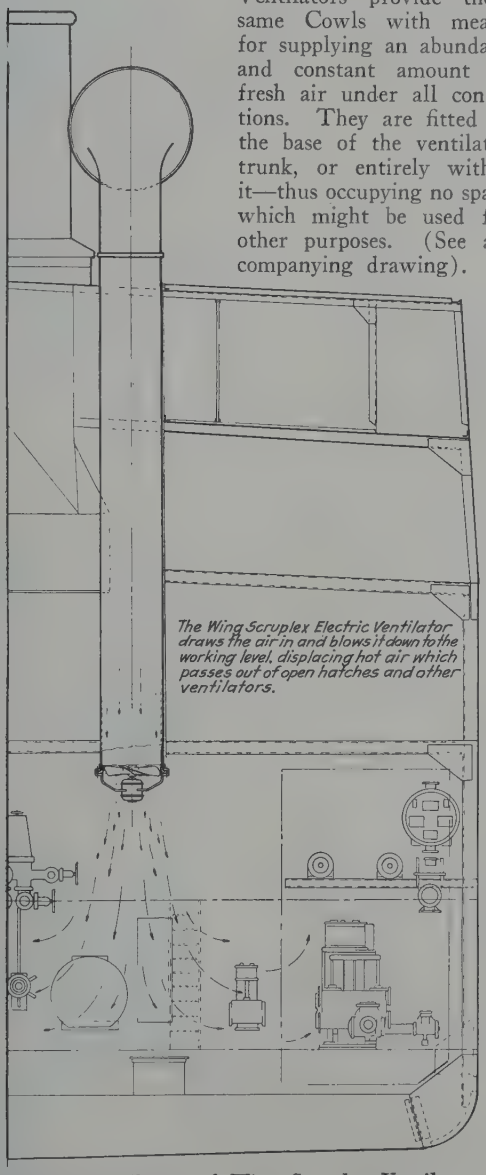
Size of Cowl	B	C	D	E	F	G	H	J	K	L	M
1	2	1½	2	1/6	1/6	1	—	—	4	1½	1⅛

Wing Scruplex Electric Ventilators

Wing Scruplex Ventilators vs. Cowl Ventilators

The amount of fresh air provided by Cowl Ventilators, commonly used for ship ventilation, is dependent entirely upon, the velocity and direction of the wind, and the speed and direction of the vessel. Therefore, it is quite obvious that with a "following wind" or when "hove to" or in port, they frequently fail to function, causing conditions below to become unbearable, and perishable cargoes to rot in the holds.

Wing Scruplex Electric Ventilators provide these same Cowls with means for supplying an abundant and constant amount of fresh air under all conditions. They are fitted to the base of the ventilator trunk, or entirely within it—thus occupying no space which might be used for other purposes. (See accompanying drawing).


The Wing Scruplex Electric Ventilator draws the air in and blows it down to the working level, displacing hot air which passes out of open hatches and other ventilators.

Typical Installation of Wing Scruplex Ventilator

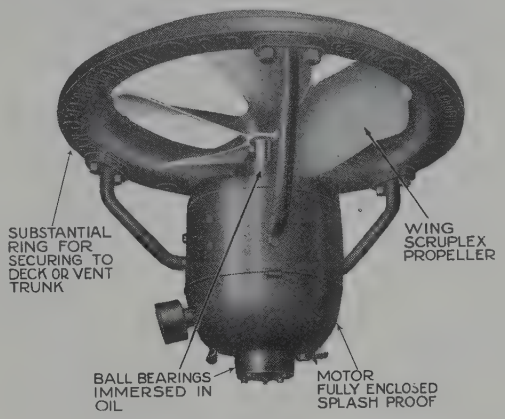
Over 750 vessels of various types, Pleasure Craft, War Ships, Cargo and Passenger Ships, are equipped with Wing Scruplex Electric Ventilators.

Features of Design

Wing Scruplex Electric Ventilators are especially designed for ship ventilation, therefore, light yet rugged construction, and proper protection from the injurious action of the elements, has been one of the prime considerations.

The propeller (screw design) delivers a solid column of air at high velocity.

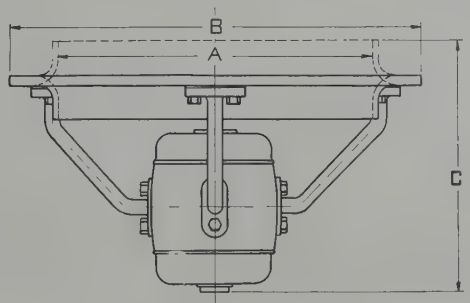
The Motor is splashproof and liberally designed for constant operation with a minimum of attention.


SUBSTANTIAL RING FOR SECURING TO DECK OR VENT TRUNK
WING SCRUPLEX PROPELLER
BALL BEARINGS IMMERSED IN OIL
MOTOR FULLY ENCLOSED SPLASH PROOF

Wing Scruplex Electric Ventilator

Engineering Data

The drawing and table below give general dimensions, capacities and speeds of the various standard sizes which will enable the engineer to select the unit best suited to each location.



Size	Capacity Cu. Ft. Min.	Speed Rev. Per Min.	Dimensions A	B	C*
10	1,100	2,000	10	12½	11
13	2,000-2,500	1,500-1,750	13	16	12
17	3,000-4,800	1,150-1,750	17	20	14
22	3,800-5,900	1,150-1,750	22	26½	14
25	6,000-9,100	1,150-1,750	25	29	16
30	7,500-12,500	700-1,150	30	35	19
36	10,500-15,000	600-850	36	41½	21
42	14,000-24,000	500-850	42	47	28
48	19,000-30,000	450-700	48	55	29

*Approximate.

Note.—Highest and Lowest Standard Speeds and capacities are given above—intermediate speeds and resultant capacities varying directly with the speeds may be furnished if occasion demands.

Among other products of the L. J. Wing Mfg. Co. are Wing Turbine Blowers for Forced Draft, used extensively on oil burning ships.

L. J. WING MFG. CO.

352-362 WEST 13TH ST., NEW YORK, N. Y.

Marine Sanitary Fixtures

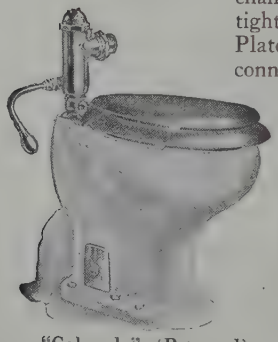
Number S-1

Description

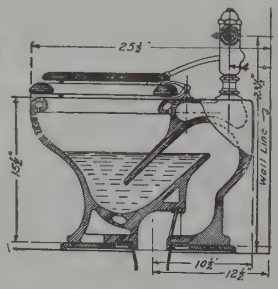
Suggestion for complete arrangement of bathroom. Hot and cold, salt and fresh water. Arrangement of piping condensed to minimum and confined to one bulkhead. Furnished with iron pipe connections ready for piping.

"Model"

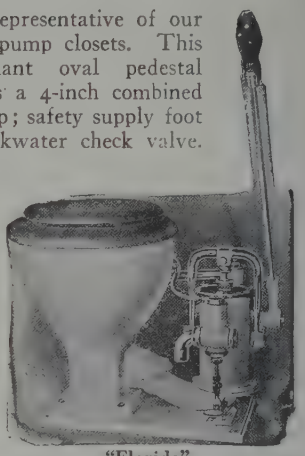
The "Model" is a heavy vitro-adamant syphon action wash-down flushing rim bowl closet with large waterway and special jet; two-inch N. P. brass flush pipe and connection. Galvanized cast iron base plate furnished when specified. Lead or iron outlet connection. Known as Plate F-1203. This closet can also be fitted with high-up enameled iron tank and watertight cover; bulkhead brackets; Plate F-1202. Supply 1¾-inch connection.



"Colorado" (Patented)



The "Colorado" syphon jet water closets are fitted with non-return valves at outlet and the "Utilis" lever handle side inlet flush valves. The non-return valve prevents water and foul air from re-entering and has been very largely and successfully used. The "Colorado" can also be supplied with flush tank instead of valves as shown. Supply 1¾-inch connection.



"Florida"

The "Florida" is representative of our extraordinary line of pump closets. This particular vitro-adamant oval pedestal bowl water closet has a 4-inch combined supply and waste pump; safety supply foot valve, and patent backwater check valve. The pump is finished white with nickel trimmings. Mahogany seat and cover. Cast iron white enameled base plate. Can be used above or below the water line. Made with pump right or left-hand side. Always sent as illustrated unless otherwise ordered.

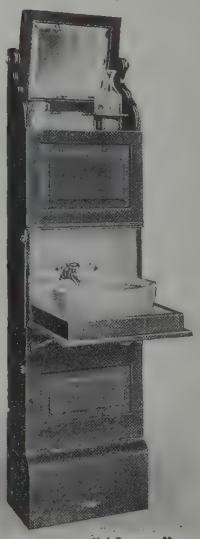
"Superb"

We offer lavatories in a wide range of sizes and styles. The "Superb" is a vitro-adamant lavatory with overlap, surge rim slab, basin, back, overflow and apron, all made in one piece; supported by concealed hanger. Can be fitted with N. P. brass water heater.

Dimensions: slab 18″x20″; basin, 11″x24″; back, 6″.

Wide Range of Styles

"Sands" stateroom lavatory outfits have been placed on some of the best equipped ships afloat. We can furnish vitro-adamant, metal, white enameled, or cabinet finish lavatories in any number of styles; including folding lavatories. Our "Jefferson." Glenwood," "Breton" and "Alcona" outfits have been received with much favor.



"Alcona"

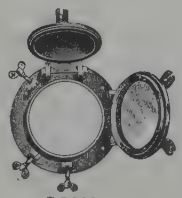
"Clinton"	Oak and Mahogany
"Glenwood"	Oak and Mahogany
"Hoborn"	Vitro-Adamant
"Sunset"	Vitro-Adamant
"Alcona"	Cabinet Finish

Marine Sanitary Fixtures

"Serena" Lavatory Combination

The "Serena" Stateroom Lavatory Combination—vitro-adamant lavatory, waste jar and supply pitcher. The lavatory is 16"x17" with integral back and bracket and moulded soap dish; N. P. chain stay, chain with rubber stopper; N. P. brass waste plug and tail piece. Can be furnished with oak toilet rack and plate glass mirror, supplied with carafe; tumbler and china toothbrush vase; a shelf for comb and brush and a toilet bar.

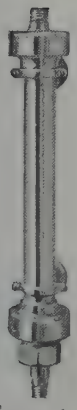
F-3058



S-1003

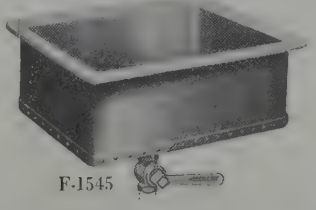
Port Lights

Round composition port lights in a wide range of standard sizes. Plates shown are our F-3058 and S-1003. Plate F-3058 is made 5" and up. All sizes under 7" have one clamp. Plate S-1003 is made 6" and up. Both are fitted with our storm shutter to be used when glass is broken or in case of emergency.



"Compactus" Heater

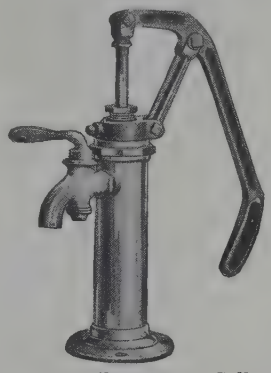
The "Compactus" heaters are furnished in two, three and four-foot lengths. Are designed to stand a pressure of 100 pounds per square inch and are capable of raising the temperature of water from 40° F. to 105° F. at the rate of three to ten gallons per minute with a steam pressure of 20 to 25 pounds per square inch. Connections ¾" I. P. size steam; ¾" I. P. size water inlet and outlet; ½" I. P. size drain.



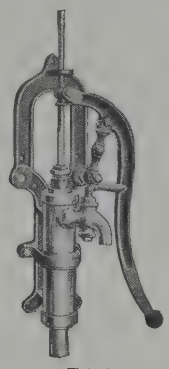
F-1545

Lever Handle Plug Cock

Galvanized cast iron flat rim galley sinks furnished in numerous sizes and styles to fit your requirements. Fitted with nickel plated brass strainers and 1½" lever handle circular opening plug cocks shown in illustration below. Can be connected with steam coil from heating system. Can supply all standard sizes; 6", 10" and 12" deep.



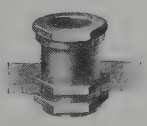
F-1620



F-1619

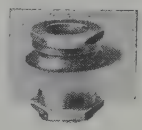
Galley Pumps

Rough composition cylinder bulkhead and dresser galley pumps with reversible handles. Furnished with additional side outlet when so ordered.



F-2550

F-2560

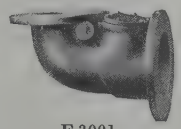


F-2551

Deck Fittings

Heavy composition deck drains for showers, etc., with N. P. or polished removable strainer top 1½" I. P. outlet. Sands' water-tight through deck fittings are of heavy cast pattern composition. Plate F-2550 having lock nuts above and below having integral floor flange and slip coupling nut above the floor.

F-3000



F-3001

Cast composition automatic back water swing check valves with vertical flanges and the elbow pattern with one vertical and one horizontal flange. Special Pitch Flanges made to order.

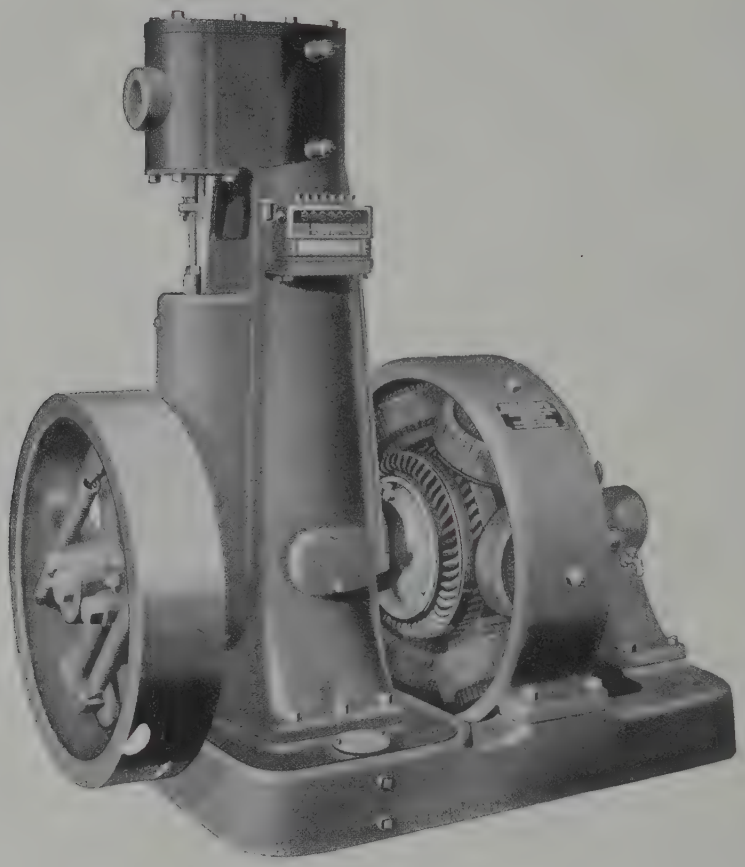
Manufacturing Experience

We have been established since 1849 and have had ample time to standardize all our fixtures so that parts are interchangeable. With our own foundry, machine, pattern, tool, wood-working, and sheet metal departments we produce a line which we readily recommend and guarantee.

Our well organized shipping department, and large stock carried, enables us to make prompt shipments.

The greatest care has been exercised in placing our goods on the market and we offer only such as we have found, in our long experience, are worthy of endorsement.

Generating Sets



Introduction

Engberg Engines and Generating Sets are pre-eminent. They are positively a model of perfection—an ideal formulated after twenty years experience in designing, building and testing Engines and Generators.

We have produced the very best and the record of our machines and the growth of our business verifies this statement. It proves we have been most successful in the undertaking. It shows the design has been very carefully worked out on scientific and modern engineering principles, and furthermore that the workmanship and materials cannot be excelled. We invite careful inspection and investigation, because the general principles, as well as the smallest details, have never failed to attract the attention of the most critical buyer. For Economy, Durability and successful operation they are most acceptable.

Simplicity and Compactness

An inspection of the illustrations shows a most beautiful, pleasing and carefully prepared design. It has been our aim to eliminate complication and still not sacrifice a single feature that adds to dependable and successful performance. Accessibility and ease of adjustment of all working parts give distinction to Engberg Engines.

Removable side doors are provided on each side of the engine frame, allowing access to the cross-head, wrist pin, and all adjacent parts, while the hand-hole plates on the opposite side of the engine frame give access to the lower end of the connecting rod. All adjustments have been simplified to the fullest extent, still maintaining the most positive and modern methods.

With every Engberg Engine are supplied a sight feed lubricator, cylinder relief valves, cylinder drain cocks and full set of wrenches.

ENGBERG'S ELECTRIC & MECHANICAL WORKS

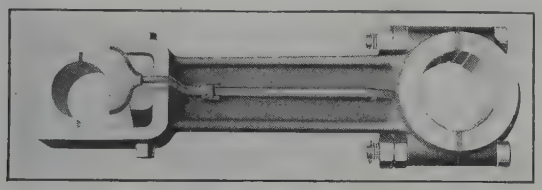
ST. JOSEPH, MICHIGAN

Connecting Rod

The connecting rod, as shown below, is undoubtedly the heaviest and most substantial rod used on this type of engine. It is made of special connecting rod steel and on all engines up to an including frame D, the rod is drop forged, while on the larger sizes the rod is of cast steel.

It has an extremely wide bearing at the lower end, which is fitted with a removable babbitt bushing. The upper end is fitted with a bronze box and provided with the latest standard wedge adjustment on all engines except frames A and B, while on the A and B frames the upper end of the connecting rod is fitted with a bronze bushing, which has a taper fit on the cross-head pin.

You will notice the connecting rod is very simple and made up of as few parts as possible still maintaining positive adjustment, strength and proper proportions. It is one of the Engberg ideals—flawless in design—flawless in materials—flawless in workmanship.

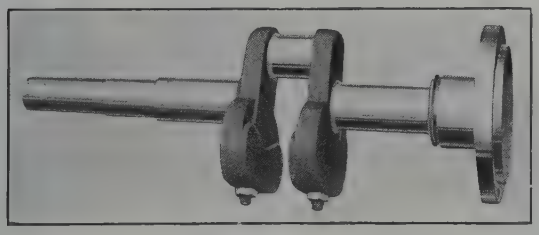


Connecting Rod

Crank Shaft

The crank shaft, illustrated below, is made of the very best forged steel and fitted with counter-balances on all sizes except engines built on frames A and B.

The main bearings are provided with babbitted bushings, which can be renewed without removing the crank shaft, consequently eliminating the annoyance usually experienced when re-babbitting.

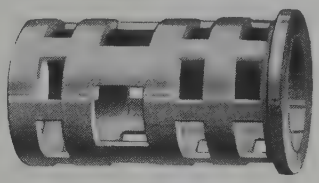


Crank Shaft

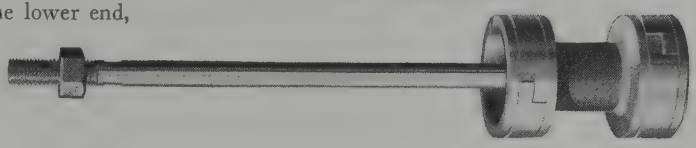
Valve

The valve, as shown in the accompanying cut, is of the balanced piston type, is of close grained iron and is ground to a perfect fit in the valve chamber. It is accurately fitted to the valve rod and secured by a nut and lock nut. The lower end of the valve rod is threaded and screws into the valve slide and is secured by a lock nut by means of which the valve can be adjusted.

On all sizes larger than frame B, the valves are provided with rings.



Valve Chamber Bushing



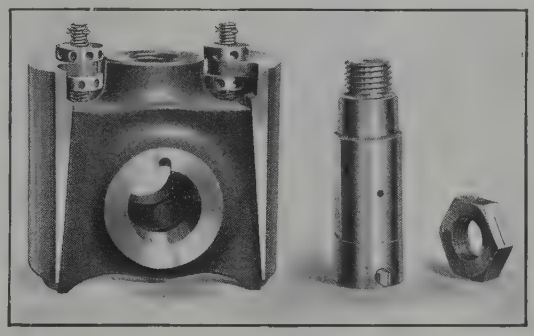
Valve with Rings and Stem

On all sizes larger than frame A, the valve chamber is fitted with a removable bushing, illustrated in the following column, which makes it unnecessary to ever rebore the valve chamber, as these bushings can be removed and properly fitted to the valve at a very minor expense.

This is a feature that is strongly endorsed and insisted upon by the leading engineers.

Cross-Head

An inspection of the cross-head, shown below, shows conclusively that every precaution has been exercised to make this, the most vital part of the engine, exceptionally strong, and most suitable for dependable and continuous performance.



Crosshead and Pin

The working surfaces are fitted with phosphorous-bronze shoes, with wedge adjustment by use of a bolt and lock nut.

The cross-head pin is steel, hardened and ground, has taper fit in cross-head and is keyed in, although easily removable for inspection.

Piston and Rod

The piston is made of selected metal, and so designed to give lightness, still maintaining maximum strength. It has taper fit on the piston rod, with nut on top and riveted on. Both piston and rod are ground true on centers, and to the proper diameter. The rings are accurately fitted, assuring a steam tight piston.

The piston rod is made of carefully selected crucible machinery steel.

Lubrication

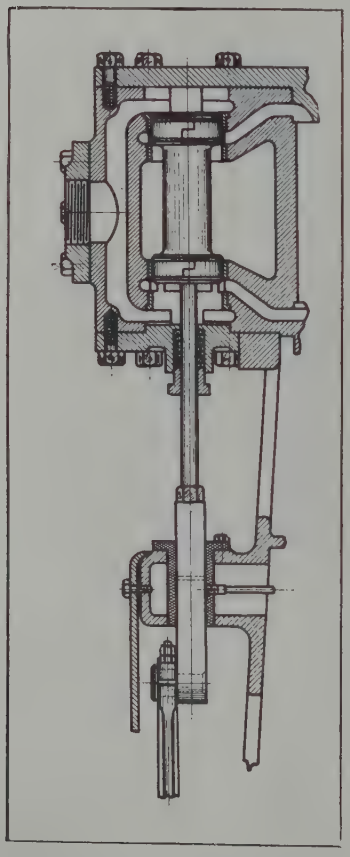
The lubricating system has been perfected after twenty years of careful study and experience in the designing, building and marketing of this type of engine. Only after most exacting tests and experience have we been able to offer such a perfect, reliable and economical system.

On all engines larger than frame A, the lubricating system is made up with an oil pump, as shown in the cross-section below, situated in the base of the engine, pumping the oil from the oil reservoir, which is located in the base of the engine, up into a distributing oil trough situated on the side of the engine frame. This distributing trough is provided with adjustable sight feeds to each individual bearing. From here oil pipes lead to all bearings, which are properly grooved to insure proper distribution of oil. Then the oil is redrained back into the base, refiltered and repumped.

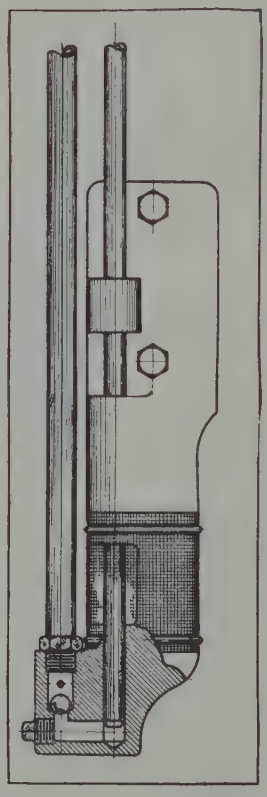
In addition to the direct feed leading to each individual bearing, the supply pipe leading to the cross-head slides, etc., is so liberal as to cause a constant dripping on to the counter balances, which rethrows the oil, causing all reciprocating parts to operate in a constant spray, in addition to the direct feed.

To fully appreciate the many advantages of this lubricating system, it is necessary to see the exact conditions under which each bearing is operating, as provision has been made so that the continuous spray is distributed to each bearing, in addition to the direct feed from the distributing trough.

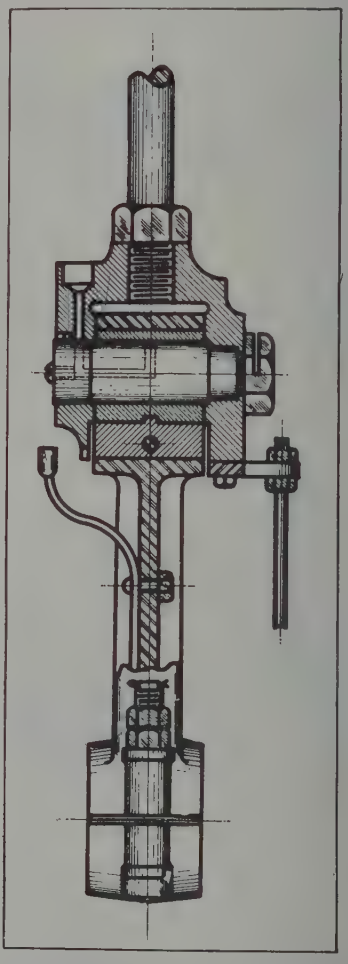
On all engines larger than Frame A, there has been provided a water shed partition preventing the oil from coming in contact with the hot cylinder and carbonizing, thereby leaving good clean lubricating oil in the oil reservoir at all times. This partition also prevents the lubricating oil from following the piston rod into the cylinder, consequently reducing the loss of oil. It also makes it possible to keep the cylinder free from oil should it be desired to operate the cylinder without lubrication.



Arrangement of Valve and Valve Chamber for Frames B to J inclusive. A slight glance will show immediately how quickly and conveniently the valve can be adjusted. This also illustrates the valve chamber bushing and shows the carefully prepared design, exercised on all reciprocating parts



Arrangement of oil pump, which pumps the oil from the base of the engine up into the distributing oil trough. Notice how simple and what few parts—still the positive action of this pump.



Arrangement of cross-head and connecting rod on engine, Frames A and B and oil pump plunger on Frame B together with method of operation. Notice how substantial and well proportioned all parts are. Each individual part is distinctive and superior in design

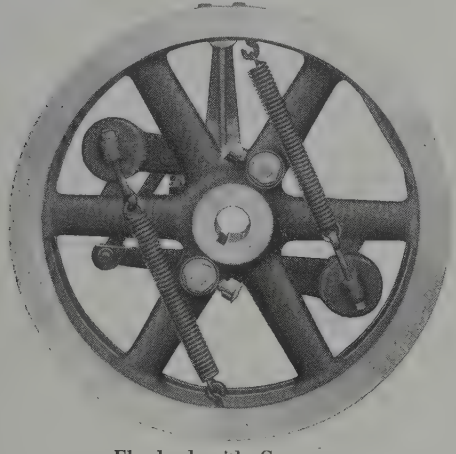
Engines on frame A receive perfect lubrication from a conveniently located sight feed multiple oiler. The oil is drained from the bearings into the engine base where it can be redrained, refiltered and re-used.

A study of the sectional drawing, shown on the preceding page, will immediately make clear the method of distributing the oil, and furthermore, will substantiate anything we have said or might say regarding the dependability and efficiency of the Engberg Lubricating System.

We especially call attention to the perfectly fitting side doors, water shed partition and the oil shields around the main bearings, which reduce the loss of oil to a minimum.

Fly Wheel and Governor

The fly wheel is designed to retain the greater part of the weight up close to the main bearing of the engine frame, relieving to some extent the breaking strain on the shaft. It is of large diameter, properly balanced, and of proper weight to insure a smooth running engine.



Flywheel with Governor

The governor is of our own design and upon inspection of the illustration above, it will be seen that it is very simple; still it has proved in actual operation to be one of the most effective and dependable governors on the market. It controls the speed within two per cent from no load to full load. There has also been provided means for changing the tension on the governor springs, should it be necessary to change the speed of the engine.

WEIGHTS AND DIMENSIONS

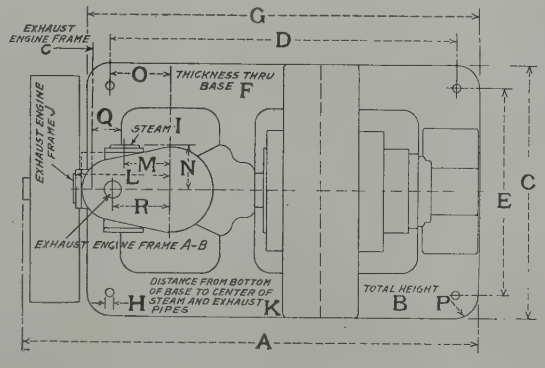
Engine Frame	K. W.	No. of Poles	Size of Engine Feet	Steam Pressure Lbs.	Rev. per Min.	Diameter of Pipes in Ins. Steam	Diameter of Pipes in Ins. Exhaust	Weight in Pounds Net	Weight in Pounds Crat.
A	1	4	3½x3½	90	750	1	1¼	550	600
A	1½	4	3½x3½	90	750	1	1¼	575	625
A	2½	4	3½x3½	90	750	1	1¼	625	690
B	3½	4	4½x4	90	500	1¼	1½	995	1065
B	5	4	4½x4	90	700	1¼	1½	985	1040
C	6	4	6x5	90	400	1½	2	1825	1925
C	7½	4	6x5	90	500	1½	2	1845	1950
D	8	6	6x6	90	375	2	2½	2860	2985
D	10	6	6x6	90	450	2	2½	2900	3025
D	10	6	7x6	90	350	2	2½	3000	3125
D	12½	6	7x6	90	425	2	2½	3050	3175
F	15	6	7x7	90	400	2½	3	4840	5040
F	17½	6	8x7	90	400	2½	3	4850	5250
G	20	6	8x8	90	325	3	3½	5400	5600
G	25	6	8x8	90	400	3	3½	5450	5650
I	25	8	10x9	90	325	3	3½	6800	7000
I	30	8	10x9	90	300	3	3½	7000	7200
J	40	8	10x10	90	300	3	3½	9650	9950
J	50	8	12x10	90	275	3	3½	10750	11050

Remarks

Engberg Dynamos and Engines are designed and built in one shop, so that every feature is harmonious and exactinly adapted to its requirements. Every precaution has been exercised in the designing and building of these Units to eliminate all complication without sacrificing a single feature which adds to endurance, reliability and service. They are built up to an ideal, not down to a price.

Every detail has demonstrated its supreme excellence by continuous and satisfactory performance.

For dependability, economy in steam and oil and low cost of maintenance, they are positively supreme.

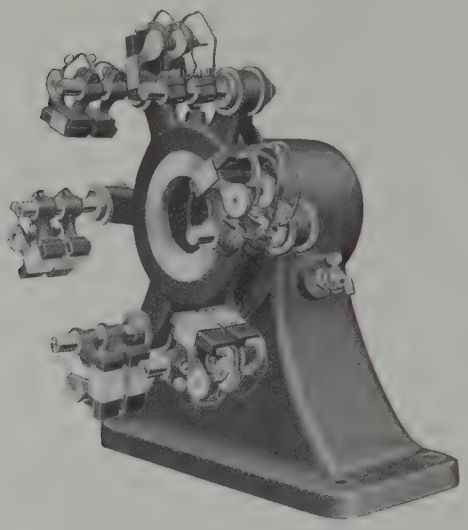


DIMENSIONS

Engine Frame	Dynamo Frame	K. W.	R. P. M.	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
A	1–A	1	750	31½	32¼	19½	18	16½	3¼	22	2½	1	1¼	28		2¾	3	4½	2¾		4¾
A	2–A	1½	750	31½	32¼	19½	18	16½	3¼	22	2½	1	1¼	28		2¾	3	4½	2¾		4¾
A	A	2½	750	31½	32¼	19½	18	16½	3¼	22	2½	1	1¼	28		2¾	3	4½	2¾		4¾
B	B	3½	500	39	44	20	28	15¾	3¾	33	2½	1¼	1½	39⅝		4½	3½	3½	3		6¼
B	B	5	700	39	44	20	28	15¾	3¾	33	2½	1¼	1½	39⅝		4½	3½	3½	3		6¼
C	C	6	400	51¾	53½	24½	38½	18¼	4½	44½	2½	1½	2	48½		3¼	5⅛	6¾	3⅞	4	
C	C	7½	500	51¾	53½	24½	38½	18¼	4½	44½	2½	1½	2	48½		3¼	5⅛	6¾	3⅞	4	6¼
D	D	8	375	54	59¾	31	39	24	5	45½	2½	2	2½	53¼	12¼	5⅜	5¼	6¾	4¾		
D	D	10	450	54	59¾	31	39	24	5	45½	2½	2	2½	53¼	12¼	5⅜	5¼	6¾	4¾		
D	E	10	350	56½	59¾	31	42	24	5	48½	2½	2	2½	53¼	12¼	5⅜	5¼	6½	4¾		
D	E	12½	425	56½	59¾	31	42	24	5	48½	2½	2	2½	53¼	12¼	5⅜	5¼	6½	4¾		
F	F	15	400	61	70	35	42	26	6½	51	2⅝	2½	3	61	15½	5	7½	6½	6		
F	F	17½	400	61	70	35	42	26	6½	51	2⅝	2½	3	61	15½	5	7½	6½	6		
G	G	20	325	64	74½	43	43	33	7¾	53	1⅜	3	3½	66	15½	5	7½	6¼	6		
G	G	25	400	64	74½	43	43	33	7¾	53	1⅜	3	3½	66	15½	5	7½	6¼	6		
I	I–I	25	325	67½	78½	43	47	33	8	56	1⅜	3	3½	69	17¾	8	7¾	8⅜	6		
I	2–I	30	300	67½	78½	43	47	33	8	56	1⅜	3	3½	69	17¾	8	7¾	8⅜	6		
J	3–I	40	300	81¼	90½	43	61½	34	8	70½	1⅜	3	3½	81	17¾	8	8¼	11¼	6		
J	K	50	275	81¼	90½	48	60	38	8	70½	1⅜	3	3½	81	17¾	8	8¼	10½	6		

Outboard Bearing

The outboard bearing is a bronze sleeve, self-aligning and self-oiling, oil being supplied by an oil reservoir and rings. The pedestal is very neatly, as well as substantially designed, and with this, as well as with all other parts, serious consideration has been given even to the smallest details that might add to the convenience of the purchaser.



Outboard Bearing Showing Brush Holder Quadrant

Impregnated Windings

The Shunt and Series Coils of the Engberg Generator are impregnated with a water-proof compound, and by a vacuum process, which positively saturates the coils with this compound through and through, after which they are subjected to a thorough baking process.

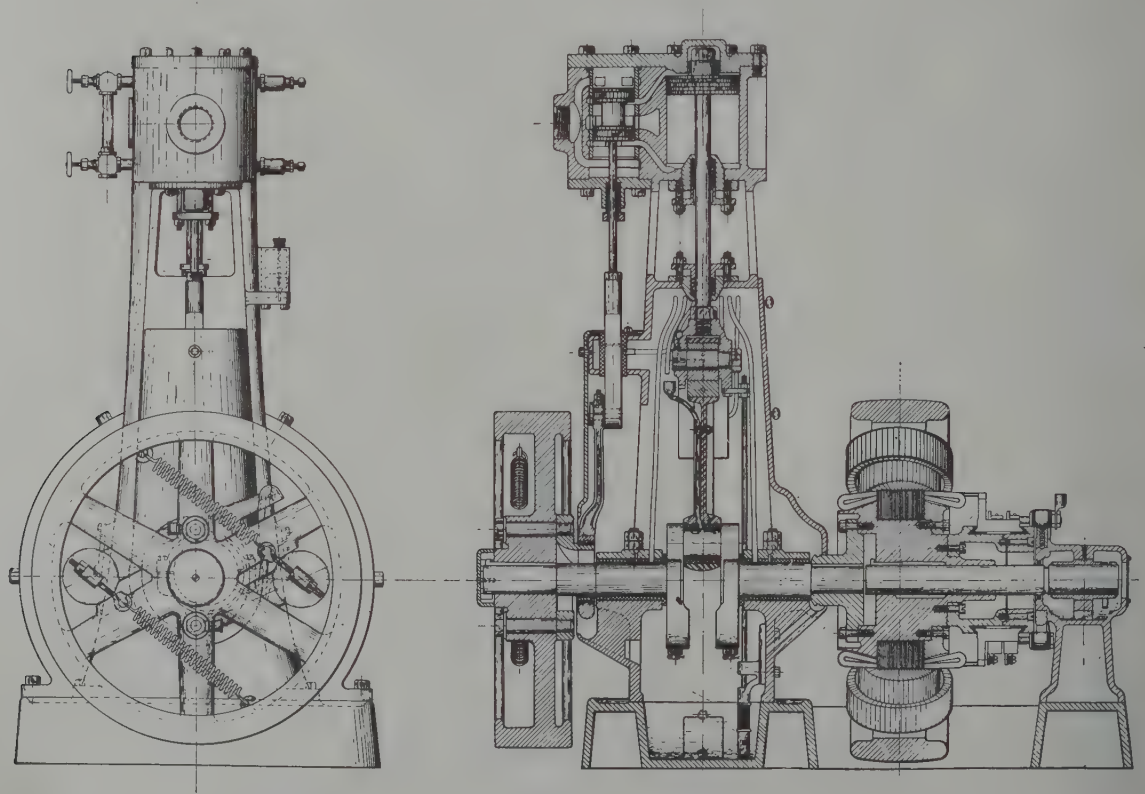
This compound being a good conductor of heat, also assists in conducting to the surface any heat that may be generated within the coil.

In addition to the above distinctive and favorable features, it serves as a protection to each individual turn of wire.

This is the most expensive and modern method of treatment of field coils and it maintains the Engberg standard of quality.

The armature coils are saturated with an insulating water-proof varnish and carefully baked insuring a perfectly developed coil.

In addition to the above treatment, which has been discussed only in a general way, all windings are properly taped and protected to insure satisfaction, even when subjected to unusually rough usage.



Elevation and Cross Sectional View of Engberg Generator Set

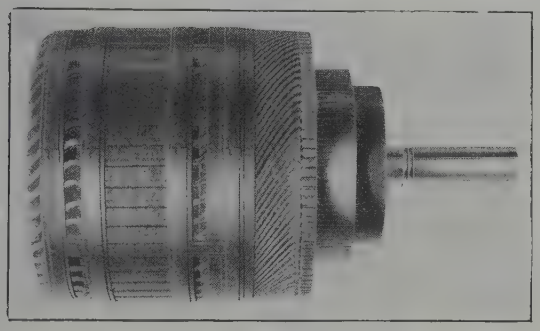
Field Frame

The frame and pole pieces are very high grade material of high magnetic permeability. Engberg Dynamos are of the multi-polar type, and compound wound for 115 volts unless otherwise specified. The shunt and series coils are separate and form wound, and are of the very best cotton covered magnet wire.

Armature

The armature is of the iron-clad ventilated type, with laminated core, built of electrical sheet steel, thoroughly japanned before assembling. The drum and core are provided with air ducts, permitting a thorough circulation of air through the same.

Nothing but the very best double cotton-covered



Armature

magnet wire of the highest conductivity is used, and the insulation is water proof.

The engine crank coupling is coupled to the armature drum, dispensing with coupling on the armature shaft.

Every armature is continually and most carefully tested during construction, besides a final operating test before shipment.

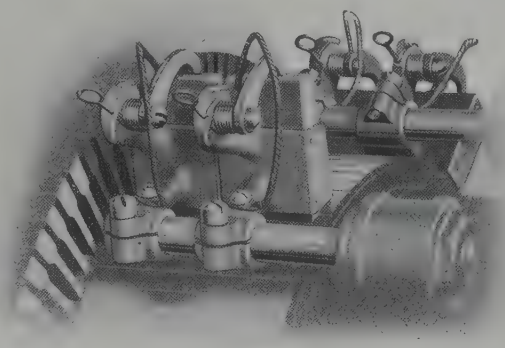
Commutator

The commutator is made of copper bars, insulated with the best grade of mica plate and is very heavy, insuring years of continuous operation without renewal. It is built up on a separate sleeve and bolted to the armature drum, so the shaft can be removed without disturbing the windings. The bars are collected in a steel chuck, specially designed for this particular purpose, and provided with large steel screws.

The chuck is heated and allowed to expand, at which time the screws are tightened to the very extreme. Then the chuck cools and shrinks, drawing the commutator in a perfect and lasting position.

Never have we heard of an Engberg Commutator becoming illshaped, or a bar working loose after the generator has been put in operation.

The commutators are placed in a heating oven and subjected to a very severe heat before being assembled to the armature, so there is positively no chance for the insulation to ooze out, in case it should be subjected to an unusually high temperature.



Brush Holder Rigging

The mica between the segments is under-cut, so the brushes always rest and wear on the commutator bars only.

Every precaution known to engineering practice has been given consideration, in order to build a commutator, as well as a complete Unit that would stand the test of time and operate continuously with practically no adjustments.

Brushholder Rigging

The brush holder yoke is a heavy iron casting, attached to the end bearing, and is of ample strength to insure a firm support for the brushes. The brush holders are of the reacting type, and of most modern design. The best grade of carbon brushes for the purpose are used.

Material and Design

All parts of Engberg Direct Connected Generating Sets are of the highest grade in regard to material, workmanship and design. All bearings are extremely large and accurately fitted, assuring smooth and constant operation with comparatively little attention.

Tests

Engberg Generators are very carefully tested and inspected during construction, after which they are subjected to a final operating test under actual load. All tests are made according to the rules adopted by the American Institute of Electrical Engineers.

They also meet the rules and inspection of the American Bureau of Shipping, Lloyd's Registry of Shipping and the United States Steamboat Inspection Service.

Finish

The castings are carefully smoothed, filled and painted. Just before shipment a final coat of machine enamel is applied to all castings, and a final coat of insulating varnish to all windings and other exposed parts of the generator.

The finish on the generator is identical with that of the engine, so the complete unit is a very attractive and finished piece of apparatus.

Steam Turbines for Auxiliaries

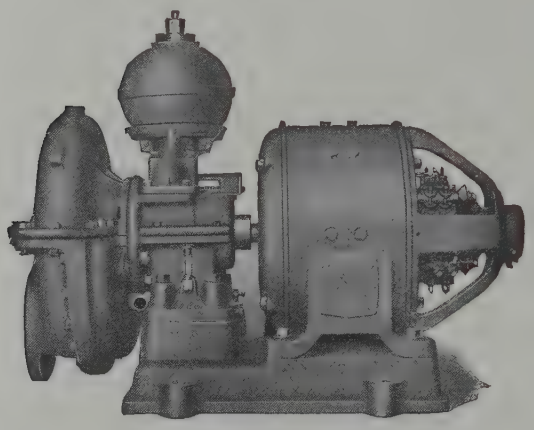
The Steam Motor

The steam turbine manufactured by the Steam Motors Co. in all sizes up to 500 H. P. is particularly well adapted to shipboard requirements of dependability and economy of space and weight by reason of its unusual compactness, ruggedness, and simplicity.

This type of turbine, requiring a single bearing only, and arranged to automatically operate as an integral part of the overall equipment, is the ideal and logical prime mover of all mechanical drive applications on shipboard or in the shipyard.

Steam Motor Lighting Set

The Steam Motors Lighting Set is furnished as a complete unit for ship lighting plants. These sets are made in the sizes listed below and will operate on any pressure from 60 lbs. to 300 lbs. initial steam pressure, and either condensing or non-condensing. The generators are of standard design, suitable for 125 to 250 volt circuits and rated for continuous full load in complete accordance with standard A. I. E. E. new rules.



Steam Motor Lighting Set

Size	Weight	Overall Dimensions in Inches			Pipe Size in Inches	
K.W.	Lbs.	Height	Length	Width	Inlet	Outlet
3	770	33¼	37½	29⅜	¾	1½
5	925	33¼	39 5/16	29⅜	¾	2
10	1050	34	43	29⅜	1	3
15	1090	35	43	29⅜	1¼	3½
25	2005	39¾	47¾	39¼	1½	4
50	2345	40¾	52¼	39¼	2	6

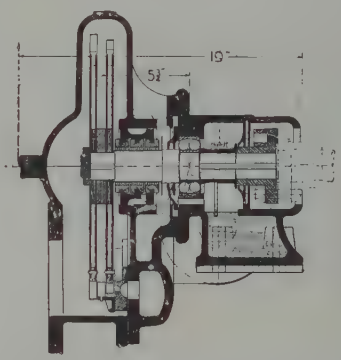
Two-Bearing Construction

The special advantages of the Steam Motor Lighting Set for shipboard lighting plants are due to its unique arrangement embodying the two-bearing construction. This arrangement, together with the other special features of its construction, makes for compactness, simplicity and reliability.

Exceptional compactness is provided by the two-bearing construction which, by eliminating the outboard turbine bearing, one of the inboard bearings, and the flexible coupling usually required, reduces the overall length about 30 per cent, and the weight about 40 per cent. The dimensions and weights given in the table in the opposite column show how well adapted these units are to meet the space and weight requirements of marine installations.

The utmost simplicity is obtained by the elimination of all superfluous parts, while retaining all the items necessary for efficiency, ruggedness, and reliability. This results in a strong, dependable, fool-proof unit, capable of operating for long periods with minimum attention and repairs.

Extreme reliability is assured by the two-bearing construction. It is a well-known fact that with a three- or four-bearing equipment great care must be exercised in the alignment of the unit and in maintaining true alignment. The so-called flexible coupling is not flexible in the true sense of the word, and for satisfactory operation this coupling and all bearings must be lined up as accurately as thought it were a solid coupling, as a cast-iron bedplate is not sufficiently rigid to maintain the alignment from the factory test floor to the final installation. Of the troubles experienced with the average set after installation, probably 80 per cent can be traced directly or indirectly to vibration, mis-alignment, coupling troubles, settling of foundation, pipe strains, etc. With the two-bearing equipment and the self-aligning type of bearing used in the Steam Motor Lighting Set these troubles are practically eliminated.



Section Showing Construction of the Steam Motor

Features of Turbine Design

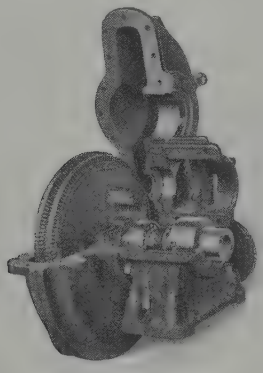
The principle of operation of the steam turbine used as a driver for the Steam Motor Lighting Set is the straight, velocity stage, impulse type, which is now accepted by authorities as the most practical and efficient for the services demanded by this class of apparatus. This standard principle of operation combined with the distinctive features of design and the careful workmanship of the manufacture of the Steam Motor result in an ideal unit for the purpose intended.

THE STEAM MOTORS CO., INC.

SPRINGFIELD, MASS.

The casing is of close grained cast iron or steel, depending on the pressures and temperatures used. It is of horizontally split case construction with steam and exhaust connections in the lower half of the casing, permitting complete inspection of the interior of the machine without breaking steam joints. Permanent alignment throughout all temperature and expansion changes is assured by suspending casing by flange at center. Parts subjected to pressure are tested hydraulically to 50 percent above the maximum working pressure.

The motor consists of a wheel of plate construction to provide maximum strength with minimum weight. The discs are mounted at the center on a substantial hub which is keyed to the shaft and held firmly against



Steam Motor Opened Up for Inspection

a shoulder by means of a large lock nut. The wheels are balanced statically and dynamically.

The buckets are drop forgings and of material best suited for the operating conditions. They are riveted between the discs, a rivet for each blade.

The guide blades are firmly mounted on a sector which in turn is bolted to the nozzle block. The blades are smooth and accurately placed to insure a minimum loss by friction at this point.

The nozzles are of a material best suited to the operating conditions. The jets are accurately machined to size and polished, giving maximum efficiency for the conditions for which they are designed.

The shaft is of high carbon forged steel of ample proportions, machined and ground.

The packing glands are of the metallic double labyrinth type made up in three independent sections and split horizontally. Punched discs are mounted on the shaft fitting into the labyrinth. This packing requires no lubrication, has no rubbing parts and is free from upkeep cost. It is applicable to all exhaust conditions from vacuum to high back pressure.

The bearing is the wide, extra heavy duty, double race, self-aligning S. K. F. Ball bearing, ideally suited for this class of work. A single oil reservoir of unusual capacity, provided with sight holes and level gauge, is used, and ring lubrication is employed.

A constant speed governor of the Pickering type is provided, with positive gear drive from the main shaft, also independent emergency governor.

Other Applications

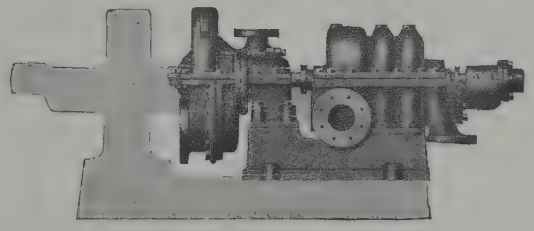
Some of the other types of service to which the Steam Motor is adapted are covered in the following paragraphs.

For Boiler Feed Pumps

The comparison cut shown below indicates the saving of space and weight permitted by the use of the Steam Motor as a driver of a centrifugal boiler feed pump. The ruggedness, simplicity, and freedom from operating troubles of a unit arranged in this manner make it admirably adapted to such work.

For Other Pumps

The Steam Motor is well adapted for use on any of the many other shipboard pump services such as circulating pumps for different purposes, condensate pumps, etc. Either an emergency or a constant speed governor or both will be furnished as required to suit the conditions of operation.



Comparison to Scale Showing Typical Four Bearing Flexible Coupling Type Pumping Equipment and a Steam Motor of Equal Capacity and Efficiency Connected to the Same Pump.

For Blowers

The Steam Motor used for blower drive can be mounted on the blower bearing foundation, and its ease of operation and dependability make it the logical selection for this purpose.

Other Uses

The Steam Motor is also appicable to stoker drive, or belt drive, and the numerous other shipyard shop, powerplant and pumping work where mechanical drive is required.

Rapid Deliveries

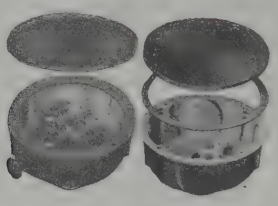
The Steam Motors Co., Inc., is in a position to make early and rapid deliveries on units from 5 to 500 H. P.

Write for quotation and compare the prices, weights, and dimensions of the Steam Motor with any other steam prime mover. You will find a distinct saving in each item including a possible saving in the driven apparatus and bed plate for the equipment.

Marine Fittings

The Western Electric line of Marine Fittings includes watertight switches and receptacles, junction boxes, connectors, and all types of electrical fixtures and portables suitable for shipyard use.

Double pole Switches are furnished with watertight standard circular or oblong boxes, rated for 10 amps, at 125 volts, or 5 amps at 250 volts. The switch is positive in action, of the quick make and break type, breaking on both sides of the circuit at two points, and can be made single by jumper connection. The boxes



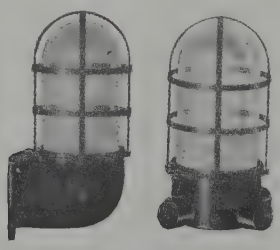
Switch Junction Box

and covers are of finished brass, or brass or iron finished in standard marine black. The box is regularly furnished not tapped for outlets, but can be ordered tapped and drilled for ½", ¾" or 1" conduit at the four side bosses spaced 90 degrees, and for ½" or ¾" outlet at the bottom.

Watertight Junction Boxes are finished either of standard depth of 1½", or extra deep, 2¼" in depth. The standard boxes are finished and arranged for tapping similar to the switch receptacles described above, and can be furnished with plunger key when specified. The extra deep box is suitable for flush work, supplied in iron only, and is not furnished with boss for plunger key stuffing box.

Condulets

Western Electric Condulets are vapor, gas, and dustproof, of iron finished in black enamel or galvanized, and will accommodate any regular Mazda lamp up to and including 40 watt, or any lamp with dimensions not exceeding 2¾" x 5¼". These condulets are furnished with receptacle, sealing plate, gaskets and fastening screws, and with clear



Condulets

globe, and guard. Condulets of special metal and finish and with specially colored globes can also be furnished.

Marine Annunciators

Western Electric Annunciators are built either non-watertight or watertight, in either case being of sturdy design and construction and suitable for marine use.

The non-watertight type, as illustrated below, has a stamped steel case, finished in black enamel. The case is hinged to permit easy access to the interior, and the backboard is provided with a metal projection drilled and tapped to receive ¾" conduit unless otherwise specified. An attractive double gong bell is mounted in the front of the case. The drops have white indicating tags about 1" x 1¼" and are hand restoring.

The watertight type has a case of United States Government B. E. Brass, or cast iron, with mounting feet for circulation of air between the back of the case and the wall. The annunciator is made watertight by a rubber gasket between the cover and the base, and

Annunciator

Bell

the glass is held in place by a waterproof cement. The drops are of the Semaphore Lock Gravity type and cannot be moved except by operating the signalling or reset button located on the case or at any convenient point. The bells may also be mounted where desired. All iron parts are electroplated to guard against corrosion, and wires are soldered to connections with non-corrosive flux.

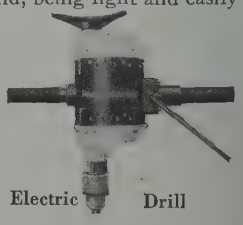
Bells

Western Electric Watertight Bells are of heavy high-grade bell metal with brass case conforming to United States Navy requirements, and resist corrosion and ship vibration. The case is made watertight by a gasket between it and the cover, and the striker operates through a watertight stuffing box. The case can be drilled to receive ½" or ¾" conduit as specified. The movement embodies the intensified stroke principle, resulting in a powerful stroke and great economy of current.

Electric Drills and Hammers

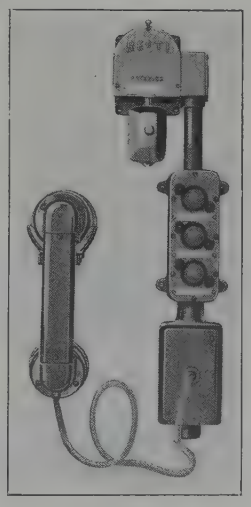
Western Electric Portable Drills and Hammers are the ideal equipment for all around service—for both light and heavy work. They have ample power and, being light and easily handled, are capable of an enormous amount of work.

Western Electric Portable Drills and Hammers are made in a number of sizes and speeds which are adapted to all classes of shipyard work.

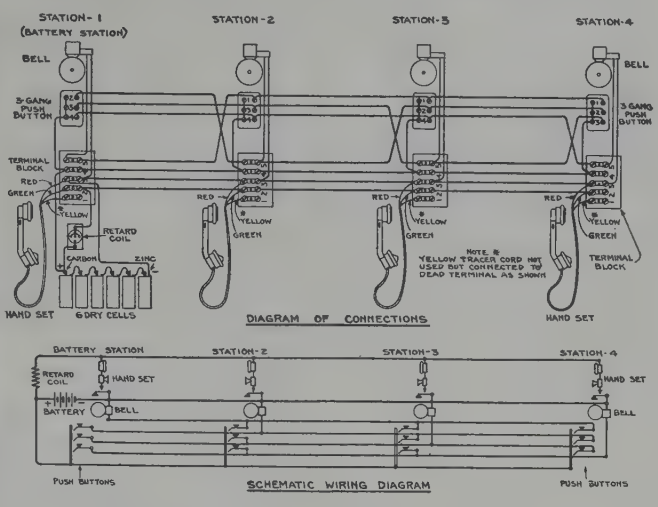


Electric Drill

Marine Inter-Phones



Inter-Phone



Typical Marine Inter-Phone Wiring Diagram

The Western Electric Marine Interphone is a non-watertight system of 3 to 8 stations, for connection between pilot house, engine room, wireless room, staterooms, and other locations as desired. Each station consists of a telephone hand set, bell, push buttons and a terminal box as shown above. The system is to be wired as shown in the diagram, and comprises a complete, dependable and durable means of communication between the various stations. All parts are specially treated for marine use. A similar system can be furnished for two stations, as from pilot house to engine room.

Push Buttons

Watertight Push Buttons of the quick break type with heavy wiping contacts are furnished, suitable for 125 volts or less. These push buttons are made watertight by rubber gaskets at joints, and a pigskin diaphragm covers the center. The unit is furnished complete with conduit box which has cast-iron feet for mounting. Other types suitable for surface mounting can also be furnished.

Portable Utility Light

The Western Electric Portable Utility Light fully meets the demands for light illumination at close range within restricted areas and is specially adapted for use on cargoes, docks, dredges, decks, float bridges, ships, landing stages, pile drivers, barges, ore boats, dry docks, canal boats, etc. With the light operating on a 100 foot throw, a 100 feet spread is obtained at an angle of 60 degrees. For a long range a 1000 watt flood lamp is furnished, while for shorter ranges a 500 watt flood lamp will be ample.

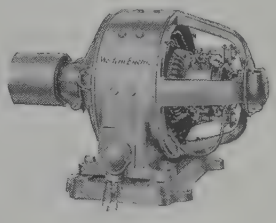
Portable Light

Construction of Light

The Portable Utility Light weighs only 30 lbs., has a rugged cast-iron housing with a wire glass front, the whole being fully waterproof. A heavy universal joint permits mounting the unit on either vertical or horizontal surfaces. The reflector is of a new type of hammered glass, producing a glareless, smooth, soft white light, neither dazzling nor streaky.

Motors

Western Electric Motors are built in all sizes, types and speeds, for alternating and direct current, and are suitable for hoists, blowers and general power purposes on board ship or at the docks. These motors are standard in construction and rating, are ruggedly built and may be furnished either open or enclosed for belt or direct drive.



Type R C Motor

Direct and Alternating Current Generators engine type, belt or direct connected, can also be furnished in all sizes for shipboard lighting, and for generating purposes in general in the shipyard.

Service

The Western Electric Company offers an exceptional national electrical service to ship outfitters and shipyards for equipment of the types described above. Large and complete stocks are carried in every one of 43 convenient distributing points located throughout the country. Following is a list of these branches:

New York	Richmond	St. Louis
Newark	Norfolk	Memphis
Syracuse	Charlotte	Omaha
Buffalo	Chicago	Cincinnati
New Haven	Indianapolis	Dallas
Boston	Detroit	Houston
Pittsburgh	Milwaukee	San Francisco
Philadelphia	Grand Rapids	Oakland
Baltimore	Cleveland	Los Angeles
Atlanta	Minneapolis	Seattle
Savannah	St. Paul	Portland
Birmingham	Duluth	Spokane
Jacksonville	Kansas City	Tacoma
New Orleans	Oklahoma City	Denver
	Salt Lake City	

Electric Wires and Cables

Electrical Conductors o Every Type

The American Steel & Wire Company manufactures electric wires and cables of all kinds, to meet specifications or conditions of all classes of work. The following list will suggest the completeness of the standard products:—Bare Wires and Cables, in copper, iron and steel for power transmission; Resistance Wire, Magnet Wire, Annunciator and Office Wire, Weatherproof and Slow Burning Wires, Lamp Cord, Reinforced Portable Cord, Deck Cables, Rubber Covered Wires and Cables, Telephone Wires, Switchboard Cables, Fireproof Cables, Lead Encased Wires and Cables, Varnished Cambric Cables, Submarine and Dredge Cables, and Braided Steel Armored Cables. Also appliances for installing cables for shore use.

Facilities

Reinforcing the extensive factory equipment, there are well equipped chemical, physical and electrical laboratories, wherein the problems incident to the solution of every difficulty encountered are handled by experts. All steel and copper used are rolled and drawn in the company's mills. Thorough testing and inspection of raw materials and of the finished product insure uniformly high quality. With such facilities the company is enabled to supply a high grade electrical conductor exactly suited to any individual requirements.

Annunciator Wire

Annunciator and Office Wire

Annunciator wire is used in primary battery circuits, for call bell or annunciator systems. Sizes of wire range from No. 14 to No. 22 B. & S. Two grades are manufactured, one for all ordinary use and the other a damp-proof wire, saturated with special paraffin wax compound, for use in damp places.

Office Wire

Office wire is used largely for interior telephone wiring, also as high grade bell and annunciator wire. It is made in two grades, the damp-proof being thoroughly impregnated with black weatherproof compound.

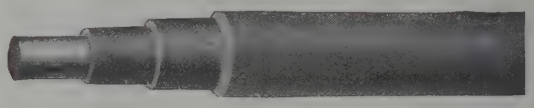
Both types of wire can be supplied in cables having any number of conductors and special kinds can be furnished as specified.

Magnet Wire Resistance Wire

The American Steel & Wire Company manufactures a complete line of Magnet Wire, round, square and rectangular, with cotton, silk, paper and enamel covering. Also Tico Resistance Wire, of nickel-steel, adapted for use where a high specific and uniform resistance is required.

Reliance Weatherproof Wire and Cable

This type has moderate degree of insulation and is less expensive than rubber insulated conductors. Reliance wire and cable is made in strict accordance with all requirements of the National Board of Fire Underwriters, sizes varying from No. 20 B. & S. to the largest feeders used, the larger sizes having stranded conductors.

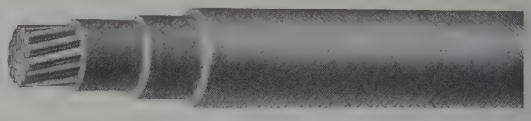


Solid Copper Wire, Triple Braid, Black Finish

Solid Copper Conductor, Double Braid, Black Finish

Stranded Copper Conductors, Triple Braid, Black Finish

Reliance Weatherproof Wire meets every requirement for use outdoors, where moisture is certain and fireproof qualities are not necessary. The conductors are first covered with two or three closely woven braids, which is then saturated with weatherproofing compound. After drying thoroughly, the wire receives a dressing of mineral wax. The surface is then burnished and polished, reducing to a minimum trouble from sleet and ice. The insulation withstands all ordinary climatic conditions.



Stranded Copper Conductor, Triple Braid, White Finish

Reliance Slow Burning Wires and Cables, with insulation that will not carry flame, are particularly adapted for use in hot, dry places and where wires are brought together, as on the back of switchboards. Each insulating braid is completely saturated with white, slow-burning compound and the outside slicked down and given a hard, smooth, white surface.

Kinds of Rubber Insulations

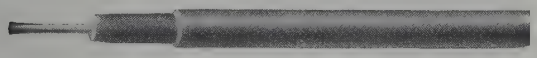
Rubber-covered wire as used for general purposes must possess three essentials—the conductor, the wall of rubber insulation and the braid, tape and braid, or other form of protection. The conductor consists of uniformly soft annealed commercially pure copper wire. It may be used in the solid form up to size 1/0 American Wire Gauge (B. & S.), or in special cases even to 4/0, or

in the stranded form. All conductors are thoroughly and evenly coated with tin to protect the copper from any injurious effect from the sulphur in the rubber insulation.

The American Steel & Wire Company manufactures many grades of Rubber Insulating Compound. The Americore Brand is made to conform to the Underwriter's Specifications, known as National Electrical Code Standard.

Amerite is a very high grade 30 per cent pure para rubber compound.

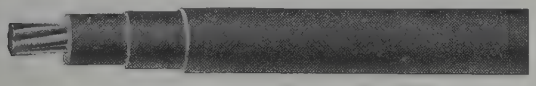
In addition to these two principal grades the company is in position to insulate wire or cable to any specification covering particular requirements, such as compounds containing anywhere from 10 to 40 per cent pure para rubber. The latter is used extensively on first class ships and is required by Marine Specifications.



Americore Solid Tinned Copper Conductor

Americore rubber can be recommended for all working conditions on voltages up to 7000. Amerite rubber is mainly used for high voltages and exacting service conditions. It possesses great strength and elasticity, high insulating qualities and long life.

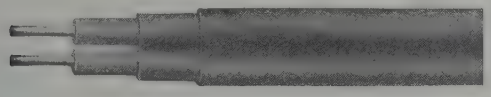
Wires and cables with these grades of insulation can be supplied in single conductors, from No. 18 B. & S. up to 2,000,000 circular mils and above.



Americore Stranded Tinned Copper Conductor

Americore Switchboard Cable

Tinned annealed extra flexible strand of highest conductivity, insulated with code thickness of high grade vulcanized rubber, protected with one or two smooth closely woven cotton braids, saturated in black weatherproof compound and smoothly finished. The above are for switchboard, brush holder and similar connections where very flexible cables are required.



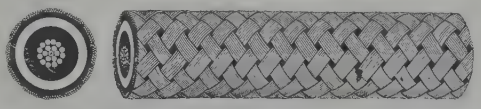
Americore Twin Rubber Covered Cable

Americore Twin Conductor Wire and Cable

These conductors are made in sizes from No. 18 to No. 4/0 B. & S. to the following specifications:—

Tinned annealed copper wires or strands of highest conductivity, each conductor insulated with code thickness of high grade vulcanized rubber, protected by saturated braid; two such finished conductors laid parallel and covered with a heavy cotton braid over all, saturated in black weatherproof compound.

Special finish may be supplied where cable is to be used for conduit work, to facilitate pulling through conduit.



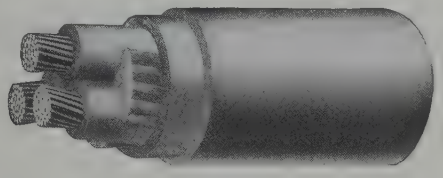
Braided Steel Armored Cable

This is a flexible, stranded conductor, weatherproof, braided and leaded cable, covered by a basket weave of galvanized steel wires. It is made in all usual sizes and is particularly adapted for wiring aboard ship without conduit. This type of braided steel armored cable is practically standard for all U. S. Navy work and its use on merchant vessels is rapidly increasing.

Installation of Underground Cables

The American Steel & Wire Company will furnish, install and guarantee its underground cables for almost any class of service. The company maintains a fully equipped cable department, supervised by experienced engineers and manned by competent cable workmen, which has for many years attended to all matters pertaining to underground and submarine cable installations.

Through this department, the company is prepared to install cables, to make estimates or to advise regarding specifications.

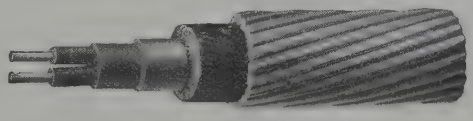


Lead Encased Cable

Lead Encased Light and Power Cables

These are made in all types, aerial, underground and submarine, suitable for every need in the transmission of power. Cables are made to the most rigid specifications, in any quantity, size or length, for any voltage and finished for any service, single or multiple conductor or concentric laid.

Types of insulation used are rubber, paper and varnished cambric.



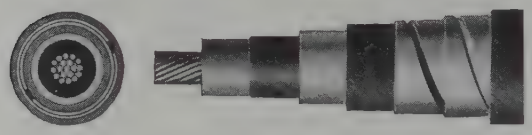
Two-conductor Submarine Cable

Submarine Cables

Large quantities of submarine cables of every design are manufactured and installed, for crossing rivers, bays, ponds or lakes. The American Steel & Wire Company is prepared to advise as to the best construction for any particular installation

and to supply this class of cable to the most exacting specifications.

Cables adapted for the transmission of power to dredges, the cable being supported on pontoons, can also be furnished.



Flat Steel Taped Suburban Cable

Flat Steel Taped Suburban Cable

This type of cable is widely used for lighting and power service where installation underground, without ducts, is desired. It is installed by being laid in trenches 15 to 30 inches deep. Steel taped cables carry their own protection. Over the insulation, of rubber, cambric or paper, is a lead covering; then a serving of saturated jute, two steel tapes laid spirally, and finally on the outside an additional serving of saturated jute. Being lead covered, they are waterproof, while the jute and steel armoring protect the cables against mechanical injury. This style of cable is most economical and easy to install.

Americore Lamp Cord

Portable Cord Lamp Cord

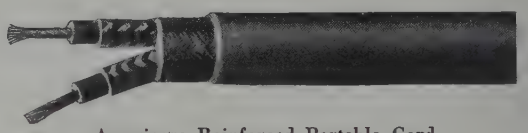
The following data is an extract from the National Board of Fire Underwriters' Specifications, and covers Americore Portable Cord:

Type C, for Pendant Lamps—In this class is included all flexible cord, which, under usual conditions, hangs freely in the air and not likely to be moved sufficiently to come in contact with surrounding objects. Pendant lamps provided with long cords, so that they can be carried about or hung over nails or on machinery, etc., are not included in this class, even though they are usually allowed to hang freely. Each conductor must have an approved braided covering so put on and sealed in place that when cut it will not fray out.

This type is insulated with 3/64-in. rubber on sizes 8 to 14 and 1/32 on 16 to 22.

Type C. W. P. for Pendant Lamps—Same as above, except must have saturated braid and 3/64-in. rubber. For use in damp places.

Type P. O. for Pendant Lamps—Parallel cord—each conductor type C, two such conductors laid parallel and covered with one silk or cotton braid.



Americore Reinforced Portable Cord

"Type P—Flexible cord for portable use, except in offices, dwellings or similar places where cord is not liable to rough usage and where good appearance is an essential feature, must meet all the requirements for flexible cord for pendants, and in addition must have a tough-braided cover over the whole. There must also be an extra layer of rubber between the outer cover and the flexible cord. All sizes (except No. 14 and larger) are insulated with 1/32 inch rubber; No. 14 and larger have 3/64 inch rubber."

"Type P. W. P.—(Same as Type P. except must be furnished with a saturated braid.) For use in damp places, the insulation must be 3/64 inch thick on sizes No. 14 and larger and 1/32 inch on sizes No. 16 and smaller, and the cord must have an outer covering saturated with a moisture-proof preservative compound thoroughly slicked down, or must have a filler of approved material instead of an extra layer of rubber, and have two outer braids saturated with a moisture-proof compound with an exterior surface thoroughly slicked down."

Type P. S., for Portables in Dwellings, Offices, etc.—In offices, dwellings or similar places where cords are not liable to rough usage and where good appearance is essential, flexible cord for portable use must meet all of the requirements for flexible or for pendant lamps, both as to construction and thickness of insulation, and in addition must have a tough braided cover over the whole; or providing there is an extra layer of rubber between the flexible cord and the outer cover, the insulation proper on each stranded conductor of cord may be 1/64 in. in thickness instead of as required for pendant cords.

Note: This cord has only 1/64-in. rubber on each conductor, sizes 16 and 18, approved by underwriters. The supplementary insulation is same as on other portable cords.

Americore Brewery Cord

Americore Brewery Cord used in cases where something better than ordinary Lamp Cord is required. It has a high grade rubber insulation covered with a weatherproof braid which keeps oil and moisture out, thus preventing shorts. Generally furnished in sizes 14, 16 or 18. Can be made up insulated with other grades of rubber if required.

Americore Canvasite Cord consists of two conductors, each lamp cord strand insulated with code thickness of vulcanized rubber and covered with a weatherproof cotton braid. These are twisted together and covered with an additional weatherproof braid.

Ignition Wire and Cable

These cables are made in a variety of styles and sizes, a few of which are here shown. They have been evolved out of an extended experience in the manufacture of electrical wires and cables of all kinds and they represent the latest advanced construction.

The dominant features which distinguish American Steel & Wire Company's ignition wires and cables are:

A soft drawn, high-conductivity copper conductor composed of many small tinned or untinned wires stranded together, insuring minimum voltage drop and maximum flexibility.

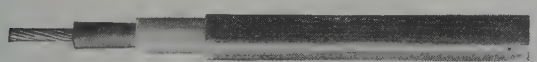
A high grade insulating compound containing a large per centage of fine up-river para rubber, treated in such manner as to insure a high insulation resistance and dielectric strength, great flexibility, strength and durability.

A plain glazed rubber finish, or with either single or double covering of glazed cotton closely braided over a wind of varnished cambric tape, then impregnated with a special compound which renders the covering both oilproof and waterproof and resists the destructive action of heat.

Made to fit standard or special bushings.

Plain Rubber Covered Primary

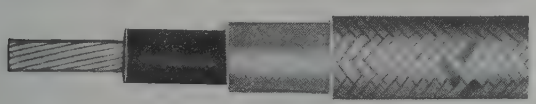
RR-5. No. 14 American Wire Gauge (B & S.). Conductor 19 wires tinned. Insulated with one layer black rubber. Outside diameter 5 mm., or approximately 3/16 inch.



Plain Rubber Covered Secondary

RR-7. No. 14 American Wire Gauge (B & S.). Conductor 19 wires tinned. Insulated with black rubber. Outside diameter 7 mm., or approximately 9/32 inch.

RR-9. Same construction as RR-7, but with heavier insulation, outside diameter being 9 mm., or approximately 3/8 inch.

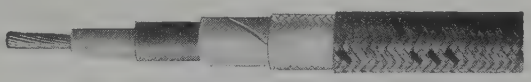


Braided Primary

B-5-14. No. 14 American Wire Gauge (B. & S.). Conductor 19 wires tinned. Insulated with 1/32 inch high grade rubber, 1 layer varnished cambric with hard glazed cotton braid, varnish finish. Outside diameter 5 mm., or approximately 3/16 inch. Weight 26.7 pounds per 1000 feet.

B-5-12. No. 12 American Wire Gauge (B. & S.). The same as B-5 except size. Outside diameter, .202, or approximately 13/64 inch. Weight 36.4 pounds per 1000 feet.

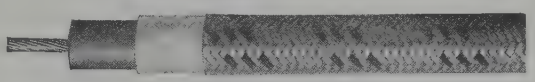
B-5-10. No. 10 American Wire Gauge (B. & S.). The same as B-5 size. Outside diameter .226, or approximately 15/64 inch. Weight 51.7 pounds per 1,000 feet.



Braided Secondary

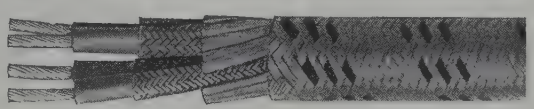
B-9. No. 14 American Wire Gauge (B. & S.). Conductor 19 wires tinned. Insulated with black rubber, two layers varnish cambric, one soft cotton braid and one hard glazed cotton braid, varnish finish. Outside diameter 9 mm., or approximately 3/8 inch. Weight 71.6 pounds per 1000 feet.

B-7. No. 14 American Wire Gauge (B. & S.). Conductor 19 wires tinned. Insulated with black rubber, one varnished cambric tape, one soft cotton braid, one hard glazed cotton braid, both varnish finish. Outside diameter 7 mm., or approximately 9/32 inch. Weight 43 pounds per 1000 feet.



Special Braided Secondary

RB-9. No. 14 American Wire Gauge (B. & S.). Conductor 19 wires tinned. Insulated with one layer black rubber, with one soft cotton braid and one hard glazed cotton braid. Both varnish finish. Outside diameter 9 mm., or approximately 3/8 inch. Weight 75 pounds per 1,000 feet.



Three and Four Conductor Primary

Conductors, 26 wires bunched untinned, cotton wound. Insulated with one layer of black rubber and one distinctively colored braid. Three or four such couductors twisted together, jute filled to make round and covered over all with one hard glazed cotton braid; all braids varnish finish.

Ignition Wires to Any Specifications

Special attention is given to the manufacture of American Steel & Wire Company's ignition wires and cables to customers' own specifications. The completeness of the standard line offers a cable for practically any conditions of service in the ignition of internal combustion engines, for shore, marine or motor boat use. Wherever conditions demand, the company is equipped to make special wire to fill exactly the requirements.

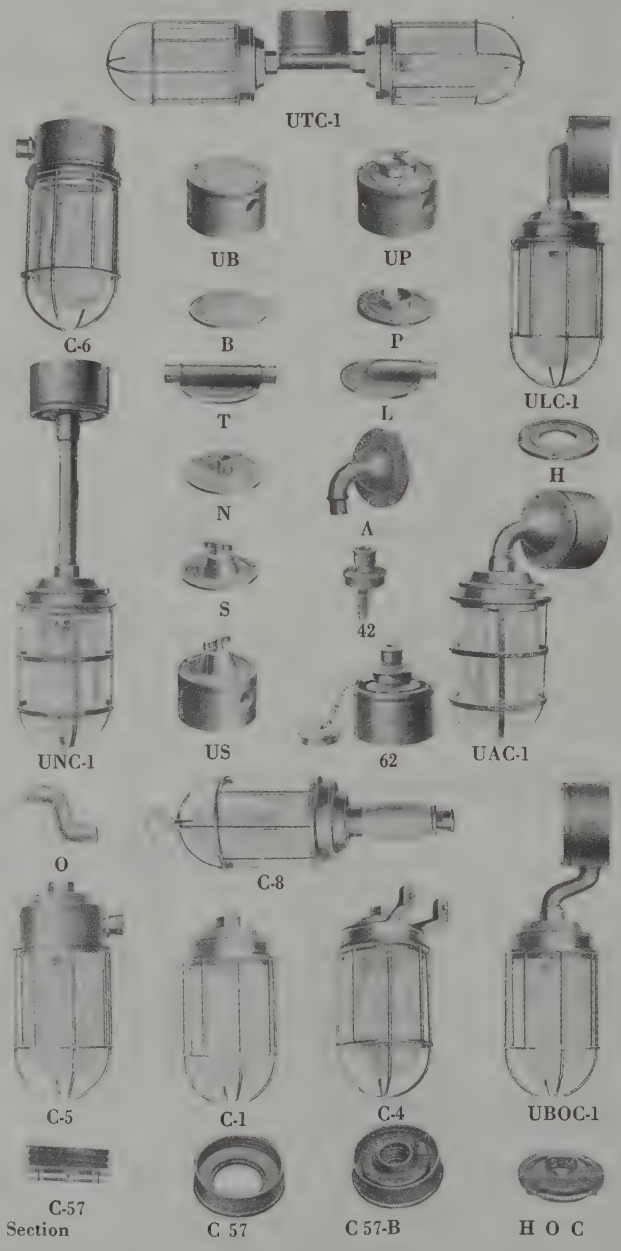
Marine Electrical Appliances

Standard Types with Special Features

The Seidler-Miner Line of Marine Electric Appliances comprises a most complete line of standard Marine Fixtures, Watertight Boxes and Fittings. Their design without deviating from existing standards embodies new features advantageous to both the Shipbuilders and Shipowners.

The Line was developed for the purpose of providing the greatest number of combinations with the least number of parts. That this has been accomplished is indicated by the fact that with the S-M line as complete a Marine conduit wiring installation as may be desired, can be made with only 24 interchangeable units giving over 1000 possible combinations. The electrician or stockkeeper can make up all the customary combinations. These exclusive features are the result of a wide and practical experience as well as manufacturing and handling Marine electrical appliances covering many years.

The simplicity and uniformity of design of all parts simplifies construction, permits rapid installation, reduces cost of maintenance and provides accommodation for the greatest possible number of wiring devices of other manufacturers' makes including foreign types, the idea being that renewals of wiring devices may be more readily procured in the open market and that the Owners are not tied up to some particular manufacturer's special make.



Watertight Fixtures

Briefly the S-M Watertight Globe Fixtures consist of all the customary Marine Types, part of which is shown in the illustration. They are of a strictly standard character. The Globes and Guards are interchangeable with other manufacturers' makes that have adapted the original Navy standard of thread and dimensions. As these are the most prevalent, renewals may be more readily procured.

Type C is for 60 Watt lamps and Type E for 150 Watt. Either will make up any of the many possible combinations of the S-M line, some of which are shown in the illustration. When furnished complete, unless otherwise specified, they are provided with Bryant Marine Wiring devices.

Combinations may be specified by referring to the letter of the respective unit—for example—U. B. is a combination of U. Box and B. Cover or U.A.C.-1 is U. Box with Angle Bracket A. and Fixture C-1.

Fixtures Type C-1 and C-5 in connection with covers N, A, T, L and O and the U. Boxes may be arranged to any angle desired. Globe Holder C-57 makes up Type C-6 Fixture with switch or C-2 without switch. This holder as shown in cross section 57 may be quickly clamped to the box similar to a hand hole cover. The screws are within the line of contact of the Globe and cannot be lost as they are retained to the clamping plate. Type C-57-B is provided with Bryant No. 4146 Receptacle which assures that no water will get through even if the Globe is missing.

Type E Globe Holder not shown is similar to C-57 but for larger Globes.

Type E Fixture is constructed similar to Type C-57 but for larger lamps. It may also be readily attached to the Universal Box or Bodies. The S-M Convertible Line may thus be completely repeated from a standard 60 watt equipment to a 150 watt, simply by the addition of this single unit. It is made of brass, furnished with Type E Globe 4¼ x 8 and Type E Guard. This fixture will make up all combinations of the S-M line of interchangeable fittings.

Marine Electrical Appliances

Universal Conduit Boxes

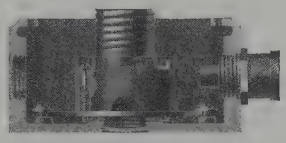
The Seidler-Miner Conduit Boxes combine both a fixture body and an outlet box. They meet practically every requirement as an outlet for electric wiring in a conduit system, and can be used for Junction, Switch, Plug, Receptacle, Angle or Pendant Fixtures and other devices. This feature is made possible by merely adding to the Universal Box different types of covers and fittings to meet the individual case.

The box is drilled and tapped to be used either for one, two, three or four way. These holes are sealed absolutely pressure tight by patented expansion plugs, thus possessing all the advantages of a knock-out box and yet being ready threaded for pipe. It is the only box in the market that has this feature.

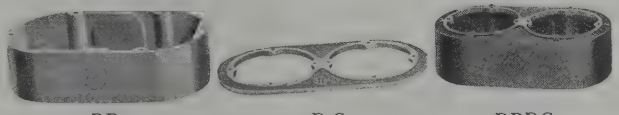
This is most useful since it makes it unnecessary to know in advance how many boxes of one, two, three or four ways are to be used, which information is so necessary in the use of boxes with threaded hubs. Unlike the latter, the Universal Boxes, once they are installed, need not be taken out when it becomes necessary to make additional runs. To take care of this, it is only necessary to knock out a plug and screw in the conduit.

The Seidler-Miner Universal Conduit Boxes are furnished either in cast iron or brass. The U. Boxes are 4″ diameter by 2″ deep and the Multiple Boxes are 8″ by 4½″ by 2½″. They are heavily bossed inside to provide extra strength at the conduit holes whether for ½″, ¾″, or 1″ pipe size. They are furnished three way for ½″ unless other sizes are specified. Screw holes for interior fittings are spaced 1⅜″ apart, this being standard for all the Bryant Marine wiring devices, but other spacings are provided in the adjustable Bottom Plate which, so to speak, forms a false bottom shown in above cross section. Wiring devices may first be fastened to the plate and the combination then inserted in the box. A slight turn brings flange of plate under the washer head screws.

S-M, U-Box
Showing Knock Out Plug

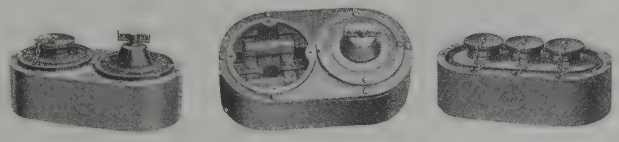


S-M, U-Box
Showing Bottom Plate and Key Operating Plug R



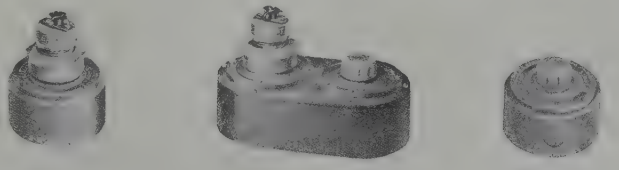
DB D-C DBDC

S-M Multiple Boxes



DBPS DBS DB3P

S-M Multiple Box Fitted with S-M Devices



UPBP DBDC,+ UBBS Switch

S-M Boxes Fitted with Bryant Devices

S-M Covers and Fittings

S-M Covers and Fittings are all interchangeable. Used in connection with the S-M Universal Box or as sub-covers for the Multiple Boxes, combinations may be made as wanted whether for Fixtures, Switches, Plugs, Receptacles, Fuse Cutouts, Interconnecting Blocks or Junction. Combinations thus made up are more economical than the "All in one Types," more practical because changes may be made without disturbing the work once installed. They reduce the assortment generally provided and insure against excess stock accumulation of the more expensive types. These covers make it possible to carry out the plan originated by Seidler-Miner to install the outlet boxes as the conduit work progresses and be assured every requirement of an outlet will be accommodated.

Type H. O. C. Cover has the features of a Hand Hole Cover, the clamp plate engaging under the lugs of U. Box or duplex cover type D. C. It affords the quickest means of putting on or taking off a cover and is particularly useful for accessibility to fuse boxes such as shown in Multiple Box D. B. S.

Catalog No. 15 S B C describing more fully the line gladly sent on request. Prices will be found not more than others but by the use of the S-M Convertible Marine Electrical Devices as they have proved, there is great economy in the original installation and that they conserve the best interest of the Ship Owner.

No mistake can be made by using S-M Conduit Boxes because they are standard and real outlet boxes. Ones with the conduit pipe outlets already in and not boxes that require the expense of drilling and tapping after purchase. You need not fear their adaptability to standard wiring devices as their design allows the use of the greatest assortment of any box in the market. They will not tie you or the owner up to only a certain manufacturer's make. They will save you real money and favor the Ship Owner.

Lighting Fixtures

Manufacturing Experience and Facilities

F. H. Lovell and Company was established originally in 1864 at John and Pearl Streets, New York City. In 1901 the company acquired the present plant, which since that time has been greatly enlarged. Situated on the Erie Railroad, seven miles from New York City, the plant is within easy motor-trucking distance of that city. Freight connections at a short distance from Arlington are made with all the large railroad trunk lines in the East.

The experience of this company in manufacturing and handling marine lighting fixtures and wiring appliances, throughout the past 56 years, has covered an enormous field, their products being sent to every part of the world.

"Lovell" lighting fixtures and appliances are being continually developed to keep pace with modern requirements and today are probably the most complete line of high grade material for this purpose.

On approximately one hundred per cent of the Navy building program in the last ten years, including practically all of the war program, lighting fixtures and wiring appliances of "Lovell" manufacture were installed on the various types of vessels. In addition to this Navy equipment, a large and varied line of "Lovell" fixtures and fittings is manufactured for merchant vessels.

Deck Fixture

Bulkhead Fixture

Deck Drop and Bulkhead Fixtures

The accompanying illustrations show "Lovell" fixtures, steam-tight and water-tight, for use on decks and bulkheads. A complete line of these fixtures was developed just prior to the war and is widely known as the "500 line." This type of fixture combines a maximum lighting unit with a minimum drop of fixture and the greatest strength.

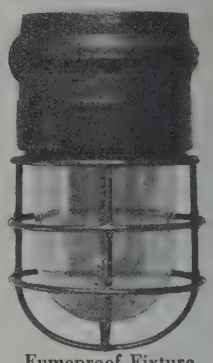
The "500 line" was installed on all the submarine chasers and countless other vessels such as transports, etc. It is now largely used on merchant vessels and on other commercial work.

In addition to the deck and bulkhead fixtures illustrated, the line includes drop fixtures, single and double angle fixtures, extra heavy fixtures where great strength is required, etc. All fixtures can be supplied for either open or conduit wiring.

The material is brass throughout. Guards are made of round wire for maximum strength with wire clips for holding in place of solder and have coarse threads to prevent jamming.

Fume-Proof Fixtures for Oil Tankers

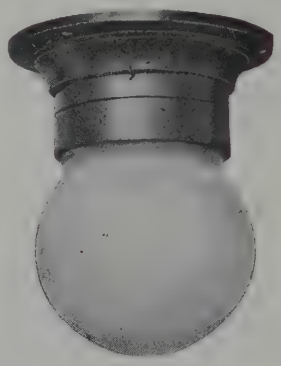
On certain types of vessels such as oil tankers, etc., fixtures must, in addition to being water-tight and steam-tight, also be fume-proof. To meet these conditions the No. 587 fixture shown in the accompanying illustration has been developed. It is recognized as standard on this class of work.



Fumeproof Fixture

Ceiling Fixtures

For interior work the general tendency in the present day is to eliminate excessive ornamentation. Simple designs combined with symmetrical lines and sufficient strength for long life characterize "Lovell" ceiling fixtures. These fixtures, of the type illustrated, admirably embody present day standards and are most suitable for use in cabins, dining saloons, etc.

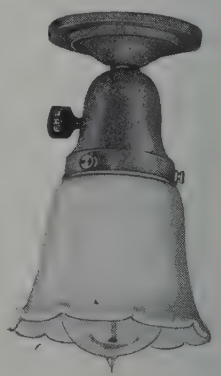


Ceiling Fixture

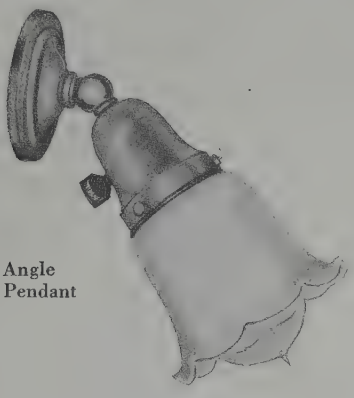
These fixtures may be furnished with or without guard, water-tight or non-water-tight, with boxes for open or conduit wiring, and with clear or frosted globes, as desired. They are of brass throughout, the boxes being of natural brass finish and the guards, where furnished, of dark navy bronze finish.

Ceiling and Angle Pendants

For passageway, staterooms, and other similar locations where water-tightness is not essential on board ship, small, neat designs of pendant and bracket fixtures are generally used. These are made in a large variety of arrangements such as with one, two or three lights, with or without box for conduit wiring, with plain or fluted base, and plain or embossed box. These pendants are of brass throughout, and are furnished with opal glass or ornamental



Ceiling Pendant



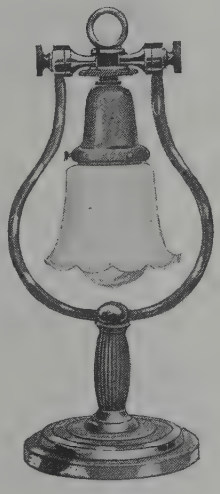
Angle Pendant

shades. They are finished in natural brass unless otherwise specified, in which case any special finish can be furnished.

Desk Fixtures

On many vessels the officers' quarters are equipped with desk lights similar to the fixture No. 845 illustrated. This fixture has the additional advantage of being a combination desk light and pendant or bracket berth light. It is detachable at the fork of the arms for use as desired.

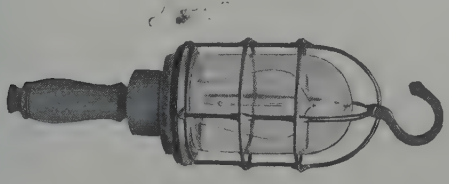
The desk fixtures are similar to the pendant type and are manufactured in practically the same variety of arrangement or finish of shade.



Desk Fixture

Hand Portables

"Lovell" Hand Portables are built water-tight or non-water-tight and with flat or round wire guard. These portables are strong and compact and can be furnished to have parts interchangeable with those of deck and bulkhead fixtures. They are made of brass throughout, with bases finished in natural brass, and guards of dark navy bronze.

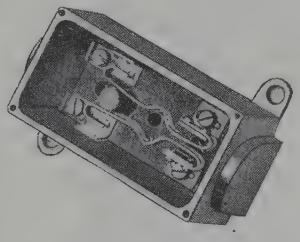


Hand Portable

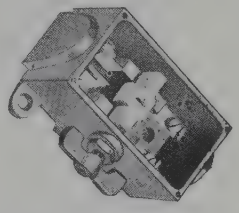
Lovell Water-Tight Boxes

As Marine lighting fixtures are water-tight, so must the wiring be. For this purpose the company manufactures switch, junction and receptacle boxes. These boxes are made of brass or iron. The company recommends the use of brass entirely and aims as far as possible to make all fixtures of this metal, which insures small expense on replacements and serves to eliminate loss through corrosion from any action in the salt air. A general line of iron boxes is manufactured for use where specified, at a slightly lower price than the brass boxes.

The interior fittings are usually made of porcelain or molded composition. A rubber gasket is inserted between the box and the cover, and all bosses are furnished blank unless tapping is specified.



Water-Tight Receptacle



Water-Tight Switch

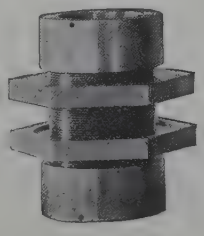
The great advantage in the design of the "Lovell" switch is the small number of parts and the great simplicity. To meet Navy requirements it is necessary to construct this equipment using standard parts, all interchangeable, and this feature has been extended to the Lovell commercial line for the convenience of users.

Thus where it is necessary to dismantle boxes, the interchangeability permits the replacing of small parts without discarding the complete box.

Stuffing Tubes

The conduits or armored cable used for wiring are lead through the decks and bulkheads and the ends are attached to any connection through the medium of water-tight tubes, known as terminal and stuffing tubes. These tubes can be furnished in varying lengths to suit the thickness of the bulkhead or deck. Where stuffing box does not fit over conduit, a hard rubber lining is furnished, and suitable gaskets can also be furnished.

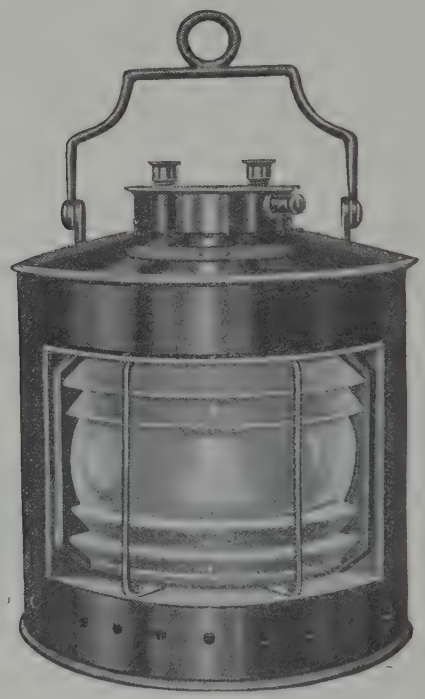
"Lovell" bulkhead stuffing tubes are built in sizes (inside diameter of hard rubber lining) 7/16", 5/8", 13/16", 1 1/8" and 1 5/16". Conduit stuffing tubes for the following I. P. S. conduit: 1/2", 3/4", 1", 1 1/4" and 1 1/2".



Conduit Stuffing Tube

Bulkhead Stuffing Tube

Ship's Lights—Cargo Reflectors



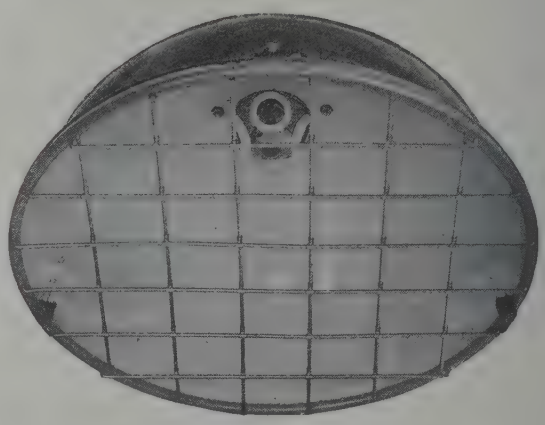
Side Light

Ship's Running Lights

"Lovell" ship's running lights are made either of brass, copper or galvanized sheet steel, and for the use of oil or electric light, or for a combination of both. The finish of these lights is either the polished natural metal of which they are made or what is known as "Navy Bronze." This is a steel color similar to a gun barrel.

The highest type of lights have a cut glass French lens, others a very high grade pressed glass lens. In all cases these lights are finished so as to be extremely durable in salt air. These lights are all of the finest construction, heavily and sturdily built to stand the most severe service to which they could be subjected.

The completeness of the line of "Lovell" ship's lights enables the company to furnish standard equipment to outfit completely any type of vessel.



Cargo Reflector

Anchor Light

Cargo Reflectors

Cargo Reflectors are furnished, fitted with wireless cluster with from two to eight lights as desired. These reflectors are fitted with a substantially made guard of ¼" round rod with clips at all crossings. The reflector body is made of heavy galvanized sheet steel and can be made with copper shell if desired. The finish is white enamel inside and black outside, the guard being of heavy rod, finished navy bronze.

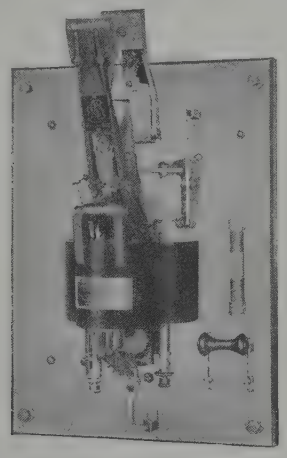
Catalog No. 500, issued by F. H. Lovell & Co., covers a most extensive line of watertight and steamtight marine wiring and lighting appliances. This catalog is sent on application.

F. H. LOVELL & CO., ARLINGTON, N. J.

Automatic Reclosing Circuit Breakers

Complete Automatic Protection of Direct Current Circuits

The Automatic Reclosing Circuit Breaker, illustrated below, was designed to control the reclosing as well as the opening of direct current circuits. It therefore affords complete protection of the line after a short circuit or overload by remaining open as long as the short circuit exists or the rheostat is in the operating position and by reclosing as soon as the load conditions are proper.



Type ARL Automatic Reclosing Circuit Breaker

Sizes and Construction

The Automatic Reclosing Circuit Breaker is built in a number of sizes for circuits of various capacities as listed below.

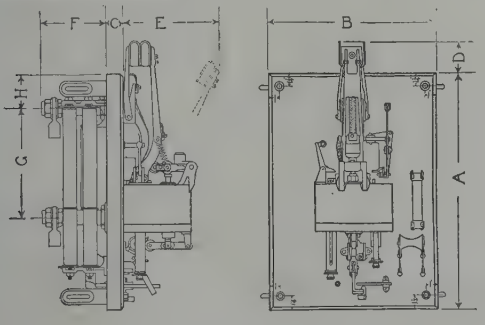


TABLE OF CAPACITIES AND DIMENSIONS

Type	Ampere Overload Calibration.			Volts	Dimensions in Inches							
	Rating	Min.	Max		A	B	C	D	E	F	G	H
CRL	25	15	50	110,250,600	21	16	1½	0	7½	4 5/16	6½	6½
CRL	50	25	100	110,250,600	21	16	1½	0	7½	4 5/16	6½	6½
CRL	100	50	200	110,250,600	21	16	1½	0	7½	4 5/16	6½	6½
CRL	150	75	300	110,250,600	21	16	1½	0	7½	4 5/16	6½	6½
CRL	200	100	300	110,250,600	21	16	1½	0	7½	4 5/16	6½	6½
CRL	300	200	500	110,250,600	21	16	1½	0	7½	4 5/16	5⅞	6½
CRL	400	200	600	110,250,600	21	16	1½	0	7½	4 5/16	5⅞	6½
ARL	300	200	500	110,250,600	21	16	1½	1¼	7	4¼	8¾	4
ARL	400	250	600	110,250,600	21	16	1½	1¼	7	4¼	8¾	4
ARL	600	400	900	110,250,600	21	16	1½	2½	8⅝	4¼	9⅜	3⅜
ARL	800	600	1200	110,250,600	21	16	1½	2½	8⅝	4¼	9⅜	3⅜
DRL	1200	900	1800	110,250,600	27	16	2	3¾	12	5	7⅞	3½
DRL	2000	1200	3600	110,250,600	27	16	2	3¾	12	5	7⅞	3½
LRL	3000	2000	4500	110,250,600	36	16	2	1½	13½	4¾	9⅛	5½
LRL	4000	3000	6000	110,250,600	36	16	2	1½	13½	4¾	9⅛	5½

The operating and trip coils are completely housed and protected in a cast iron frame which carries the operating mechanism. The main current carrying contacts are standard construction, consisting of laminated copper brush, secondary copper to copper contacts, and strong and substantial graphalloy contacts to make the final break and rupture the arc. The breakers are mounted on standard sized slate with ¼ inch beveled edges and black marine finish unless otherwise specified.

Operation

The Automatic Reclosing Cir-Breaker consists essentially of three coils: the operating coil which closes the main contact and holds the breaker closed; the overload coil which causes the breaker to open in case of an excessive current; and the trip coil which releases the lockout and permits the breaker to reclose.

The breaker being held closed magnetically, will open either in the event of voltage failure or by the momentary opening of operating coil circuit which will result from an overload or short circuit. Before the trip coil can possibly act to reclose the circuit a dash pot included in the reclosing mechanism provides a definite time interval during which the breaker must remain open regardless of the cause of opening. The circuits, coils, and contacts in the breaker are so arranged that the breaker does not attempt to close while a short circuit or overload of low resistance exists, but does close instantly and automatically upon the removal of the short circuit or overload.

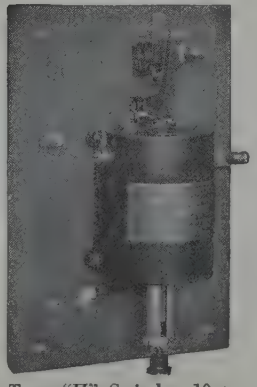
The breaker has three adjustments; an overload adjustment, a time interval adjustment, and a "dead load" adjustment. It may be adjusted to open at a certain value of current, remain open a definite time interval, and then reclose when the load conditions have become such that a current, not in excess of the "dead load" setting of the breaker, will flow when the breaker closes. For generator service, it may also be adjusted to open and remain open by thermostats which can be furnished to be placed on bearings.

Automatic Reclosing Battery Charging Switches

Type "H" Battery Charging Switches are used in the charging circuit of a battery to prevent the battery from discharging back into the source of supply in case the charging voltage drops too low to maintain the charging current.

They open automatically when the charging current falls to zero and reclose automatically when the voltage is restored to normal value for charging the battery. The opening of the switch depends directly and positively upon the charging current falling to zero.

These switches are furnished for any standard voltage and in capacities of 10, 30, 50 and 100 amperes normal rating.

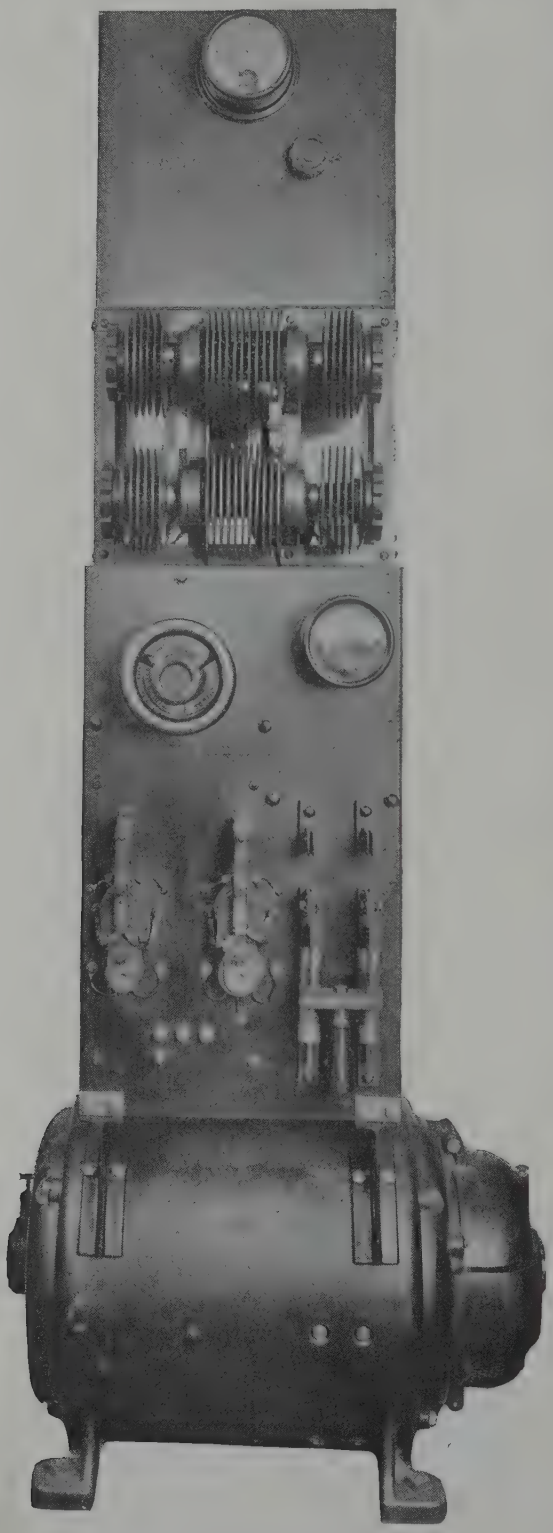


Type "H" Switch. 10 to 50 Amp. Size

AUTOMATIC RECLOSING CIRCUIT BREAKER COMPANY

COLUMBUS, OHIO

Radio Equipment



2 K W Transmitter and Motor Generator

Radio Equipment

Radio equipment is required by law on all vessels navigating the ocean or the Great Lakes and licensed to carry, or carrying, fifty or more persons, including passengers or crew, or both. The advantages of having radio available is now so generally recognized that practically all vessels now being built, whether required by law or not, are so equipped. Modern radio apparatus has reached such a state of development that it is possible to consider it just as much a part of the standard equipment of a ship as the lighting plant or galley stove.

Cutting and Washington Sets

Cutting and Washington Radio Sets have been pronounced by experts as the simplest and most efficient on the market and have been used on all types of vessels from seaplanes to submarines.

Sizes Built and Power Required

Standard sizes are 3/10 KW, 1/2 KW and 2 KW and power leads to the radio room should have capacity for approximately 700 watts, 1500 watts and 4000 watts, 110-125 volt direct current respectively for the three sizes. Special motor generators are required where 110 volt direct current is not available.

Space Required Radio Room

Illustrated on the following page is a sketch showing the minimum space required for a 2 KW set. For a 3/10 KW or 1/2 KW almost the same space is required, except that for these two sizes it is necessary to provide an operating table at least two feet longer as the transmitter rests on the table. The motor generator of the 3/10 KW is built in the panel and for the 1/2 KW the motor generator can occupy any convenient space under the table. The radio room may be as much larger as desired, and frequently is combined with the stateroom of the radio operator. The radio room should be on the main deck, or near the chart room in order to give as direct a lead-in from the antenna as possible, and for easy communication with the navigator.

Range

The Range depends on many factors, some of the more important being as follows:

1. Power and efficiency of the transmitting set.
2. The type and efficiency of the receiving set at the stations to which messages are sent.
3. The properties of the antenna, height, length and ground. (Wooden vessels should have a copper ground on the hull below the water line.)
4. The character of the surface over which messages are sent.
5. The time of day or night, winter or summer,

latitude, Atlantic or Pacific Ocean, and atmospheric conditions generally.

6. The ability and efficiency of the operators at both transmitting and receiving stations.

The table below gives approximately the daylight range that may be expected from a 2 KW transmitter on a steel ship with an antenna of the dimensions given. Take one-half of these distances for the range of a 1/2 KW and 2/5 for the 3/10 KW set. The night range may be from two to five times the daylight range, depending upon the usual conditions of radio communication.

APPROXIMATE RANGE IN MILES FOR 2 K.W. DAYLIGHT SENDING

Antenna Height Feet Above Main Deck.	Antenna Length in Feet.									
	50	60	70	80	90	100	110	120	130	140
40	200	220	240	260	280	300	—	—	—	—
50	240	260	300	320	340	360	—	—	—	—
60	—	320	340	380	400	400	—	—	—	—
70	—	—	380	400	410	420	430	440	450	460
80	—	—	420	430	440	450	460	480	490	500
90	—	—	—	450	480	500	500	500	510	520
100	—	—	—	—	500	510	520	520	530	540
110	—	—	—	—	—	520	540	540	540	550
120	—	—	—	—	—	—	550	550	560	570

For Special Conditions Communicate with the Manufacturers.

Selection of Apparatus

In selecting radio apparatus the first thing to determine is the size of set to be used and the preceding table will be of assistance, bearing in mind that coastwise vessels rarely need a daylight range of more than one hundred fifty miles and transoceanic ships of more than 300 miles. After the size of the set has been decided upon, the particular characteristics of the radio set should be considered and following are some of the features of Cutting & Washington sets which have made them so deservedly popular.

Simplicity

Cutting & Washington radio sets have fewer parts than those of any other manufacture. There are no critical adjustments and few of any kind to make. Anyone who knows the code can operate them.

Reliability

The experience of all users is well summed up by quoting from a letter from one user, "the set has now been in service for about ten months and it is entirely satisfactory and during the above period it has always been in operation."

Efficiency

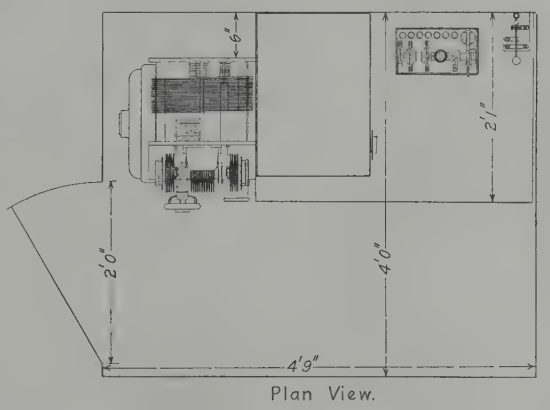
Cutting & Washington radio sets will operate through a wider range of ship's voltage than any other set made without the note breaking. The distinctive 500 cycle musical note, characteristic of our sets alone, carries through interference that would be impossible for many sets. Taking into account all of the factors of design, construction and operation it is safe to assert that they are the most efficient sets obtainable.

Quietness and Safety

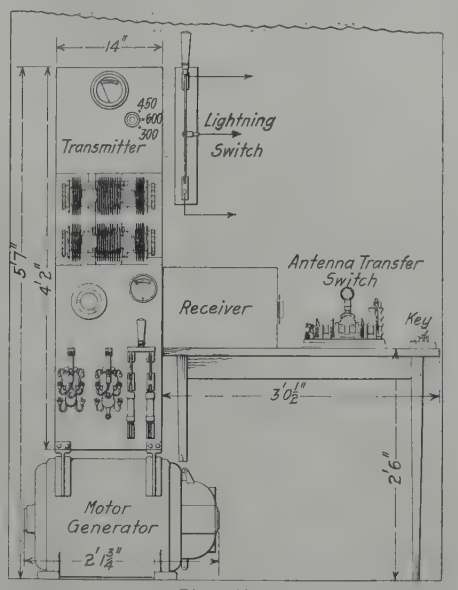
Operating on the impact excitation principle with gap voltage of 250 as compared with 8,000 to 20,000 of ordinary quench sets, it is easily understood that greater safety is obtained and lacking the flashing and crackling of the ordinary spark sets are practically noiseless, which contributes to a secrecy most desirable.

Maintenance and Service

It has been customary, until the advent of Cutting & Washington sets, for ship owners to pay large sums annually for the maintenance of radio sets. There is no more reason to pay for maintenance of Cutting and Washington radio sets than to do so for a ship's dynamo, for the average cost has not exceeded five dollars per year per ship, covering a period of several years. The accounting for messages sent or received is a simple matter.



Plan View.



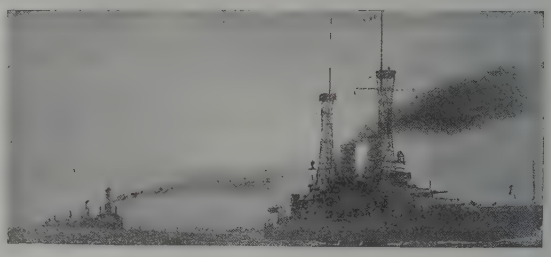
Elevation.

Minimum Space Required for Radio Room
2 KW Cutting & Washington Set

CUTTING & WASHINGTON RADIO CORPORATION
6 AND 8 WEST 48th STREET, NEW YORK, N. Y.

Electrose Insulators 1,000 to 1,000,000 Volts

U. S. S. New Mexico—Electrose Equipped



U. S. S. South Carolina Leading Two Divisions—Electrose Equipped

Electrose Insulators

Electrose Insulators are standard with the United States Navy and Army and wireless telegraph and telephone companies. Electrose is made up in a number of grades for various requirements, each grade possessing special characteristics. Electrose insulators are the best in the world for high frequency currents, power and transmission circuits.

Rod Type Strain Insulators

Rod Type Strain Insulators are made up in various sizes. The terminals are riveted to a fibre rod hermetically imbedded in the Electrose. Different styles of terminals can also be provided. This form of construction prevents the line from falling, even though the Electrose insulation becomes injured or totally destroyed. This type can also be furnished without imbedded rod.

No. 4507

No. 4514

No. 4517

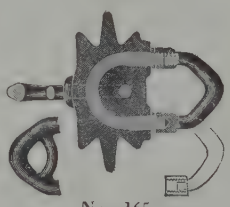
No. 4518

Rod Type Strain Insulators

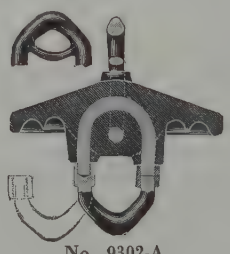
Disc Strain and Suspension Insulators

Both the "Strain" and the "Suspension" types of Insulators consist of insulating discs furnished with interlocking terminals at each end to permit connecting any number together in series long enough to provide the desired insulation. The series is often graded from a large insulator at the conductor to a smaller one at the support, thus reducing the weight and at the same time increasing the dielectric qualities of the series.

No. 157



No. 165



No. 9302-A

No. 9351

Disc Strain and Suspension Insulators

ROD TYPE AND DISC STRAIN AND SUSPENSION INSULATORS

Number	Diameter in inches	Length of Body in inches	Opening of Eye in inches	Overall Length in inches	Breaking Strength in pounds	Mechanical Test in pounds	Electrical Value Dry in volts	Electrical Value Rain in volts	Line Voltage	Test Voltage Dry in volts	Net Weight Each in pounds
4507	1½	7	⅝	10½	2,000	1,000	90,000	55,000	22,000	60,000	1
4514	1⅝	12	⅞	15⅞	3,000	1,500	14,000	80,000	33,000	10,000	1⅝
4517	2	18	1	22	5,000	2,500	185,000	100,000	44,000	12,000	3⅞
4518	2	18	1	22	6,000	3,000	185,000	100,000	44,000	12,000	3⅝
165	7½	3½	1¼x1⅝	10⅝	20,000	10,000	85,000	55,000	25,000	55,000	7¾
157	7	3	1⅜x1½	10⅛	14,000	7,000	75,000	40,000	13,000	50,000	6
9302-A	10	3¾	1¼x1⅝	9½	20,000	10,000	100,000	55,000	25,000	75,000	11
9351 Made up of 9301-A, 9302-A, 9303-A and clamp				30⅛	20,000	10,000	270,000	150,000	66,000	180,000	36

ELECTROSE MFG. CO., BROOKLYN, N. Y., AMERICA

Electrose Insulators 1,000 to 1,000,000 Volts

U. S. S. K-2, Electrose Equipped

U. S. Submarine Chaser A-2, Electrose Equipped

Electrose Standard Products

The Electrose Manufacturing Company make Disc Strain and Suspension Line Insulators, Pin Type Line Insulators, Insulator Pins, "Safety Strain" Insulators, Disc Hood, Thimble and Rod Type Strain Insulators, Spool and Bracket-Arm Strain Insulators, Roof Barrier and Wall Bushings and Insulated Connectors, Single and Multi-Part Plain and Locking, Water and Gas Tight, Bushings and Insulated Connectors, Bus-Bar Insulators, Insulating Supports and Pedestals, Arc Lamp Insulators, Insulating Knobs and Handles, Insulating Sheets, Tubes and Rods, etc.

Also, Electrose Railway Overhead, Surface and Underground Line Insulators: Safety and other types of Strain Insulators, Brooklyn Strain Insulators, Insulated Turn-Buckles, etc. A complete line always carried in stock.

Electrose Insulation (certain grades) is recognized as the best obtainable for use in connection with insulating parts for Radio Work, Ignition Service for Automobiles, Aeroplanes, Motor Boats, etc.

Electrose Insulation for ignition parts: Distributor Blocks, Discs Switch Bases, Spools, Brush Holders, Knobs, Handles, etc.

Insulators and insulating parts and devices of special size and forms, designed and made to order.

No. 2

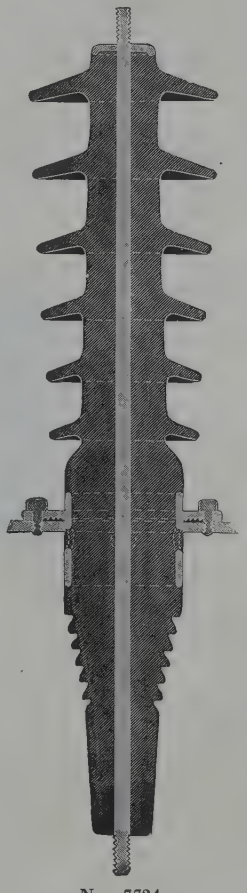
No. 7

No. 14

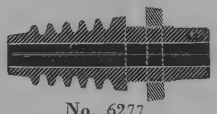
No. 10 (New Type)

No. 10 (Old Type)

Safety Strain Insulators

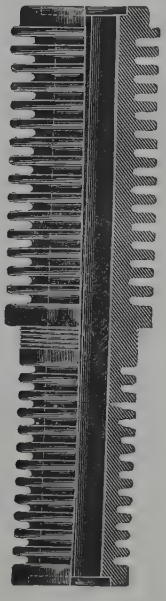


No. 7724
Insulated Connector



No. 6277
Insulating Bushing

No. 6815
Insulated Connector



No. 6030
Insulating Bushing

SAFETY STRAIN INSULATORS

Number	Diameter in inches	Length of Body in inches	Opening of Eye in inches	Overall Length in inches	Breaking Strength in pounds	Mechanical Test in pounds	Electrical Value Dry in volts	Electrical Value Dry in volts	Test Voltage Dry in volts	Line Voltage	Net Weight Each in pounds
2	2¼	1¾	1x⅝	4½	7,000	4,000	12,000	7,000	5,000	2,500	⅞
7	3⅛	2⅝	1x¾	5¼	10,000	6,000	25,000	12,000	10,000	6,600	1¾
14	5	2⅝	⅞x1⅜	5¼	10,000	6,000	25,000	15,000	15,000	6,600	2⅛
10 New Type	4	3	1½x⅞	7⅛	20,000	10,000	45,000	25,000	20,000	11,000	3⅝
10 Old Type	4	4 1/16	1 1/16x⅞	8 1/16	20,000	10,000	40,000	20,000	15,000	11,000	4¼

CONNECTORS AND BUSHINGS

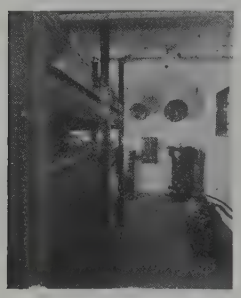
Number	Diameter of Body in inches	Overall Length in inches	Electrical Value Rain Test in Volts Upper End	Electrical Value Dry Test in Volts Upper End	Electrical Value Dry Test in Volts Lower End	Puncture Value in oil	Tested to	Line Voltage	Net Weight Each in pounds
7724	6	41	190,000	235,000	110,000	250,000 volts	85,000 volts	66,000	75
			Electrical Value Rain Test Outside End	Electrical Value Dry Test Outside End	Electrical Value Dry Test Inside End				
6030	7	33½	130,000	180,000	130,000	180,000 "	130,000 "	66,000	65
6277	2¼	9⅝	35,000	60,000	45,000	90,000 "	45,000 "	11,000	2¾
6815	1⅞	6¼	20,000	50,000	20,000	85,000 "	20,000 "	6,600	2

ELECTROSE MFG. CO., BROOKLYN, N. Y., AMERICA

Marine Storage Batteries

The Edison Storage Battery in Wireless Service

As lights or emergency wireless apparatus may be required on a ship at any time during the day or night, there must be always at hand some constant and dependable source of electric current. The Edison Nickel-Iron-Alkaline Storage Battery meets this situation and at the same time overcomes the weaknesses of the older types of storage batteries.



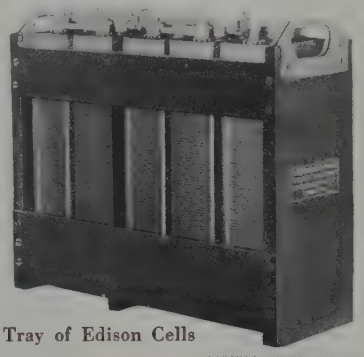
Typical Wireless Installation

Wireless Telegraph Apparatus demands reliability of the highest order. Emergency apparatus must be available that will enable the operator to obtain full power instantly for operating the radio equipment.

The Edison Storage Battery has met the exactions of marine auxiliary wireless service more closely than any other source of power.

Edison Batteries do not require the attention of experienced battery men to carry out an elaborate system of inspection and maintenance. The operating rules are few and simple.

The Edison Storage Battery is built entirely of steel, is practically unbreakable and is so constructed that it can be tipped to an angle of 45 degrees without spilling the electrolyte. Should the solution be spilled it is harmless, and as it contains no acid, the metal fastenings of the hull will not be affected if the liquid runs into the bilge.



Tray of Edison Cells

The Merchants and Miners Transportation Company, the United Fruit Company, the Standard Oil Company and many other large Steamship Companies are using Edison Storage Batteries exclusively for auxiliary lighting and emergency wireless purposes.

Used in Shipyards for Trucks and Tractors

Trucks and Tractors equipped with Edison Storage Batteries are widely used in shipyards for carrying parts from one shop to another, and on docks for loading and unloading vessels. The superiority of these trucks over man-power is demonstrated daily in thousands of installations.

Storage battery trucks are built to withstand hard usage. What about the storage batteries? Obviously a storage battery built throughout of steel — steel plates, steel poles, steel container — and having nothing about it to break or crack is the logical battery for this service.

With no regular plate renewals, no broken parts, no cracked containers, and no ordinary accident that will put the battery out of commission, the Edison Storage Battery gives continuous and uninterrupted service.

Edison Trucks in Shipyard

Edison Storage Batteries have the highest Service Factor. They will operate every working day at 100 per cent capacity and do a full day's work each day. This indicates the reason why Edison Storage Batteries have been specified for thousands of electric trucks and tractors.

Distributors

Distributors are located in New York, Boston, Philadelphia, Cleveland, Chicago, New Orleans, San Francisco and Seattle. The General Distributor for New York City and Vicinity is the Smith-Meeker Engineering Co., 123 Liberty St., New York City.

DATA AND TRAY DIMENSIONS OF EDISON STORAGE BATTERIES

Type of Cell (letters denote size of plate, figures denote number of positive plates)	B1H	B2	B4	B6	A4	A5	A6	A8	A10	A12
Rated capacity, ampere-hours	18.75	37.5	75	112.5	150	187.5	225	300	375	450
Average discharge voltage per cell	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Rate of charge, amperes for 7 hours	3.75	7.5	15	22.5	30	37.5	45	60	75	90
Normal rate of discharge, amperes	3.75	7.5	15	22.5	30	37.5	45	60	75	90
Weight of single cell, pounds	4.9	4.7	7.5	10.8	13.9	16.7	19.4	27.2	33.3	41.3
Weight per cell, in trays, pounds	5.7	5.4	8.3	11.7	15.3	18.1	20.9	29.5	36.2	44.8
Overall Tray Dimensions, in Inches										
Width of tray	6⅛	6⅛	6⅛	6⅛	6⅛	6⅛	6⅛	6⅛	7¾	9
Height over all (filler cap closed)	11⅝	9⅝	9⅝	9⅝	14⅜	14⅜	14⅜	14¾	14¾	15½
Height over all (filler cap open)	12⅜	10⅝	10⅝	10⅞	16	16	16	16⅜	16⅜	17
Length of trays: 1 cell tray	3⅛	3⅛	4¼	5⅜	4⅝	5¼	5¾	7¼	7½	7½
2 " "	5	5	7⅜	9⅝	7¾	9	10	12⅞	13½	13½
3 " "	6⅞	6⅞	10½	13⅞	10⅞	12¾	14¼	18⅝	19½	19½
4 " "	8⅞	8⅞	13⅝	18⅛	14	16⅜	18½	24⅛	25⅞	25⅞
5 " "	10¾	10¾	16¾	22⅜	17⅛	20	22¾	29¾	32¼	32¼
6 " "	12¾	12¾	19⅞	26⅝	20¼	23⅝	27¾	36	.....	.....
7 " "	14⅝	14⅝	23	31¼	23¼	28½	32	41⅝	.....	.....
8 " "	16½	16½	26	35⅝	27¼	32¼	36¼	47⅛	.....	.....
9 " "	18½	18½	29¾	39⅞	30⅜	36	41⅛	53⅝	.....	.....
10 " "	20⅜	20⅜	32⅞	44⅛	33¼	40¼	45⅛	.....	.....	.....
11 " "	22¼	22¼	36	.....	36⅜	43⅞	.....	.....	.....	.....
12 " "	24⅜	24⅜	39	.....	40⅛	.....	.....	.....	.....	.....

EDISON STORAGE BATTERY CO.

ORANGE, N. J.

Engine Room Telegraphs

Single Dial Engine Transmitter

Single Dial Reply Engine Transmitter with Engine Room Indicator

Single Dial Engine Transmitters are made in standard sizes, as shown in the table below, either of the "Reply" or "Non-Reply" type, and with Automatic Direction Tell-Tale Pointer if required.

These Transmitters are made entirely of polished brass with oil lamp, combined oil and electric lamp, or both oil and electric lamps; polished brass head on cast iron pillar; and cast iron head and pillar, with brass front rim and brass lever handle.

The Indicators are made in standard sizes, as shown in the table below, either of the "Reply" or "Non-Reply" type, fitted with loud-sounding gong. When required they are made with Duplex Gongs, having a deep tone for "Ahead" and a shrill tone for "Astern" orders, and also with Automatic Reply Pointer actuated from the weigh shaft.

All our instruments are of first class workmanship and finish throughout, being made by a staff of thoroughly qualified workmen, and are guaranteed against defective material or faulty construction for a period of 12 months from date of delivery. We will replace, free of cost, any part or parts, which may prove defective during that time.

Double Dial Engine Transmitters

Double Dial Engine Transmitters are made in standard sizes, as shown in the table below, either of the "Reply" or "Non-Reply" type, and with Automatic Engine Direction Tell-Tale Pointer if required.

These Transmitters are made entirely of polished brass with oil lamp, combined oil and electric lamp, or both oil and electric lamps; polished brass head on cast iron pillar; and cast iron head and pillar with brass front rim and brass lever handle.

The Indicators are made in standard sizes, as shown in the table below, either of the "Reply" or "Non-Reply" type, fitted with loud-sounding gong. When required, they are made with Duplex Gongs, having a deep tone for "Ahead" and a shrill tone for "Astern" orders, and also with Automatic Reply Pointer actuated from weigh shaft.

All our instruments are of first class workmanship and finish throughout.

When sending inquiries for Telegraphs, give the approximate size of dial required, and, if possible, also state number of angles in the lead, together with the approximate length of lead, as this enables us to send in accurate quotations and also to supply the exact quantity of fittings required.

Double Dial Reply Engine Transmitter with Engine Room Indicator

TRANSMITTERS

Visible Diameter of Dial in inches	Diameter over Rim in inches	Height from Base to Top of Head in inches
6	7½	28
7	8½	30
8	9½	39
9	10½	42
10	11½	43
11	12½	45
12	14	46
14	16	46
16	18½	46
18	20½	46
20	23	46

INDICATORS

Visible Diameter of Dial in inches	Diameter over Rim in inches
9	11
11	13
12	14
14	16
16	18
18	20
22	24
24	27

TRANSMITTERS

Visible Diameter of Dial in inches	Diameter over Rim in inches	Height from Base to Top of Head in inches
6	7½	28
7	8½	30
8	9½	39
9	10½	42
10	11½	43
11	12½	45
12	14	46
14	16	46
16	18½	46
18	20½	46
20	23	46

INDICATORS

Visible Diameter of Dial in inches	Diameter over Rim in inches
9	11
11	13
12	14
14	16
16	18
18	20
22	24
24	27

Chadburn Ship Telegraphs

Chadburn Experience

More than 200 years ago the original Chadburn plant was established, at Liverpool, England, for the manufacture of various types of instruments. Chadburn ship instruments are the development of over 50 years experience in this type of work. During this time many special features have been developed which make these instruments distinctive—the recognized standard of quality.

Chadburn Ship Telegraphs, for example, are installed in more than 12,000 vessels, for merchant, naval, and, in fact, every type of service. This fact demonstrates the wide use and satisfactory service of Chadburn instruments.

The Chadburn Plant at Troy, N. Y.

Manufacturing Facilities

The Chadburn Ship Telegraph Company of America, incorporated in New York State, manufactures high grade ship equipment of the Chadburn design and workmanship throughout. The plant, at Troy, N. Y., is building ship telegraphs, engine counters, and other types of ship equipment for mercantile service, as well as many special instruments for the United States Navy.

The complete equipment and convenient location of the factory insure prompt deliveries. Where desired, the installation work can be handled entirely by the Chadburn Company.

Dependability of Chadburn Ship Telegraphs

It is particularly necessary that Ships' Telegraphs be absolutely and unquestionably trustworthy. Upon the faithful transmission of orders from the bridge to the engine room depends the engineer's prompt obedience to the master's manoeuvering instructions. Failure to record these instructions correctly, for any reason, may endanger the safety of the entire ship, its passengers and cargo.

The Chadburn Standard Ship Telegraph was designed by experienced engineers, recognizing its importance as a part of the ship's equipment. No efforts have been spared to make it the best on the market. The many thousands of vessels of all types, fitted with the highest grade of Chadburn Ship Telegraph, are by its use safeguarded to a degree which fully justifies the installation of only one grade of ship telegraph—the best.

The Standard Chadburn Ship Telegraph is recommended for every installation as the highest grade instrument obtainable.

Construction of Standard Ship Telegraphs

The Bridge Transmitters are of cast brass with bright finish and with pointers protected by plate glass. They are arranged for illumination by either oil or electric lights and all patterns can be furnished with hand reply or non-reply.

The receiving indicators have enameled dials with pointer protected by plate glass and can be furnished with single bell or duplex gong. All engine telegraphs can be fitted with automatic direction tell-tales, and steering telegraphs have an automatic reply from the rudder head. Dials may be made with special orders to suit requirements in any language.

The transmission system, as well as the transmitter and indicator, has been developed to a point of utmost reliability and is most simply and sturdily constructed. The wires, chains, pulleys and brackets are all of ample strength and arranged for maximum ease of operation as well as dependability.

These instruments can be fitted on board complete, including all connections, wire, chain, pulleys, etc., or furnished packed for shipment.

The "Liberty Five" Ship Telegraph

The "Liberty Five" Ship Telegraph has been developed to meet the demand for a comparatively low priced instrument. As a working proposition, this telegraph is quite as good as the Chadburn Standard type, the interior mechanism and transmission system being exactly the same. By the omission of certain exterior features, however, the "Liberty Five" can be furnished at an extremely moderate price.

Where a ship telegraph of the utmost dependability is desired, at low cost, the "Liberty Five" is recommended.

For Naval and Large Merchant Vessels

The Chadburn Sihp Telegraph Company of America manufactures a new rod and bevel gear pattern of ship telegraph which is now fitted to all vessels on the active list of the British Navy. This type is also adapted for use on the larger ships of the Merchant Marine.

These telegraphs are arranged for engine room, stokehold, and steering orders. They contain many exclusive features which make for rapid, convenient and positive transmission of orders, and completely eliminate errors or ambiguities.

CHADBURN SHIP TELEGRAPH CO. OF AMERICA

TROY, NEW YORK

Chadburn Ship Telegraphs

The transmitter is arranged so that the wheel handle makes one complete revolution for each change or order. The pointer of the receiving dial is actuated by a mechanism which causes it to rest only at the center of each order. The gearing is arranged so that all backlash and spring is taken up during that portion of the wheel handle revolution in which the pointer is not being moved. The increased leverage of this system makes it possible to put the telegraph over from "full speed ahead" to "full speed astern" in three seconds.

A further improvement consists in the system of ball bearing brackets of special design which supports the hollow steel shafting, permitting the shaft to adapt itself to variations which may take place in the structure of the vessel. In large vessels this feature is particularly valuable. It insures absolute rigidity to torsional stresses and complete correspondence between transmitter and receiver. At the same time the connection is flexible and works very easily.

Liberty Five Ship Telegraph

Sizes of Chadburn Standard Ship Telegraphs

The dimensions of the Chadburn Standard Ship Telegraph vary somewhat with pattern and size of telegraph, the following being approximate and intended to serve only as a guide.

Diameter of base—12". Overall height—4'-1⅝". Overall width, including light—1'-3 ⅜". Shipping weight—100 to 200 lbs.

All patterns of the Chadburn Standard Ship Telegraph are made in ten standard sizes with dials having outside diameter as follows:

Size No.	1	2	3	4	5	6	7	8	9	10
Transmitter	18"	16"	13"	12"	11"	10"	9"	8"	7"	6"
Indicator	21"	21"	18"	18"	14"	14"	10"	10"	7"	6"

Patterns of Chadburn Ship Telegraphs

Chadburn Standard Ship Telegraphs for Mercantile Service can be arranged for placement and operation as follows, connections being made by chain and wire:—

For Single Engine Telegraphs—
- Transmitters on Bridge.
- Receiving Dial in Engine Room.

For Multiple Engine Telegraphs—
- Transmitters on Deck or Bridge with multiple dials for engines.
- Receiving Dial in Engine Room with different tone gong for each engine.

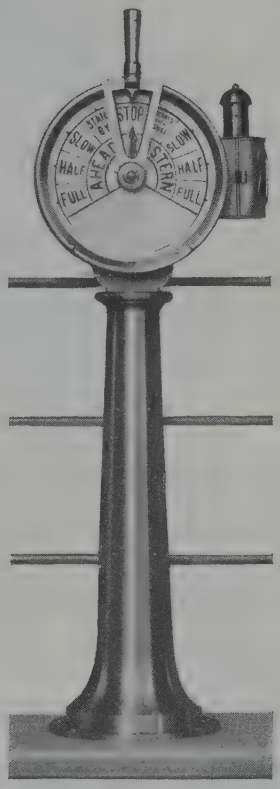
For Stokehold Telegraphs—
- Transmitters in Engine Room.
- Receiving Dials in Boiler Room.

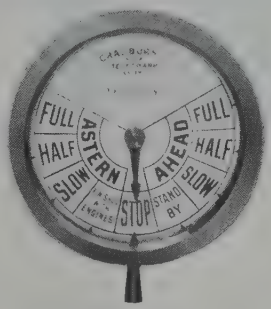
For Steering Telegraphs—
- Transmitters on Bridge with automatic rudder indicator.
- Receiving Dials at Helmsman's Station with low tone gong for starboard and high tone gong for port.

For Docking Telegraphs—
- Transmitters on Bridge.
- Receiving Dials on Forecastle and Poop.

For Look-Out Telegraphs—
- Transmitting and Receiving Dials on Bridge.
- Receiving Dials at Forecastle-head or Crow's nest.

Special designs and arangements, to meet any requirements, can be developed and manufactured.





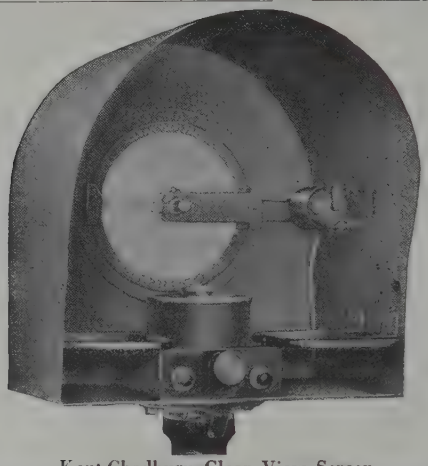
Chadburn Standard Ship Telegraph

Revolution Counters and Speed Indicators

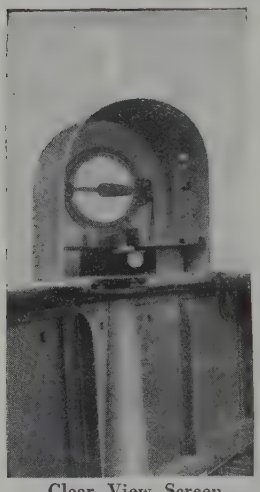
The Chadburn Engine Revolution Counter is of special patented construction and has been installed in more than 2,000 vessels. The counter may be made for either reciprocating or rotary drive, to register in either one or both directions of rotation, and with working lever set at either end of the spindle. Either six or seven figures may be furnished, and all the number wheels may readily be set at zero.

Chadburn Speed Indicators may also be furnished with dials in the engine room or on the bridge indicating the speed of the main shaft in revolutions per minute and also the direction in which the engines are running.

Clear View Screens—Steering Wheels



Kent-Chadburn Clear View Screen



Clear View Screen Mounted in Hood

Clear View Screen Mounted in Wheel House

Insuring Clear Vision at Sea

The Kent-Chadburn Clear View Screen provides a lookout window through which a permanently clear vision may be obtained, in spite of spray, rain or snow. Every navigator knows the difficulty of using binoculars in bad weather. Behind an ordinary window they are frequently useless because of rain or spray on the pane. In the open the lenses rapidly become obscured by rain or spray.

Under the worst weather conditions the Kent-Chadburn Clear View Screen provides a continuously clear vision, either with the naked eye or with glasses.

Construction of Clear View Screens

The apparatus consists of an 11-inch glass disc which revolves rapidly in its own plane on a central bearing, being driven by a small electric motor. This rotation throws off instantly any rain, spray or snow, maintaining perfect transparency.

No loss of light or definition is occasioned by the disc until an angle of about sixty degrees on either side is reached. The clearance between disc and frame is so formed that it is impossible for rain or spray to drive through.

Types of Clear View Screens

The Kent-Chadburn Clear View Screen is made in two types, as illustrated. One type is mounted in a rectangular frame which can be fitted in place of the existing window in the wheel house or other shelter. The other type is mounted in a special, revolving hood, suitable for use in any position on the bridge, forecastle-head, etc.

The hood pattern screen can also be supplied, if desired, with a bearing indicator or pelorus.

Wide Use of Clear View Screens

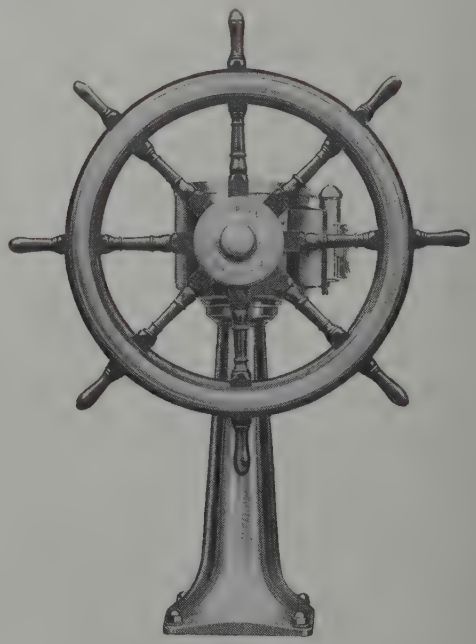
The Kent-Chadburn Clear View Screen is of equally great service on small craft and big ships. It is being used on vessels of every type, from a 55-foot motor boat to a 46,000 ton liner. Large numbers of freighters are now being fitted with the window type.

The following are some of the liners equipped, most of them carrying both the hood and window types:—Mauretania, Aquitania, Cennania, Orduna, Caronia, Olympic, Celtic, Cedric, Baltic, Adriatic, Belgic, Megantic, Empress of France, Lapland, Regina, Snowdrop, Rexmore.

The Kent-Chadburn Clear View Screen can be fitted to any vessel. Full details supplied or demonstration given on request.

Chadburn Steering Wheels

The Chadburn Steering Wheels are of the most improved design and the best material and workmanship throughout. The stand is a heavy, polished brass casting of graceful shape and supporting the steering head which is arranged for illumination by electric or oil light. The steering wheel is placed at a convenient height, and is built up of high grade wood, handsomely finished.



Chadburn Steering Wheel

Binoculars—Binnacles—Sounding Machines

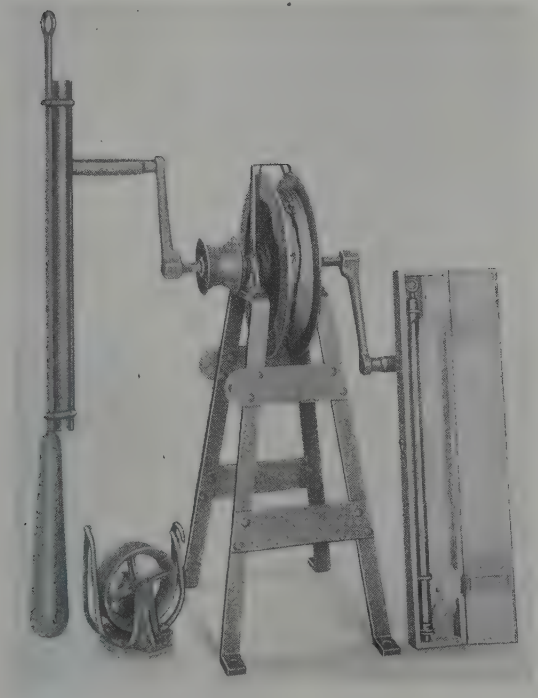
Chadburn Hezzanith Binoculars

Chadburn-Hezzanith Binoculars

These binoculars, as illustrated, are of high power with large and very bright fields, providing clear and sharp definition of objects, and each glass is thoroughly tested and certified before leaving the works. The construction is of the best throughout and particularly strong to stand every-day use.

"Bassnett" Sounding Machines

The Bassnett Sounder is a perfectly reliable and widely used instrument made by the patentees, who have had more than 50 years' of experience in the manufacture of Sounding Machines. Each tube is tested separately and the scale engraved to suit it. This is done even though half the cost of manufacture could be saved by engraving tubes to a standard, as it is impossible to make two tubes with identical capacities. The process used absolutely insures accuracy and more than warrants the additional cost.



Bassnet Sounding Machine

The winch has a wrought iron stand, malleable detachable handles, steel spindle keyed to the wheel, hard brass bearings, and a rope brake which when worn can be replaced from the ship's stores, and which is the most efficient brake possible.

The wire line is heavily galvanized, and strong enough to bear a strain several times greater than it will ever have to stand when sounding. The sinker is specially designed to sink rapidly and to offer the least resistance when hauled in.

Chadburn Binnacle

Chadburn Binnacles

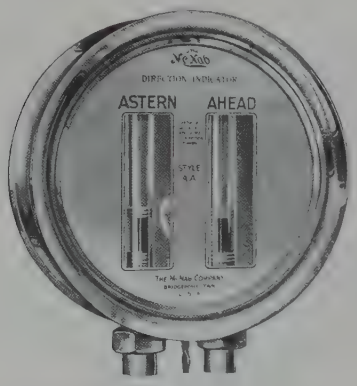
Chadburn Binnacles can be supplied either with teak stand or brass column. The same high quality of design and workmanship is found in these instruments as in all Chadburn ship equipment. The binnacles are supplied completely equipped with compass and card, oil lamps, etc., and with every feature necessary for accuracy and convenience of reading.

Full details regarding Chadburn Binnacles will be supplied on request.

The McNab Marine Appliances

Engine Movements on the Bridge

The McNab Direction Indicator when installed on the Bridge, Pilot House or whereever desired, shows by night or day the actual speed at which the engines are turning in either the "ahead" or "astern" direction, in fact, it places the Navigating Officer and the Engineer so close together that the one cannot make a mistake without the other's instant knowledge.



McNab Direction Indicator

So great has been the demand for McNab Direction Indicators that 95% of American tonnage has this installation, as well as many hundreds of ships throughout Continental Europe and the Far East.

Engine Revolutions in Chart Room

Hundreds of these Counters have been installed on the vessels of the new American Mercantile Marine. A single line of piping from our Bridge Direction Indicator installation operates the Counter.

By its use, the Navigating Officer can at all times see in the Chart Room every revolution which the propeller shaft has made. The McNab Counter is invaluable for Dead Reckoning.

McNab Pneumatic Counter

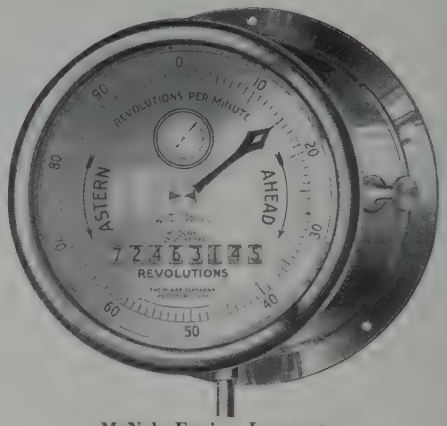
McNab Engine Room Logometer for Turbine Units

So successful was the operation of the "Logometer" that approximately four hundred (400) installations were made during 1919 in the Engine Rooms of vessels equipped with turbine propelling units.

The McNab "Logometer" is a triple instrument, contained within a single 10-inch diameter polished brass case. The information given by the McNab "Logometer" is as follows:

1st Direction Ahead and Astern of propeller shaft.

2nd Speed in revolutions per minute of propeller shaft.



McNab Engine Logometer

3rd The total number of revolutions the propeller shaft has made.

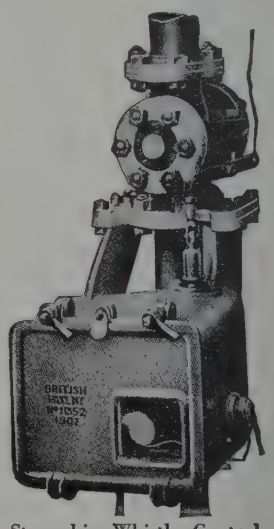
The McNab "Logometer" is built like a marine engine, but has the accuracy of a delicate instrument of fine precision.

Willett Bruce Steamship Whistle Control

We are familiar with the feeble response which the lanyard operated whistle makes, the result being a shower of water accompanied by a thin intermittent sound which greatly adds to the anxiety and risk during foggy or heavy weather.

The Willett Bruce Automatic Steamship Whistle Control has eliminated all the old time faults and incorporated the following advantages:

1. Clear and distinct blasts.
2. Instantaneous action.
3. Complete drainage of whistle pipe.
4. No valve on whistle itself.
5. No clockwork in its construction.
6. Valve on deck where accessible.
7. Automatic control for fog signalling.
8. Electric control for Helm and Morse Signalling.
9. Hand Lanyard control as standby.



Steamship Whistle Control

Many hundreds of vessels equipped throughout the world.

THE McNAB COMPANY

BRIDGEPORT, CONN., U. S. A.

Marine Telephone and Signal Equipment

The Klaxophone

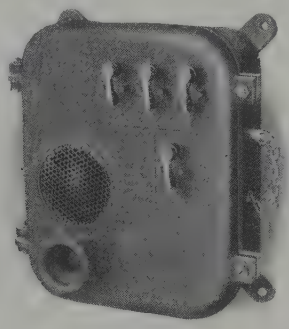
The Klaxophone is a Loud Speaking Telephone. It reproduces the normal voice of the speaker so loudly and so clearly that transmitted messages can be heard and understood perfectly at a distance of three to ten feet from the instrument without the use of ear receivers.

Applications

On board ships Klaxophones are used for general communication between the captain's room and the chief engineer's room, bridge and engine room, between bridge and lookout stations, between bridge and gunfire control stations and between bridge and after bridge (for docking, etc.).

Specifications

Marine Klaxophones are built in accordance with U. S. Navy Specifications and are approved by the Bureau of Steam Engineering. They are made to withstand the roughest usage. The housings are watertight and are made of heavy B E composition. They form conduit connecting boxes which are tapped, standard pipe sizes. The telephones are furnished in a durable dull black finish.



Klaxophone

The instruments are adapted for ten or twenty volt storage or dry battery circuits and can be energized also from a motor generator with the addition of impedance coils and condensers. The current consumption of the instruments ranges between 200 and 500 milliamperes. When the telephones are not in use no current is consumed. Klaxophone Systems are made to operate from 2 to 8 stations.

The Klaxon Horn

A powerful, penetrating, unmistakable note makes the Klaxon Horn an unfailing signal. Its saw-tooth note cuts through practically any noise and makes itself instantly heard and recognized—instantly obeyed. It can be heard at a distance of from a quarter of a mile to a mile.

Applications

On board ships Klaxon Horns are used for sounding fire alarms, code calls and hoist signals. In shipyards Klaxons are used as warning signals on cranes, and on other moving machinery, as signals and as fire alarms.

Specifications

Klaxon Horns meet all U. S. Navy specifications and are approved by the Bureau of Steam Engineering. The instruments are waterproof and are of unusually rugged construction. They may be had in black or red enamel finish. The

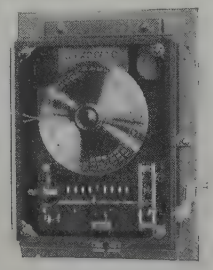
Klaxon Horn

cases are made of cast iron. All current carrying parts are enclosed in waterproof terminal housings which form conduit connecting boxes tapped for three-quarter-inch pipe.

The horns are furnished for operation on standard voltages from 6 to 230 volts D.C. and 12 to 440 volts A.C. The watt consumption of D.C. Horns is 50 watts—A.C. Horns 95 watts.

The Klaxocator

The Klaxocator System is a system for locating promptly any important man in a shipyard or on board a ship. It eliminates the wasting of time in hunting for men. It makes every one instantly available at any time.



Klaxocator

The system consists of a Klaxocator and a number of electric signals placed so that when sounded they are heard in every part of a shipyard or a ship. Signals of varying sound volume and of different tone qualities, such as bells, gongs, buzzers, chime bells, etc., can be furnished. The Klaxocator automatically operates these signals in such a manner as to sound various code signals.

Each important man is assigned a number corresponding to a number on the Klaxocator Dial. When a man is wanted the Dial is turned to his number and the small lever at the right is pulled back. The proper signal is sounded simultaneously everywhere to tell him he is wanted. He goes to the nearest telephone and is connected to the man who wants him.

Pneumercator Tank and Draft Gauges

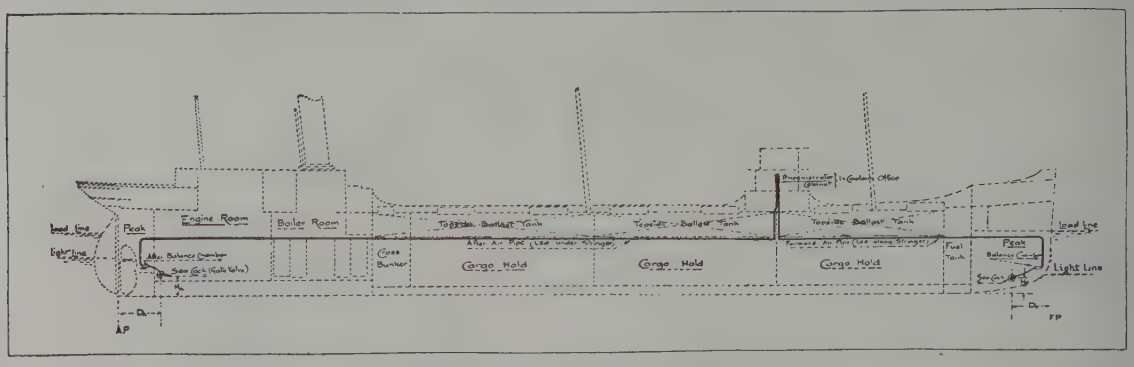


Diagram of Draft Indicator Installation

Product and Service

"Pneumercator" Tank Gauges applied to cargo, fuel, ballast or water tanks or bilges indicate the depth, weight, volume or specific gravity of the tank contents.

They provide perpetual inventory of liquid in tanks.

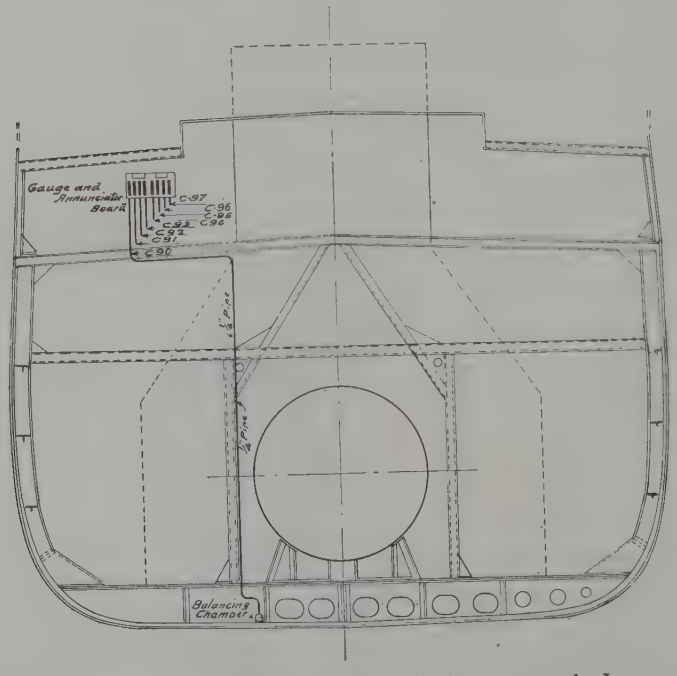


Diagram Showing Method of Connecting the Apparatus to the Inner Bottom Tanks Aboard Ship

An accurate check on liquid put in or withdrawn.

In the case of fuel oil, they indicate the quantity on hand, check invoices and indicate the amount consumed per hour or day.

They will operate with equal accuracy on tanks open to atmosphere or under pressure or vacuum. Accuracy is not affected by temperature changes.

There are no floats, diaphragms or delicate mechanism of any kind to stick or get out of order.

Throw away your sounding rod.

"Pneumercator" Draft Gauges indicate the fore and aft draft of the vessel, register the mean draft and corresponding tons displacement.

They weigh bulk cargoes loaded or unloaded with extreme accuracy.

They enable a ship to be loaded to capacity without danger of overloading.

They are invaluable in loading or discharging at night or in rough water.

In case of leaks caused by collision or otherwise they constantly show every variation of trim and draft and whether or not pumps are controlling the inrush of water.

The instrument is working for the owner day and night, because it permits a correct measure of the cargo loaded or discharged. This is impossible by reading the draught figures on the hull of the ship.

With the Pneumercator Draught Gauge the draught can be ascertained with accuracy down to the fraction of an inch, whereas the motion of the waves makes any other reading inaccurate, even when the water is comparatively still.

Principle

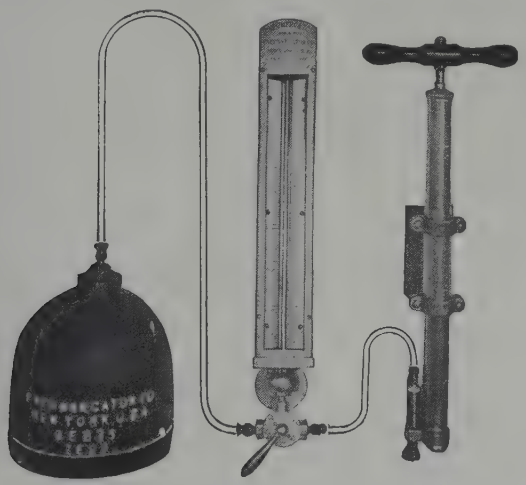
The operation of all models of "Pneumercator" Gauges is based on the maintenance of a true hydrostatic balance between the head or depth of liquid to be measured and a column of mercury or other indicating medium. The

PNEUMERCATOR COMPANY

15 PARK ROW, NEW YORK, N. Y.

Pneumercator Tank and Draft Gauges

pressure of the liquid is transmitted to the gauge by air confined in a small connecting tube between the liquid and the gauge.



Balance Chamber | Gauge and Control Valve | Air Pump

Essential Parts of the Pneumercator Tank Gauge

Component Parts

The component parts of all "Pneumercator" gauges are as follows:

1. Balance Chamber.
2. Mercury or other gauge, calibrated for the particular tank or vessel.
3. Hand air pump or other means of furnishing compressed air.
4. Control valve or valves.

Installation

The Balance Chamber is located at a predetermined point below the surface of the liquid to be measured and with a direct opening to the liquid.

The liquid trying to enter the Balance Chamber, by its own weight, compresses the air in the chamber, and in the connecting pipeline to the mercury gauge, thus causing the mercury to rise or fall in direct ratio to the pressure exerted.

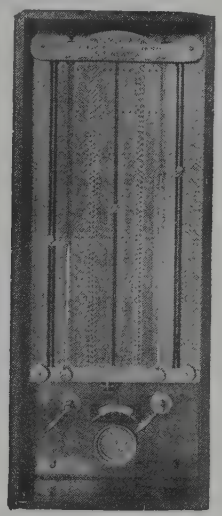
The installation of the "Pneumercator" is simple. The small air pipe can be led anywhere, the number of twists, bends, indirect leads or the temperature through which it may be led—whether it be through the boiler room or a refrigerator—have no effect on the accuracy of the reading.

Identifying "Pneumercator" Products

The coined word "Pneumercator" is our Registered Trade Mark and is applied to all instruments manufactured or sold by the Pneumercator Company or its representatives or licensees under its patents throughout the world.

Satisfied Customers

United States Navy.
Japanese Navy.
Emergency Fleet Corporation.
Wm. R. Grace & Co.
Luckenback S. S. Co.
Union Sulphur Co.
New England Fuel and Transportation Co.
Florida East Coast Ry.
Panama Railroad Co.
Ward Line.
Matson Navigation Co.
Oceanic S. S. Co.
Warner Quinlan Asphalt Co.
Standard Transportation Co.
Etc., Etc.



Model D-1 Pneumercator Draft Gauge. Indicates forward and aft drafts, registers mean draft and corresponding tons displaced. Weighs cargoes and bunkers.

Information Necessary for Quoting

As each instrument has to be calibrated for the particular tank or ship to which it is to be applied, in order to quote intelligently it is necessary that we have the information covered in the following paragraphs.

Necessary Tank Gauge Information

Dimensions of tanks—particularly the depth.

Distance from each tank to point where indicator is installed.

Nature and specific gravity of liquid, and whether tank is under pressure, vacuum or atmospheric pressure.

Necessary Information for Ship Draft Gauge

Length of vessel—
Moulded depth—
Light draft—
Loaded draft—
Total tons displacement.

PNEUMERCATOR COMPANY
15 PARK ROW, NEW YORK, N. Y.

Indicating Thermometers

150 Years of Experience

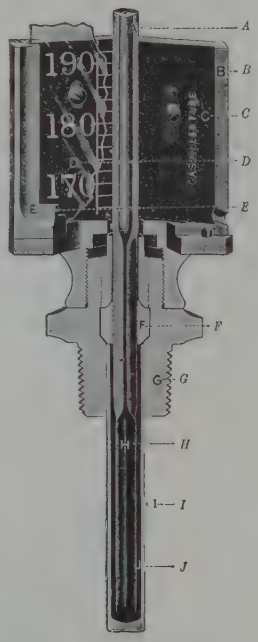
TAG Industrial Thermometers represent the ultimate perfection of 150 years of development and progress—and are guaranteed to provide the maximum in accuracy, durability and dependability. During the recent World War, TAG Thermometers were purchased in large quantities by the U. S. Government and prominent shipbuilders.

Permanent Accuracy

Only electrically annealed or "seasoned" tubes are used in TAG Thermometers and a special scale is made for each instrument—thus insuring permanent thermometer accuracy throughout its entire temperature range.

Other Special Features

Besides the specially seasoned tube case there are many other distinctive features of construction of TAG Industrial Thermometers, some of which are briefly stated below with letter references to the accompanying section.



Superior Structural Features of TAG Industrial Thermometers

The Scale-Case (B) is triangular to protect the tube and make scale-reading easy. The Scale (C) is graduated for the exact conditions under which the thermometer is to be used. The Glass-Front (D) also protects the tube and prevents soiling of the scale. The Front Frame (E) is easily removed for cleaning the glass front which it holds. The Stuffing Box (F) and Packing hold the glass tube securely but not rigidly, assuring long service. The Connection (G) for attaching the thermometer to apparatus is varied to best suit the particular application. The Bulb (H) is held exactly centered by the stuffing box, which reduces breakage of the bulb to a minimum. The Bulb-Chamber (I) which protects the glass bulb is so constructed that it is impossible for leakage to occur. The Bath (J) serves as a conducting medium for the almost instantaneous transmission of the temperature.

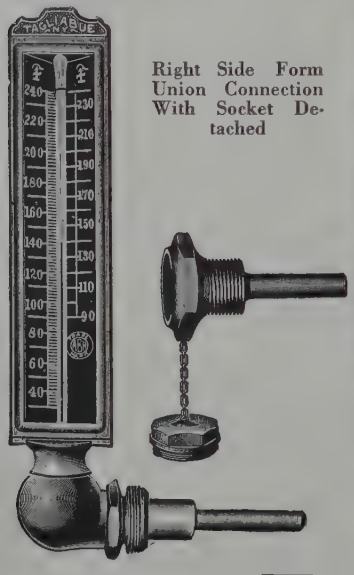
Partial List of Applications

TAG Thermometers serve best wherever accurate temperature determinations are essential and, therefore, are particularly desirable on board ship. Some of the many places where they are a real necessity are:

Auxiliary Condensate Overboard Discharge.
Main Thrust Turbine Bearing Drains.
Discharge from Feedwater Heater.
Main Turbine Exhaust Pipe.
Oil Cooler Water Outlet.
Oil Cooler Water Inlet.
Oil Cooler Oil Outlet.
Oil Cooler Oil Inlet.
Lubricating Oil Drain Tank.
Main Overboard Discharge.
Condensate Pump Section.
Superheated Steam Line.
Air Pump Discharge.
Fuel Oil to Burners.
Main Feed Tank.
Main Injection.

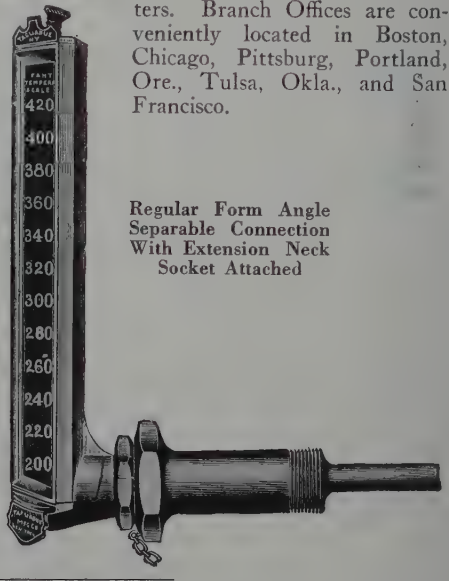
For Further Details

Catalog C-325 contains 64 pages of useful thermometer information. Write for a copy and also ask for quantity discounts on TAG Thermometers. Branch Offices are conveniently located in Boston, Chicago, Pittsburg, Portland, Ore., Tulsa, Okla., and San Francisco.



Right Side Form Union Connection With Socket Detached

Straight Form Separable Connection with Socket Detached



Regular Form Angle Separable Connection With Extension Neck Socket Attached

C. J. TAGLIABUE MFG. CO.

18-88 THIRTY-THIRD ST., BROOKLYN, N. Y.

Nautical Instruments

Nautico Products

Nautico Products are manufactured in our own factory. We have an excellent personnel, and a system of production and inspection which guarantees absolute accuracy and perfect workmanship. Every instrument is carefully examined by experts who have specialized for many years in the manufacture and adjustment of high grade technical instruments both here and abroad. Their experience and judgment stand behind every Nautico Product.

There is a distinct advantage in dealing direct with the manufacturer—especially since there are only two or three companies in the United States which manufacture Navigating Instruments and Equipment.

We invite inquiries regarding all kinds of Nautical Equipment—particularly, Compasses—Liquid or Dry, Peloruses—Binnacles—Sextants and Taffrail Logs.

Luminous Dial Life Boat Compass

and 0° to 360°. This compass is very desirable for life boats or launches and small boats in general—and the price in quantities is unusually low.

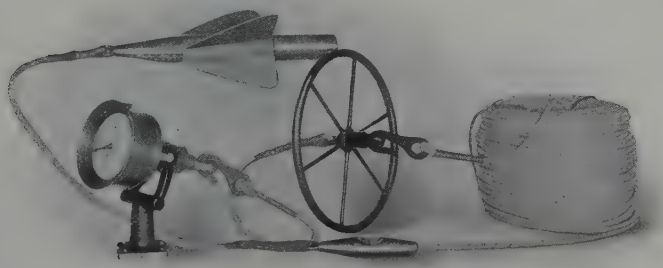
The Nautico Standard Binnacle is made of heavy spun brass on cylindrical teak stand, fitted with compensating magnets, heeling magnet and spheres, hinged front cover with slides, lamps and day cups for oil or electric illumination. Fitted with mechanical device for adjusting magnets.

Nautico Dry Compass

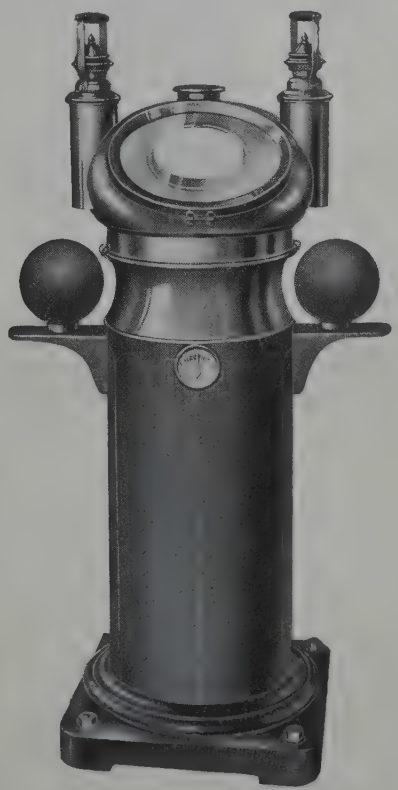
Nautico Dry Compass, with 10″ Card, gimbal ring, and improved spring suspension.

The Nautico Taffrail Log is constructed according to our own improved design. Ball bearing main shaft, links, balance wheel and log, made of phosphor bronze.

This Luminous Dial Lifeboat Compass is our special 2″ flat card liquid compass in mahogany box, with plain or luminous dial, graduated to quarter points



Nautico Taffrail Log



Nautico Standard Binnacle

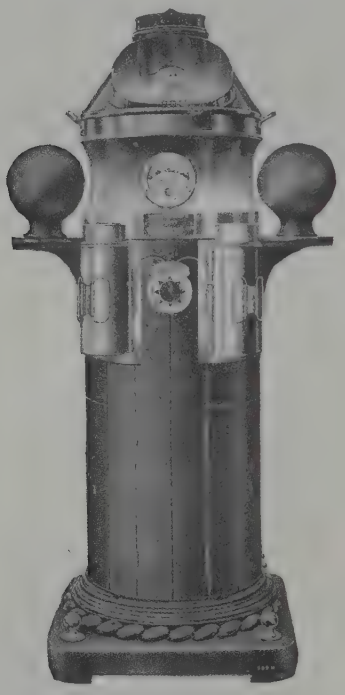
NAUTICAL INSTRUMENTS MANUFACTURING CO.

NEW YORK, N. Y.

Navigational Instruments

The Kelvin & Wilfrid O. White Co.

The Kelvin & Wilfrid O. White Co. is the American house of Kelvin, Bottomley & Baird, Ltd., makers of the Kelvin Navigational Instruments (Trade Mark "Kelvite") acknowledged by the world's navigators, and accepted by all large steamship companies, as the most accurate and dependable instruments on the market.



"Kelvite" Standard Compass

The trade mark "Kelvite" on navigational instruments is synonymous with the highest scientific and mathematical requirements, and the most rugged construction, coupled with beauty of design and first-class workmanship.

The Kelvite Standard Compass

This is the only compass which when properly adjusted will take you around the world without large deviations; the reason being that there is no magnetism induced in the correcting Globes and Flinders Bars from the small needles of the compass card.

The liquid compass with its high-powered magnets has a use on vessels when the vibration is extreme or where they are subject to shock, as from gunfire; but these same magnets are the cause of large deviations.

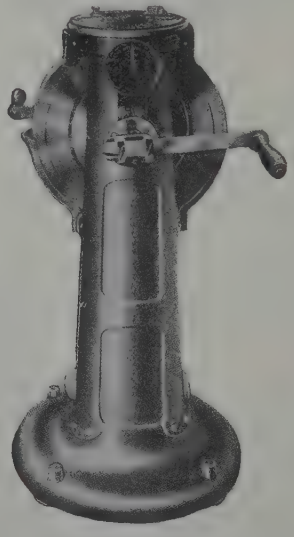
The compass being the most important instrument of navigation on a ship, it follows that the best is required. The first cost of the instrument is very moderate, and the cost of upkeep over a period of years is infinitesimal. The increased cost of this compass over that of other makes is more than made up in the lifetime of a ship, by the feeling of confidence it gives to the masters and the consequent gain of time on their voyages.

The compass complete is equipped with the "Kelvite" Azimuth Mirror for taking bearings of celestial or terrestrial objects. This is the only instrument used for taking bearings that will give an accurate bearing when the ship is yawing several degrees on each side of her course.

The Kelvite Sounding Machine

More ships have been run ashore through the desire of captains to make quick passages, than for any other reason. They will not cut down the speed of the vessel in order to take the necessary soundings. With the Kelvite Sounding Machine, there can be no excuse for imperilling the vessel as accurate soundings can be made without decreasing the speed in any depth of water up to 100 fathoms. A line of soundings can thus be taken and the correct position of the vessel found in thick weather without loss of time.

When making up your specification for navigational equipment, always specify "Kelvite" or "Genuine Lord Kelvin" instruments. There are imitations on the market that are not made with the same care and precision as the "Kelvite," and will not stand up under service conditions.



Merchant Marine Pattern Sounding Machine

KELVIN & WILFRID O. WHITE CO.

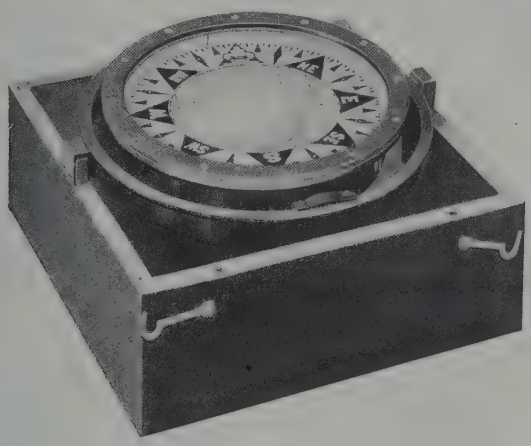
112 STATE ST., BOSTON, MASS.

Liquid Compasses and Nautical Instruments

The Ritchie Liquid Compass

The distinctive feature of this compass is the attachment to the compass card of an air chamber, by which almost the entire weight of the card is supported by the buoyancy of the liquid; thus reducing the friction and the wear on the pivot to a very small amount, and increasing the sentitiveness of the compass.

The type of compass shown below is made with the central buoy supporting six magnetic needles, giving great magnetic force and making the compass much easier to adjust in steel ships.

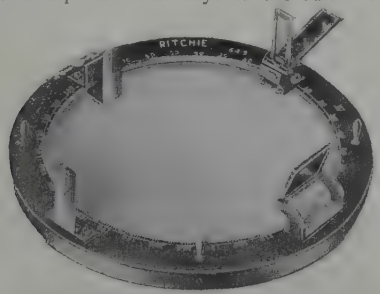


Flat Card Compass with Central Buoyancy Plain and Graduated Card

Every compass made by us has Ritchie, Boston, U. S. A., printed upon the card and the running number stamped upon the top ring. We have manufactured and sold more than 58,000 since our establishment in 1850.

Azimuth Circle

The United States Navy Azimuth Circle is made to fit the Navy Standard Compass and is most complete and accurate, embodying many new features. The ring carrying the optical parts is turned to fit accurately the top of the Standard Compass. The rays of the sun are received upon a cylindrical convex mirror, and reflected through a right-angle prism on the opposite side of the ring to the cylindrical lens below, appearing on the card as a bright bar of light upon the graduations. This can readily be seen when the sun is much obscured, enabling accurate readings to be made. The double arrangement enables the circle to be tested for accuracy by comparing one reading with the other.



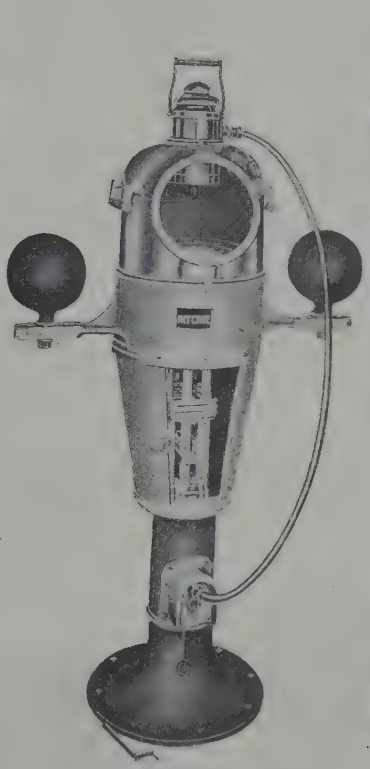
United States Navy Azimuth Circle

United States Navy Standard Binnacle

This Binnacle which is made for the United States Navy is the result of much study and experiment. It is made of gun metal, in one casting and weighs 170 lbs. without the hood.

All adjustments, except for quadrantal error, are made in the magnet chamber, and once made and the door locked, cannot be meddled with.

In the arms carrying the soft iron balls for quadrantal correction are slots allowing a movement of 11 to 15 inches from the center of the compass.



U. S. Navy Standard Binnacle

Illuminated Dial Pelorus

Illuminated Dial Pelorus

The Pelorus shown above is complete in every detail, and is the type which we furnish to the United States Navy. The special feature of this instrument is the underlight electric lamp placed below the Pelorus bowl inside the standard. The light which is reflected upward illuminates the glass dial thus eliminating the use of the navigator's auxiliary lantern. The standard is a thick brass tube fitting into gun metal bowl and base, total being 52 inches high.

Gyroscopic Compasses and Stabilizers

Fig. 1

Fig. 2

Fig. 3

Fig. 4

Fig. 5

Fig. 6

Fig. 7

Gyroscopic Compass Equipment

Gyroscopic Compass Equipment

The Gyroscopic Compass Equipment consists of Master Compass (Fig. 1), Control Panel (Fig. 2), Motor Generator (Fig. 3), Auxiliary Battery (Fig. 4), Steering Repeater (Fig. 5), Recording Compass (Fig. 6), and Bearing Repeater (Fig. 7).

Additional repeaters may be installed as required. The Master Compass is usually installed in a protected place at about metacentric height.

Advantages

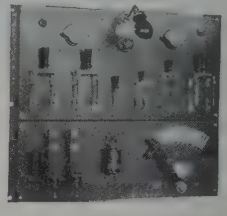
The Gyroscopic Compass has the following advantages: 1. Points True North; 2. Non-Magnetic, hence—3. Has no variation or deviation; 4. Has no lag, hence a navigator may hold closely to his course and shorten his voyage.

This compass is the standard for the World's Navies. It is now being used in the World's Merchant Fleets.

Gyroscopic Stabilizer Equipment

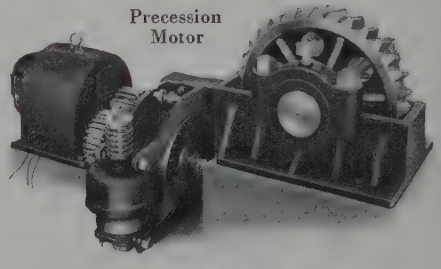
The Gyro Stabilizer utilizes about one per cent of the ship's tonnage displacement, for large vessels. In small craft this amount may be exceeded slightly. Stabilizers have been installed on vessels of all sizes, up to 20,000 tons. They are practical for any vessel and will reduce the rolling from 30° to 2 or 3°.

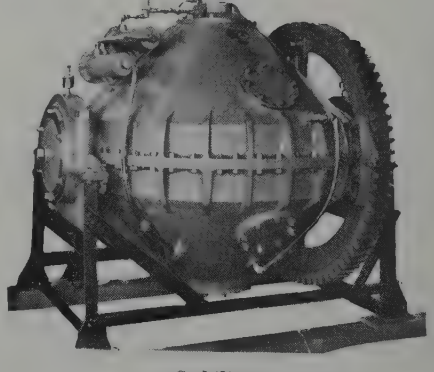
Control Gyro



Control Panel

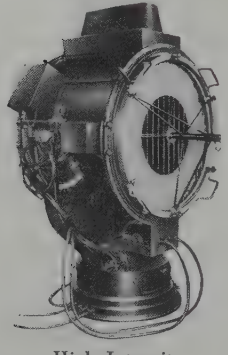
Precession Motor



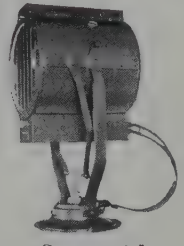


Stabilizer

Gyroscopic Stabilizer Equipment



High Intensity Searchlight



Commercial Searchlight

Searchlights

The Sperry High Intensity Type Searchlight is made in 24″, 36″ and 60″ sizes, suitable for large vessels. Candle power 500,000,000 to 1,250,000,000. The Sperry Commercial Searchlight is adaptable for medium size and small craft. It is made in 12″, 15″, 18″ and 24″ sizes.

Shipmate Ranges

Eight Foot Shipmate Range
Two Fires Three Ovens

Width	Height	Height to top of rail	Size of Ovens	Size of Fire Box of 5-foot section	Size of Fire Box of 3-foot section	Size of Pipe Collar of 5-foot section	Size of Pipe Collar of 3-foot section
34 inches	32 inches	37 inches	28x17x16	20x12x9½	20x8½x9½	10-inch	8-inch

Shipmate Ranges

Shipmate Ranges are made specially for vessels and are in every way suited to the peculiar requirements of vessel work and to the convenience of users. They are thoroughly well made and durable, and are warranted to work perfectly.

Capacities of Ranges

While the number of persons for whom a range will do the cooking is greatly affected by the extent and variety of the bill of fare, as well as by the skill of the cook, the following estimate will be found nearly correct in ordinary cases,

Range No...	1	112	114	115	16	132	133	45	53½	54	65
No. Persons.	4	6	8	10	15	20	25	30	40	40	75

greater requirements being provided for by the 6-foot, 8-foot, 9-foot, 11-foot, 12-foot, etc., Shipmate Ranges.

Eight-Foot Shipmate Range

This range, illustrated above, is made up of one 5-foot section and one 3-foot section. Like the Eleven Foot Shipmate Range, it can be extended as far as desired by adding 3-foot sections. The 5-foot section and the 3-foot section can be fitted to burn hard or soft coal as desired. Waterback can be furnished for either section.

If necessary to put the range through a small doorway it can be so taken apart as to be in sections 23½ x 28 x 30 inches. The bolts to be removed for this purpose can be marked with white paint when the range is shipped and the operation thus made very simple.

Shipmate catalog, containing full details on all ranges and heating stoves, will be sent on request.

No. 133 Shipmate Range

DIMENSIONS OF SHIPMATE HEATING STOVES

Stove No.	Diameter of Globe	Height on Feet	Spread of Feet
80	10 inches	27 inches	17 x16½ inches
90	11 inches	31 inches	18¾x16 inches
100	12 inches	32 inches	18¼x17 inches

TABLE OF SIZES AND DIMENSIONS OF SHIPMATE RANGES.

No.	Size of Oven inches	Size of Fire Box for Coal inches	Size of Fire Box for Wood inches	Size of Top inches	Size of Cover Holes inches	Size of Pipe Collar inches	Height of Range inches	Height to top of Rail inches	Extreme Spread of Rails inches	Projection of Hearth beyond perpendicular of front standard	Distance from Perpendicular of back rail to front edge of bottom	Smallest Doorway through which Range will pass	Spread of Feet inches	Weight lbs.
1	9 x 9 x 7	7¾x 5	11 x 6	20 x13¼	6 and 3	4½	18¾	23¼				14½″	22¼x13½	92
112	12 x11½x 8½	9 x 5¼	11 x6¾	24½x16¾	8	5	20½	25	25½x18	2½″	20½″	15¾″	24 x14½	151
114	14 x11½x 8½	12½x 5¼	15 x6½	23¼x24½	7	5	20½	25	25¾x24¼	2½″	26½″	15¾″	24 x18¼	212
115	16 x11½x 8½	14¼x 5¼	17¼x6½	24¼x25	8	5	20½	25	25¾x26½	2½″	29″	15¾″	24x20¾	230
16	16 x14 x10	14 x 6¼	17¼x8	29 x26½	8	6	22	26½	30½x28¼	3½″	31¼″	16¾″	27¼x21	291
36	28 x17 x16	20 x 8¼		38½x34	8	8	32	37					38½x28½	900
132	16½x16½x10	14 x 6¼		25½x32¼	7	6	25½	29½	33¾x27	2″	29″	18″	29¾x21	332
133	19½x18 x11	16 x 6½		28 x35½	8	7	26½	30½	37 x29½	2¼″	31¼″	18¾″	32½x22	408
122	16½x16½x10		17¼x8	25½x32¼	7	6	25½	29½	33¾x27	2″	29″	18″	29¾x21	322
123	19½x18 x11		19½x8½	28 x35½	8	7	26½	30½	37 x29½	2¼″	31¼″	18¾″	32½x22	400
45	22 x22 x11	18 x 9¼		29½x42	8	7	27½	32½	41⅝x29⅝	3″	33″	20¼″	37½x23½	512
*54	13 x19 x11	17¼x10		50½x28½	8	8	28	32	52½x31	3¾″	34½″	20¾″	38 x31	648
*65	28 x17 x16	20 x12		62 x34	8	10	32	37	62½x34				62 x28½	1,260

*Has two ovens.

THE STAMFORD FOUNDRY CO., STAMFORD, CONN.

Ships' Ranges

Deane's Ships' Ranges

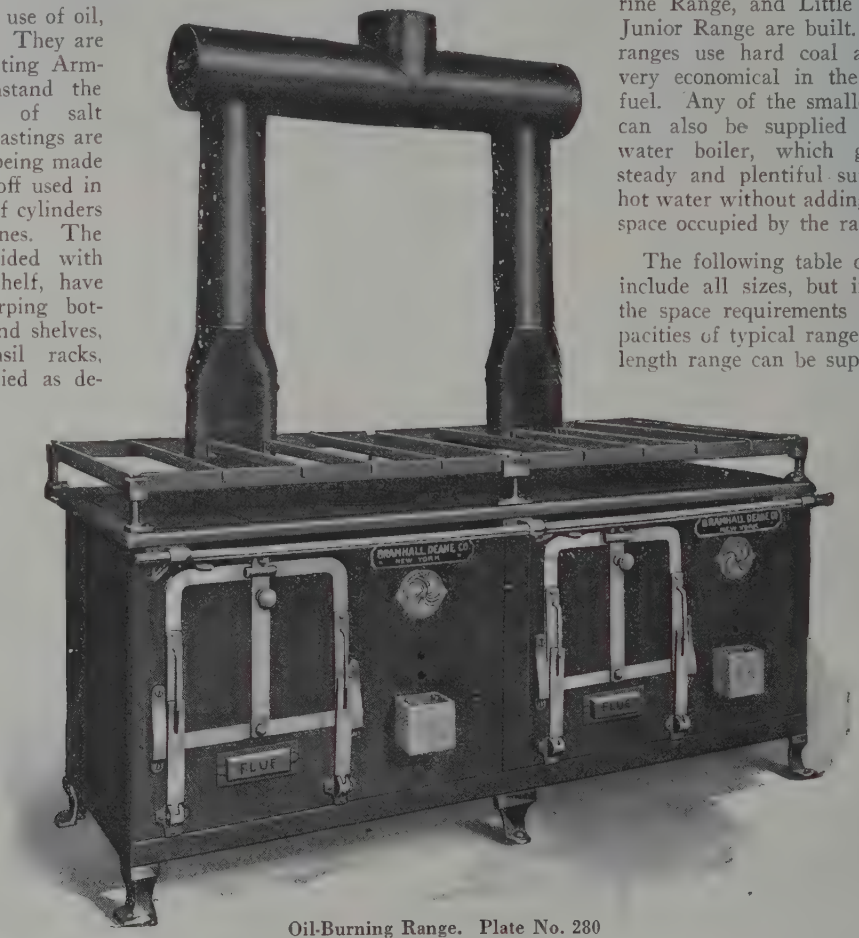
For more than half a century the Bramhall, Deane Company has been supplying galley equipment of the highest quality, for use on vessels of every type. The company is in a position to furnish almost everything for the outfitting of ships' galleys.

Deane's Ships' Ranges are built in a number of standard sizes, for the use of oil, hard or soft coal. They are made of rust-resisting Armco iron, to withstand the corrosive action of salt water. The top castings are extremely heavy, being made of the same pour-off used in the manufacture of cylinders for gasolene engines. The ovens, each provided with sliding movable shelf, have sectional, non-warping bottoms. Full back and shelves, water-backs, utensil racks, etc., can be supplied as desired.

Deane's Coal-Burning Ships' Ranges

The variety of standard types and sizes of Deane's Coal-Burning Ships' Ranges offers a style exactly suited for practically any vessel. The Deep Sea Range, similar in general design to the oil-burning range illustrated, is built especially for large vessels, such as passenger and cargo steamers. For smaller vessels, such as tugs, river boats, yachts, etc., the Colonial Yachts' Range, Little Marine Range, and Little Marine Junior Range are built. These ranges use hard coal and are very economical in the use of fuel. Any of the smaller types can also be supplied with a water boiler, which gives a steady and plentiful supply of hot water without adding to the space occupied by the range.

The following table does not include all sizes, but indicates the space requirements and capacities of typical ranges. Any length range can be supplied.



Oil-Burning Range. Plate No. 280

Specifications for Oil-Burning Ranges

Oil-Burning Ranges are rapidly coming into favor, because of their cleanliness, economy in the use of fuel, and their great convenience. A large number of Deane's Oil-Burning Ships' Ranges have been supplied to the following shipyard specifications.

TYPICAL COAL-BURNING RANGES

Type	Depth	Unit Length	Height With Feet	Height Angle Iron Base	Oven Size, Inches
Deep Sea	39″	3½′	36″	31″	18x28x16
Little Marine	24″	23″	23″	19″	11x15x10
Little Marine, Jr. ..	19½″	22″	23″	19″	9½x10x15
Colonial.....	Made in Five Different Sizes.				

SPECIFICATIONS FOR OIL-BURNING GALLEY RANGES

—— Bramhall, Deane Oil-Burning Galley Ranges —— feet long and 39 inches deep, with —— fire boxes and —— ovens, the latter to be —— inches wide, —— inches deep and —— inches high. To be constructed of Armco American Ingot Rust-Resisting Iron and heavily insulated throughout. Equipment to consist of special firebrick, drip pans and nipples, baffle plates, lighting plate and shutter, fuel oil burners, oil supply tank, steam separator, oil burning cocks and reflex gauges. Top of ranges to be fitted with portable sea-rails mounted on heavy stanchions complete with all necessary cross-bars. Each range to have extra heavy smoke pipe and damper.

STANDARD SIZES OF OIL-BURNING RANGES

Length in Feet	Depth in Inches	Number of Fires	Number of Ovens	Oven Size in Inches: Width	Depth	Height
7	39	2	2	18	28	16
6	39	1	2	22½	28	16
4	39	1	1	22½	28	16
3½	39	1	1	18	28	16

Note: Any number of 3½- or 4-foot units may be bound together to form a range of any desired length.

Galley Equipment

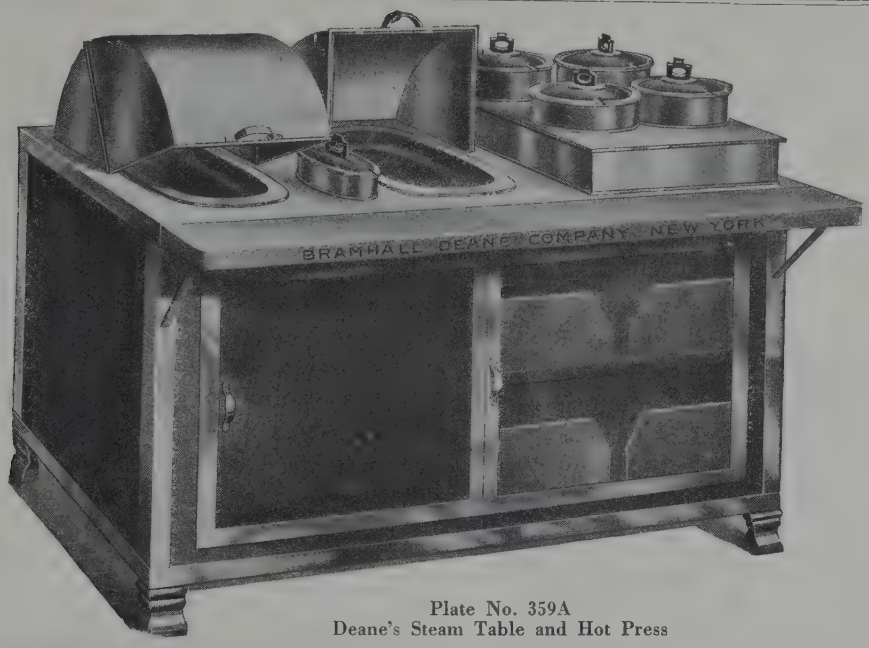


Plate No. 359A
Deane's Steam Table and Hot Press

Deane's Steam Tables

Deane's Steam Table and Hot Press is particularly desirable for use on large vessels. Any size of table, or arrangement of dishes, can be supplied. The type illustrated is 5 feet long by 2 feet deep, with an 8-inch movable carving board in front. It has two chafing dishes, two gravy wells, and four boot-legs for vegetables, etc.

Deane's Coffee Urns

Deane's Royal Urns for heating water, coffee, tea, cocoa, etc., can be supplied singly or in batteries, arranged for heating by steam or electricity and for capacities up to 15 gallons. They are of best grade copper, buffed and polished, or nickel plated, and supplied with porcelain or white enamel interiors. The stand for a battery of three urns may be supplied in the form of a cup warmer.

Deane's "Shiptipe" Urn is a single urn of moderate cost, made of heavy copper, lined with tin and arranged for heating by steam. The urn stands 50 inches high when equipped with 22-inch iron stand. Made in various capacities. Where desired, this urn can also be furnished with cast brass feet 4 inches high.

Deane's Vegetable Cookers

Deane's Eclipse Cooker is made for cooking vegetables and other foods by live steam at 240 degrees under 10 pounds pressure, thus retaining all the nourishing qualities of the foods. This cooker is built of heavy Armco iron and is provided with safety valve and temperature and pressure gage. Any special size or arrangement of chambers may be furnished.

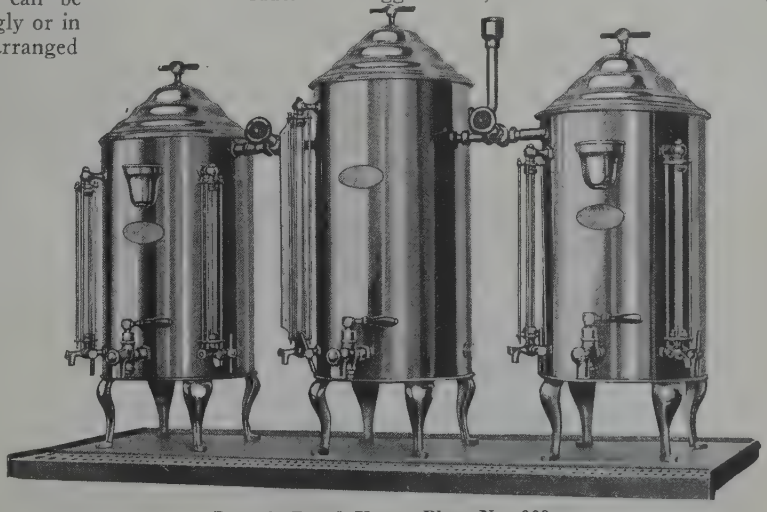
Other Galley Equipment

The Bramhall, Deane Company also manufacture a wide range of other galley equipment.

The Rumford Ships' Oven of Armco iron is built in various sizes, the largest baking 160 loaves at a time. This oven uses hard coal.

Plate Warmers for use in the officers' pantry are built to fit in the pantry dresser, with shelves set on steam coils.

Automatic Egg Boilers, with from 2 to 6 buckets, can be supplied. Electrically driven appliances include Food Chippers, Dish Washers, Vegetable Parers, and Kitchen Machines, the latter for mixing cake batter and general pastries.



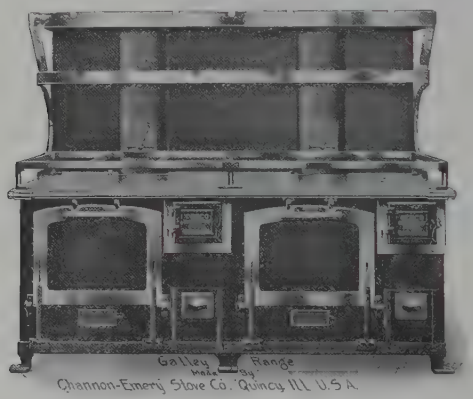
Deane's Royal Urns. Plate No. 398

The Bramhall, Deane Company is equipped to make layouts showing most efficient arrangement of apparatus, to recommend the best galley outfit for any vessel, and to supply the equipment complete.

Ship Ranges

For All Types and Sizes of Vessels

Cesco Ship Ranges, manufactured by the Channon-Emery Stove Company, are built in sections of convenient size and shape and suitable for use on vessels of all types and sizes. They are arranged for burning either coal or oil as desired, and can be fitted with special fittings and accessories such as utensil shelves, waterfronts, etc., as ordered, at an extra price.



Seven Foot Cesco Galley Range for Soft Coal

Size of Oven—24x24x17 in. Size of Top—32x33x84 in. Wt.—1700 lbs.

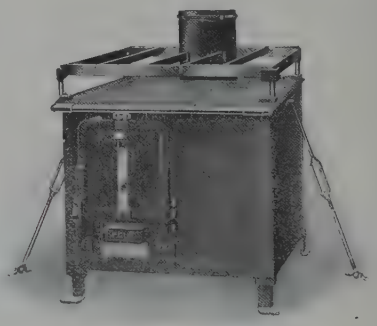
Features of Construction

These ranges are specially designed for heavy work and will be found to meet all requirements of shipboard service. Each part is carefully made and fitted and all unnecessary ornamentation is omitted.

The bodies of the ranges are all constructed of extra heavy gage steel, lined with heavy asbestos with an interlining of heavy cast iron or steel as an insulation to retain the heat.

Five or Six Foot Cesco Galley Range for Soft Coal

No.	Size of Oven	Size of Top	Weight
18 DD	Two 18x24x16 in	60x34 in	950 lbs
24 DD	Two 24x24x16 in	72x34 in	1100 lbs



Cesco Navy Standard Range for Oil

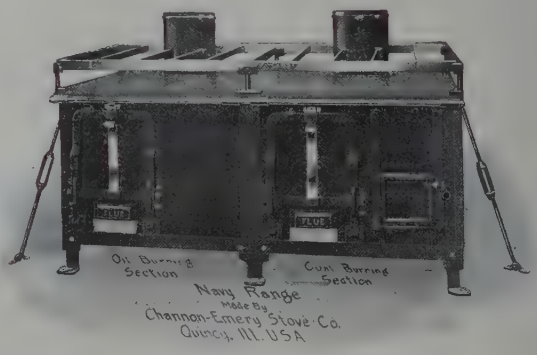
3 Foot Section, Wt. 825 lbs. 3½ Foot Section, Wt. 1000 lbs.

The ovens are extra large and are made of extra heavy gage cold rolled steel thoroughly braced at top and bottom with cast angle irons to prevent warping.

The fire boxes are large and very heavy with easily removable grates and extra heavy fire backs which are also easily removable.

Double bottoms are provided with free circulating air between them, giving absolute deck protection.

All ranges are equipped with the necessary sea rails on the top to prevent the ware from sliding, and the feet have bolt holes to fasten the range securely to the deck.



Cesco Navy Standard Range for Coal

3 Foot Section, Wt. 1350 lbs. 3½ Foot Section, Wt. 1600 lbs.

Navy Standard Ranges

Cesco Navy Standard Ranges are built in 3 foot and 3½ foot sections and can be furnished for either coal or oil burning. These ranges have been adopted as standard by the U. S. Navy and are used on all battleships, cruisers and destroyers. They are similar in general construction to Cesco Ship Ranges and are fitted with sway-bracing bolts with a turn buckle to assist in insuring rigidity and correct positioning.

Electric Galley Equipment

Advantages of Electric Galley Equipment

Duparquet Electric Galley Equipment is extremely simple to install and operate. It is ready for use at all times and is noted for its quickness in heating, perfect control of temperature and thorough sanitation. Duparquet Heavy Duty Electric Galley equipment is built to meet every requirement for use in ships' galleys.

Duparquet Electric Ranges

Duparquet Electric Ranges and Grills (Grills consisting of Cooking Top, Broiler, Toaster, Oven) are made in a variety of styles and sizes, and are so constructed that any number of units may be built up, side by side, to give any desired capacity. Duparquet Electric Ranges are also built to order to fit any desired space.

When desired, combination coal and electric ranges can be supplied. For any given conditions, we will be glad to recommend the best installation.

The range shown in the illustration is the typical

Electric Range Type R-48
Hotel Type—Similar Type Designed for Galley Service

Heavy Duty type. The usual galley utensil equipment is not shown. The hot plates are cast iron ¾ inches thick, heavily ribbed, into which the sheathed wire heating element is moulded. The top heating surface is 36″ x 24″, constituting four 9″ x 24″ hot plates, each consuming 4 K. W. maximum and 1 K. W. minimum.

Coffee and Hot Water Urns

The illustration shows a Combination Coffee and Hot Water Urn, which works automatically. This Urn has a Monel Metal coffee compartment which is superior to the china jar both for utility and maintenance, and is provided with a special Monel metal percolator or leacher (eliminating the unsanitary cloth leacher) which extracts only the health value and its aromatic flavor, leaving the cruder substances and acids, thereby giving a clear, perfect brew, uniform coffee, without re-pouring or boiling. Two valves constitute the entire mechanical features. This simplicity of operation is a great advantage.

Coffee Urn

Type	Capacity Coffee Gallons	Capacity Water Gallons	Diam.	Height Over-all	Total K.W.
C-U3 ..	3	6	15½″	43″	3
C-U5 ..	5	10	18″	46″	4
C-U8 ..	8	13	19½″	51″	6
C-U10 .	10	15	21″	54″	6

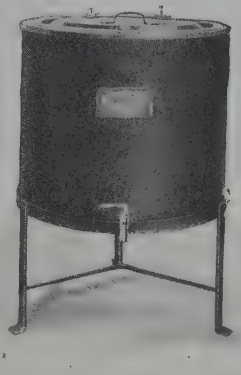
Separate gauge glasses and also draw-off faucets are provided for both the coffee and water compartments. The water compartment is larger than the coffee compartment providing hot water for tea or other hot drinks.

When desired, separate urns for coffee or hot water can be supplied. Metal stands for one, two or three urns are built in black, polished or nickel plated finish.

Stock Kettles

Stock Kettles may be used as boilers, Coffee Urns, Vegetable Cookers, and for Pot Roasts, etc. The interior, tops and insulated covers of these kettles are constructed of heavy Monel metal which is as strong as steel, and non-corrosive.

These compartments have semi-hemispherical bottoms to facilitate cleaning and draining, with draw-off faucet. All seams are welded or silver soldered. If heat is accidentally turned on with no water in the vessel, it will not be damaged. Stock Kettles can be supplied in square or round pattern, or in a two-compartment oblong Duplex pattern depending upon capacity desired. The table below gives data on the square pattern.



Stock Kettle

Type	Gallons Capacity	Diam. Outside	Diam. Inside	Height	Depth	Total K.W.
RK10	10	21″	15″	38″	16½″	3
RK20	20	27″	21″	38″	16½″	6
RK30	30	27″	21″	44″	22″	6
RK40	40	31½″	25½″	44″	22″	9
RK60	60	36″	30″	44″	22″	12

Other Galley Equipment

Practically any type of electric cooking apparatus can be supplied by us such as Griddles, Toasters, (Our new 20 slice toaster toasts both sides at once.) Automatic Egg Boilers, Warming Closets, and Dish Heaters; also Heated Carving Tables, Broilers, Roasting and Baking Ovens. We also carry a complete line of Galley Utensils, furnishings and labor-saving devices.

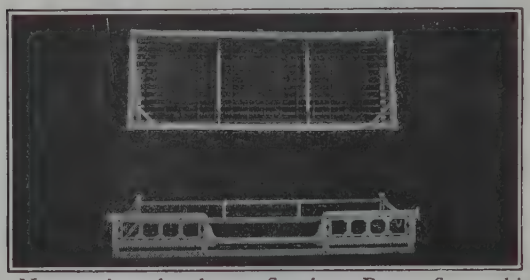
We are fully prepared to equip the largest or smallest galley with the highest grade cooking apparatus, either Electric, Coal, or Steam, or combinations thereof.

Southern-Rome Marine Berths

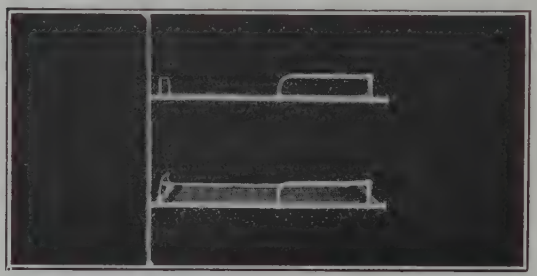
Durability, Variety, Economy

Southern-Rome equipment is constructed not only to meet the fullest requirements of sanitation and comfort, but also, by special emphasis on strong materials, malleable fittings and a spring fabric with a special "give", to overcome hard usage, side sway and end sway.

Southern-Rome berths are built on these fundamentals, with models covering all possible cabin and deck conditions.



No. 30 is a handsome Southern-Rome first cabin model, built for double bulk-head installation. It is so constructed that the complete upper berth can be fastened back against the wall.

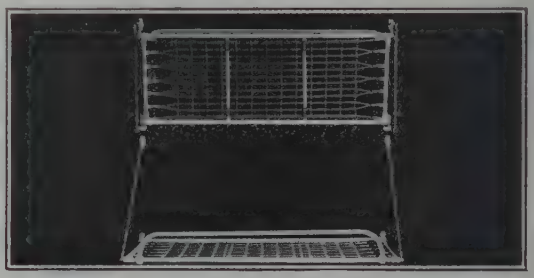


No. 180 Southern-Rome berth is a popular berth for second cabin use with a single rise lee-rail and foot-rail; for bulk-head and standee support, or double bulk-head installation.

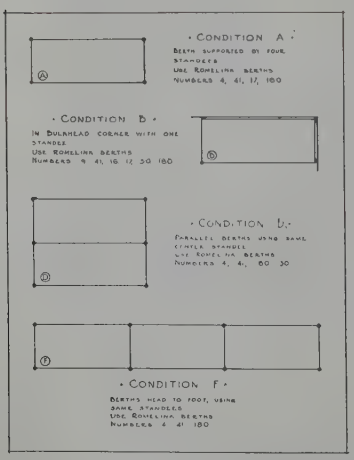
All Southern-Rome berths are intelligently designed and constructed. Their staunchness makes for long life, and consequently, for ultimate economy.

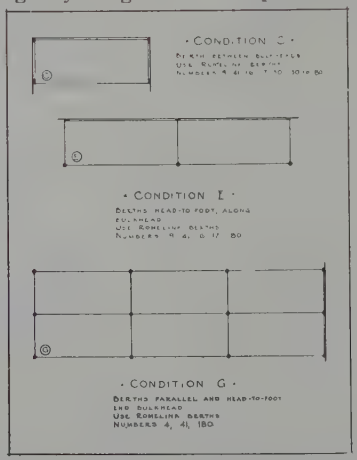
But the Southern-Rome engineers designed them for comfort, too. Whether above or below deck, in cabin or quarters, the word "Southern-Rome" means complete satisfaction.

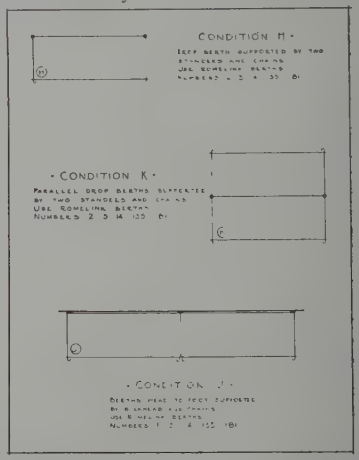
With Southern-Rome No. 4 steerage and crews' berth there is no rattle, side sway or end sway. It withstands strain and rack from all directions.



Below deck, where space is essential, nothing equals No. 31 berth, because it occupies minimum space, is absolutely sanitary and will outlast other equipment. The endurance of the malleable fittings and the well known Rome Link spring fabric is especially noticeable in comparison with the ordinary berth.


• CONDITION A •
BERTH SUPPORTED BY FOUR STANDEES
USE ROMELINK BERTHS
NUMBERS 4, 41, 17, 180
• CONDITION B •
IN BULKHEAD CORNER WITH ONE STANDEE
USE ROMELINK BERTHS
NUMBERS 4 41 16 17 30 180
• CONDITION D •
PARALLEL BERTHS USING SAME CENTER STANDEES
USE ROMELINK BERTHS
NUMBERS 4, 41, 180 30
• CONDITION F •
BERTHS HEAD TO FOOT, USING SAME STANDEES
USE ROMELINK BERTHS
NUMBERS 4 41 180


• CONDITION C •
USE ROMELINK BERTHS
• CONDITION E •
BERTHS HEAD-TO FOOT, ALONG BULKHEAD
USE ROMELINK BERTHS
NUMBERS 4, 41, 17, 180
• CONDITION G •
BERTHS PARALLEL AND HEAD-TO-FOOT END BULKHEAD
USE ROMELINK BERTHS
NUMBERS 4, 41, 180


CONDITION H •
USE ROMELINK BERTHS
• CONDITION K •
PARALLEL DROP BERTHS SUPPORTED BY TWO STANDEES AND CHAINS
USE ROMELINK BERTHS
NUMBERS 2 3 14 35 81

BERTHS	BEDSTEADS
First Cabin, Nos. 30, 130, 140, 150, 160, 170. Second Cabin, Nos. 9, 16, 17, 130, 140, 150, 160, 170, 180. Officers, Nos. 130, 140, 150, 160, 170. Crew and Steerage, Nos. 1, 2, 3, 4, 14, 31, 35, 41, 181. Hospital, Nos. 9, 35.	First Cabin and Officers, Nos. 286-6, 2320. Crew and Steerage, Nos. 9, 157-2, 361.
	SPRINGS
	De Luxe, Liberty, Rome Link, Nos. 40, 42.

Ship Repairs

Repairing and Overhauling

The Wm. J. Kennedy Company are specialists in repairing and overhauling the mechanical equipment of steam, motor, or turbine driven vessels. The work also includes ordinary trip repairs in the engine, deck and passenger departments, the reconstruction of passenger vessels heretofore used as troop or freight carriers, the fitting up of freight vessels for the carriage of cattle or horses, and alterations in deck structures.

Location

The plant, located a stone's throw from the famous Chelsea Piers, New York, covers over fifty thousand square feet of space. Our situation affords easy access to the entire North and East River fronts, thus eliminating loss in traveling time to and from the ships which are undergoing repairs.

Personnel

The majority of the Foremen connected with the Wm. J. Kennedy Company are fully certificated Marine Engineers, who have had many years of training in marine repairs and the reconditioning of vessels. The rank and file comprise skilled mechanics, competent to handle repair jobs of any size. The plant employs:

Plumbers
Pipefitters
Electricians
Pipecoverers
Engineers
Patternmakers
Carpenters
Machinists
Boilermakers
Blacksmiths
Coppersmiths
Electric Welders
Acetylene Welders
Sheetiron Workers

Each department is fully stocked with all fittings and materials appertaining thereto.

Shop Facilities

The Machine, Boiler and Blacksmith Shops contain sixty machines, ranging from the small drills and lathes to mammoth boring mills and power hammers. Each machine has been especially selected for the type of work to be done. Our low overhead costs enable us to quote rates which will be found to compare very favorably with those of other contractors or shipyards in the port. Quotations on contract jobs, or on the cost plus basis, will be furnished cheerfully.

Reliability

The Wm. J. Kennedy Company was organized fourteen years ago, and has constantly grown and enlarged its scope until it now numbers among its patrons the following:

International Mercantile Marine Lines
The United States Navy Department
The United States Shipping Board
The Army Transport Service
The Hudson Navigation Co.

and other representative steamship companies in the port of New York.

The Kennedy Fusible Plug

We manufacture and market the Kennedy Fusible Plug for marine boilers, inside or outside type, in any of the desired sizes. These plugs have been used on the largest ocean steamers continuously for a dozen years, and have never failed to give full satisfaction. Only the finest grade of Banca Tin enters into their composition. This article is made under the supervision of the U. S. Steamboat Inspection Service.

The Kennedy Cylindrical Liferaft

The Kennedy Cylindrical Liferaft is built to accommodate from 12 to 25 persons. It is of standard form and shape, carefully made, and can be supplied with or without the equipment required by law. The prices of these rafts will be furnished upon application and will be found attractive. The liferafts are also made under the supervision of the U. S. Steamboat Inspection Service and bear their stamp of approval.

THE WM. J. KENNEDY COMPANY

518-524 WEST 22nd ST., NEW YORK, N. Y.

Marine Supplies

Main Store of Geo. B. Carpenter & Co.

Variety of Product

Geo. B. Carpenter & Co. manufacture and deal in Marine Hardware and Supplies for vessels of all classes. Among the many specialties which can be furnished are:—

Deck Fittings
Cabin Fittings
Engine Room Fittings
Rigging Equipment
Nautical Instruments
Engine Accessories
Auxiliary Machinery
Naval Stores
Iron Pipe
Pipe Fittings
Carpenters' Tools
Machinists' Tools
Engineers' Tools
Blacksmiths' Tools
Bolts, Nuts and Washers
Rivets
Paints, Oils and Greases
Sails
Hatch Covers
Canvas Ventilators
Paulins
Canvas Goods of all kinds for Marine Use

and other Ship's Requirements in great variety

Besides the products mentioned above, some of which are shown on the following page, Geo. B. Carpenter & Co. furnish all material (with the exception of lumber) for the building and equipment of gasoline motor boats, sailing yachts, work boats, etc., description and prices of which are shown in a special catalog devoted to everything pertaining to small craft.

Quality of Product

The policy which has guided Geo. B. Carpenter & Co. from the start in the selection of goods has been to consider them from the users' standpoint; suitability to their purpose and durability being placed above salability.

The foundation of their business was in the line of vessel supplies and ship chandlery. This has been extended to cover the needs of contractors, railroads and municipalities. In all of these channels their goods are expected to protect the life and limb of the users. It is self-evident, therefore, that unreliable or inferior goods will not be sold or recommended by them under any conditions.

From the beginning their ideal has been to progress through service to their customers, doing this not only by the distribution of goods but by being ready to give expert advice in regard to the suitability of their articles to the buyers' needs and in all transactions making the satisfaction of their customer their sole object. Their great growth and popularity has demonstrated that their policy is the only one to stand the test of time.

Deliveries

The large storehouses of Geo. B. Carpenter & Co. permit maintaining large stocks on all standard equipment and insure prompt shipment of practically all orders of ordinary size. The central location of these storehouses in Chicago also reduces the time required to ship to all parts and permits the quick delivery desirable in all cases and particularly necessary in urgent cases. Quick delivery is also facilitated by the location of warehouses on a belt line railroad connecting with every line leading from Chicago.

Service

Geo. B. Carpenter & Co. have made a specialty of marine supplies for eighty years and offer the services of a corps of experts experienced in each of the general types of equipment supplied. Information and assistance will gladly be furnished on the most improved rigging practice, best method of mixing and applying paints, etc., for various purposes, the selection of complete cabin and lavatory outfits, and on any other equipment herein described.

Sails

Sailmaking for eighty years has been a strong department of this firm. They are well and favorably known in this line all over the world.

Their foremen are all men of long practical experience and they employ none but the most skillful sailmakers to be found in the country.

They have supplied sails and canvas work to the principal ship building companies of the U. S. for many years.

In addition to Sails of all kinds, they furnish:—

Hatch Covers
Deck Awnings
Canvas Ventilators
Paulins

Canvas work of every description for marine use.

A View of Our Main Sail Loft

Flags and Flag Signals

A large variety of Flags is made by this firm who manufacture nothing but the highest grade made of the most durable material. They specialize in Flag Signals for boats of all kinds. Among the various types of flags which can be furnished are the following:

United States Flags
United States Pennants
United States Ensigns
United States Jacks
Special Flags
Night Pennants
Tell Tale Flags
Plain Burgees
Fancy Burgees
Yacht Club Signals
Officers' Flags
Private Signals
Weather Signals
International Signal Flags

All the necessary equipment for flying these signals can be furnished, including

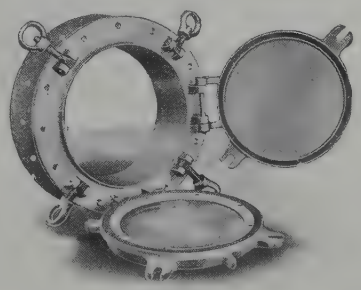
Flag Poles
Flag Pole Balls
Signal Bags
Flag Staff Brackets
Upright Flag Staff Sockets
Flush Flag Staff Sockets

Rigging

As a kindred line to sail-making, Rigging has also received a large share of attention. Carrying as they do an immense stock of Wire Rope, Geo. B. Carpenter & Co. are splendidly equipped to furnish rigging for craft of all sizes. Their riggers are experienced men in all kinds of work and all of their product displays workmanship and skill of a high order.

Air Ports

In addition to the immense stock of Ship's Fittings which they carry in stock as dealers, they manufacture Air Ports in all sizes and styles with many other items of Marine Hardware. Their Air Ports are approved by the U. S. Shipping Board and have been supplied in large



Air Ports

quantities to the Emergency Fleet Corporation and the leading shipyards. Among other items of Cabin Fittings produced by them may be mentioned the following:—

Ship Locks
Ship Knobs
Chest Locks
Ship Bolts
Transom Centers
Ring Bolts
Berth Catches
Sash Fasteners
Chest Handles
Deck Lights
Cabin Ventilators
Eye Bolts

They also have on hand one of the largest stocks of Ship's Plumbing, Water Closets, Bath Room Outfits, etc. They issue a large and complete catalog of Vessel Equipment which is sent free on application.

GEO. B. CARPENTER & CO., CHICAGO, ILL.

S. S. Defiance in Upper Dry Dock

Three Complete Shipbuilding Plants

The three plants of the Baltimore Dry Docks & Ship Building Co. contain the most up-to-date facilities for building high grade steel ships. This company has seven shipways for building steel vessels up to 12,500 D. W. tons, such as cargo carriers, oil tankers, refrigerator ships, barges and tugs. The 62,000 ton refrigerator ship "South Pole" which was built in forty days, during the war, established a world's record in construction for steel ships of this type.

These plants are also equipped for handling quick and efficient repairs of all kinds on various types of steel and wood ships at moderate cost.

The company also rebuilds steel and wood passenger ships. One of the most notable contracts of this kind covered the recent rebuilding of the passenger steamer "Midland" that had been burned to the water's edge.

Repairing, Rebuilding, Reconditioning

The Company's three plants are ideally located in the heart of the shipping district, within easy reach of all ships in Baltimore Harbor. The repair facilities include completely equipped shops such as blacksmith, boiler, carpenter, joiner, paint, copper, etc.; also shear legs, traveling cranes and stiff leg derrick.

With these facilities and the company's efficient organization, many difficult repair jobs have been completed in record time. The Standard Oil tanker "F. Q. Barstow," which had been badly damaged by fire, was repaired in 64 days—one day ahead of the contract time. The shortest time that the next competitor had specified in the bidding was 130 days.

The Baltimore Dry Docks & Ship Building Co. is also busily engaged in reconditioning a large number of vessels that were used as troop ships during the war. These ships are being reconverted into cargo carriers. Some of these ships recently reconditioned are the "Eurana" and "Lancaster" of the Green Star Line, the "Edward Luckenbach," "Julia Luckenbach," "K. I. Luckenbach," "F. J. Luckenbach," and "Edgar Luckenbach" of the Luckenbach Steamship Company; the "Texas" and "Ohioan" of American Hawaiian Line, the "Geo. H. Jones" and the "Philippines."

Most of these contracts were awarded in New York and Boston, and nearly all of these ships were towed from those ports to the yards of the Baltimore Dry Docks & Ship Building Co. at Baltimore. At times there are as many as 30 to 35 vessels undergoing repairs by this Company.

Dry Docks and Marine Railways

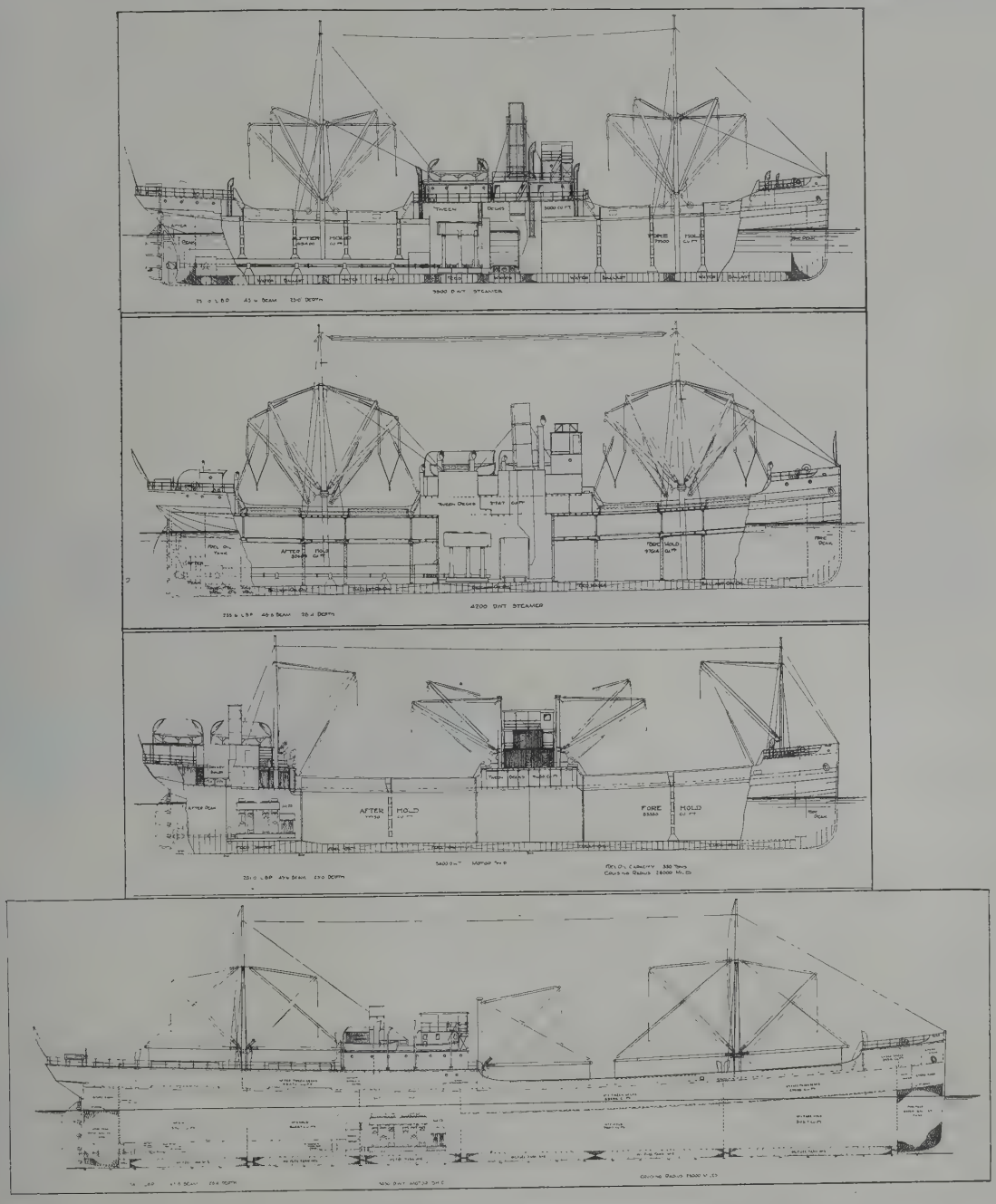
The dry dock at the Upper Plant is 610 feet long and will accommodate the largest ship entering Baltimore. This dry dock is served by two traveling cranes having exceptionally lengthy booms.

The dry dock at the Lower Plant is 437 feet long and is served by four traveling cranes which operate on both sides of the dock.

Two marine railways are located at the Upper Plant where smaller ships may be hauled out for repairs.

THE BALTIMORE DRY DOCKS & SHIP BUILDING CO.

BALTIMORE, MD., U. S. A.



Products

The Manitowoc Shipbuilding Company specializes in the design and construction of ocean going steam and motor ships. Passenger vessels, Freighters, Sand Suckers, Dredges, Floating Cranes, Lighters, Fire Boats, Tugs and Dump Scows are among the other types of boats which the Manitowoc Shipbuilding Company builds.

Marine Engines, Semi-Diesel Engines, Boilers, Deck and Auxiliary machinery are also designed and built by this company.

Plant and Facilities

The plant of the Manitowoc Shipbuilding Company is located on the Manitowoc River, Manitowoc, Wisconsin, and consists of ways, drydocks and outfitting berths, in addition to machine, blacksmith, electrical, tin, joiner, pipe and coppersmith shops; angle furnace, oakum shed, etc. In other words, the Manitowoc Shipbuilding Company possesses all the facilities and equipment necessary to maintain a modern shipyard that handles all classes of work.

MANITOWOC SHIPBUILDING COMPANY

MANITOWOC, WISCONSIN

Dry Docks

Types of Dry Docks

Modern dry docks are of three types, basin or graving docks, floating docks, and railway dry docks. Each type has its special merits and objections. Basin docks, due to their high first cost and costly operation, are almost exclusively government built. Floating docks and railway dry docks are the leading commercial types of to-day. Floating docks are built in the following types: single pontoon or box type, sectional type, and separate pontoons with single wing type, with various modifications as to details, of steel, wood, or composite construction. Railway dry docks are built in two types, end haul and side haul, and are constructed of steel, wood, concrete, and composite.

Floating Dry Dock

The choice of a dry dock for any particular location and repair yard requires study into the nature of the site, type of vessels to be handled, proximity to building materials, etc. If possible, competent engineers familiar with all types of dry dock design, should be consulted.

Trussed Sectional Floating Docks, Patented

The Crandall Engineering Company has developed a longitudinally-trussed floating dock which has some very interesting features. The great objection to the sectional floating dock has been its excessive flexibility which caused undue stress and strain in vessels being docked. This new type is self docking and at the same time is designed with truss panels in the wing walls of each section. When the sections are joined together these panels form a longitudinal truss in each wing and a stiff backbone for the dock. The transverse members are simple, determinate structures assuring a minimum of material compatible with proper strength, indicating a lower cost and a greater lifetime. This dock well merits the phrase "built like a bridge."

The control of the pumping machinery is centralized at the head of the dock.

Railway Dry Docks

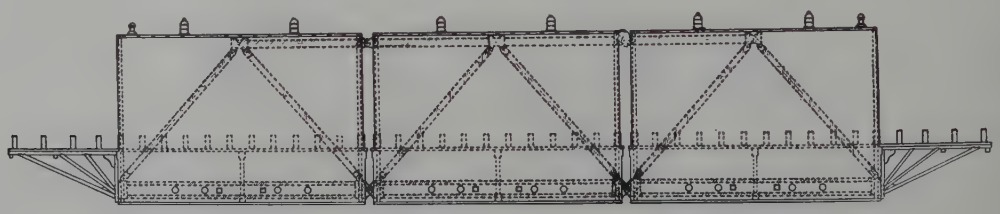
Crandall Railway Dry Docks are the result of long experience in designing dry docks for all types and classes of vessels. These docks should not be confused with the old type of marine railways, for they are similar only in principle. These old types lifted the forward end of the vessel a considerable distance out of the water before the keel at the after end had grounded on the blocks thereby causing considerable distortion and undue stress to the vessel. Crandall Railway Dry Docks lift vessels from the water on practically an even keel thus overcoming the above objection.

Railway Dry Dock

Railway dry docks cost less to build than any other type and the cost of operation and maintenance is much lower.

Dry Dock Engineers

In 1854 the Crandalls entered the field of dry dock design and construction. During the 65 years since that time they have made a specialty of engineering in this particular field. To-day the records of The Crandall Engineering Company show that over 140 dry docks of their design are now in operation in the various ports of the world.



Longitudinally Trussed Sectional Floating Dry Dock—"Built Like a Bridge"

THE CRANDALL ENGINEERING CO.

EAST BOSTON, MASS.

Shipyard Economists

Cost Accounting

Proved and Controlled Costs are vital to the continued success of any shipyard. A system such as installed by Alabama Dry Dock and Shipbuilding Co., of Mobile, Ala., gives the monthly cost of Materials Used, of Direct Labor, and of Overhead Burden. It gives the total Cost of Production and Collectible Charges for the month, the Profit or Loss for the month, and the consequent condition and trend of the business. It insures that no charges will be omitted from the bills, and also provides information leading to reduction in costs and expenses.

The same general methods are, of course, applicable to any business, and have been thoroughly tried out and found successful in every line of manufacture.

Industrial Engineering

In many shipyards, as in every line of manufacture, money is being literally thrown away daily. This condition was perhaps unavoidable in shipbuilding during the hurry and stress of the past period, but the time has now arrived when it is not only advisable, but necessary, to give more attention to the feature of efficiency. A great deal can be accomplished in this respect by engineers who have had long experience in creating more direct methods of routing production and handling materials; in organization of working forces; in methods of paying labor and encouraging and rewarding effort; in carrying along manufacture on definite pre-determined plans and schedules. These methods have been applied with results, sometimes almost unbelievable, in every line of manufacture. Properly applied, it means you increase output and you increase wages, but you reduce costs, and create a new spirit of co-operation and content throughout the plant.

Appraisals

The value of an Appraisal giving more information than the old standard, and made on entirely different bases, becomes evident from a study of Treasury Department Regulations regarding Depreciation and Invested Capital. Only an engineer can make the Appraisal; only an Accountant can understand its practical application.

It demands a combination of the two to obtain the full benefit of the Regulations.

Any shipbuilding company contemplating disposing of its business should also have the Engineering Appraisal.

Audits

The determination of Earnings, Expenses and Taxable Income, as well as Invested Capital, and the preparation of Tax Returns is essentially the work of the Auditor. It is his function also to determine the accuracy of records, the suitability of methods, and the effectiveness of the organization.

Further, defalcations usually occur in the most unexpected quarters, and the audit will determine how justly confidence has been placed in officials and employees.

Plant Design and Construction

Too much construction has been made without proper study of its exact and ultimate use. The result has been that the plant has had to be fitted into the buildings as best it could.

The modern way is to employ a firm which can furnish skilled engineers to first lay out the plant, determine every requirement, and then house the plant accordingly.

This is the only way to make sure the building will be permanently useful.

COOLEY & MARVIN CO., BOSTON, MASS.

Index to the Catalog Section

In the pages following, the Catalog Section is indexed by three methods.

1. Alphabetical Index of Catalogs.

In this the names of the firms represented in the Catalog Section are listed alphabetically, with the page numbers on which their catalogs appear.

2. Trade Name Index.

Here are listed, in alphabetical order, the distinctive Trade Names of the various products shown in the Catalog Section. After each name is given the manufacturer of the product, with the page numbers in the Catalog Section where the product is described.

Many products are better known by their Trade Names than by the firm name of the manufacturer. The purpose of this Trade Name Index is to identify such products, where the manufacturer is not immediately identified by the Trade Name.

3. Directory of Products.

In this index there is given, alphabetically arranged, a list of the products of the firms whose catalogs appear in the Catalog Section. Beneath each product are given the names of the firms manufacturing it, with page numbers.

Where it does not conflict with usage, the article is listed under the main noun. For example, Oil Engines are listed under Engines, Oil. Numerous cross-references are also included to facilitate the use of this directory.

The Definition Section, appearing first in the book, also serves as a combined index to the Text and Catalog Sections. Because of the fact that it gives simultaneously both installation and detailed information on specific equipment, the Definition Section will usually be the most convenient index.

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